(No Model.) 3 Sheets—Sheet 1.

G. H. GRAHAM.

ROTARY ENGINE.

No. 494,138. Patented Mar. 28, 1893.

Fig. 1.

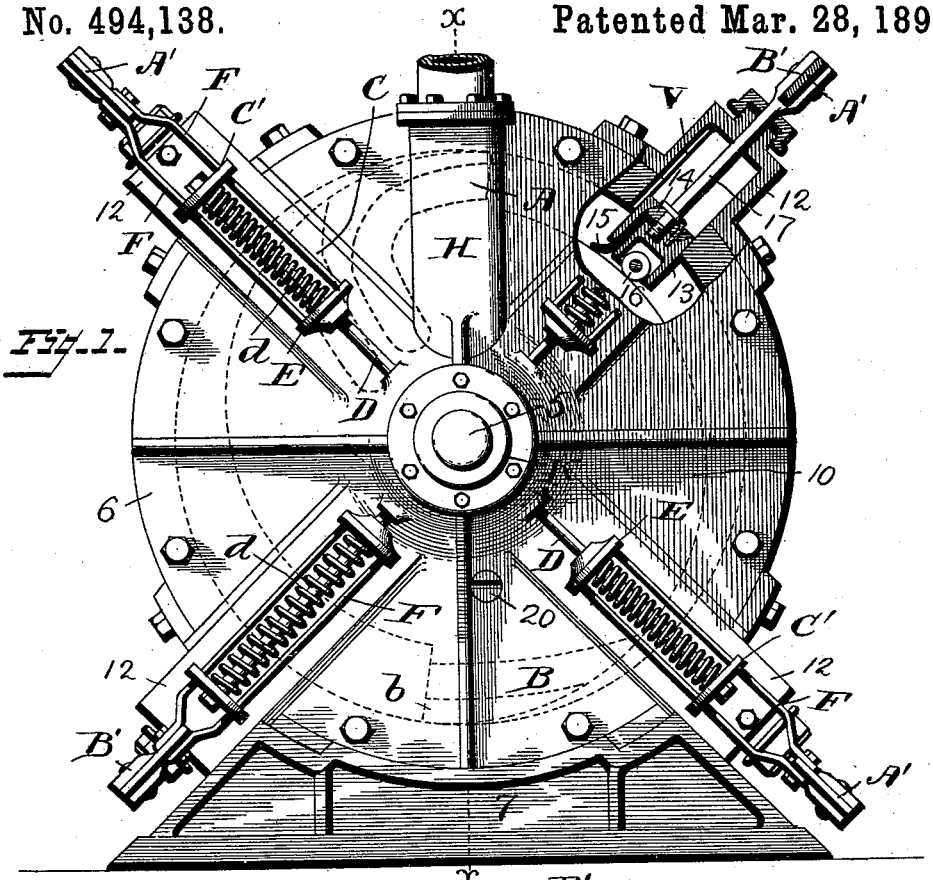
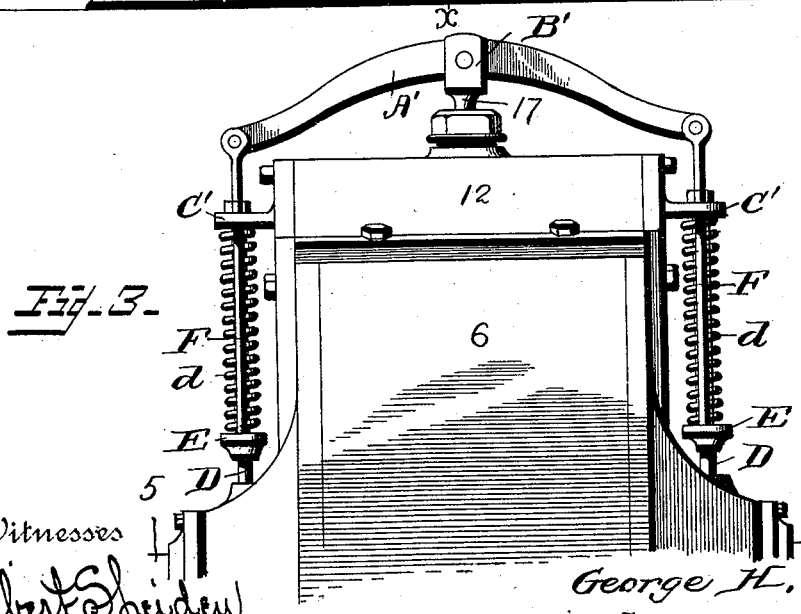


Fig. 3.



Witnesses
Albert Speiden
Van Buren Hillyard.

Inventor
George H. Graham.
By his Attorneys
R.S.& A.P.Lacey

(No Model.) 3 Sheets—Sheet 2.

G. H. GRAHAM.

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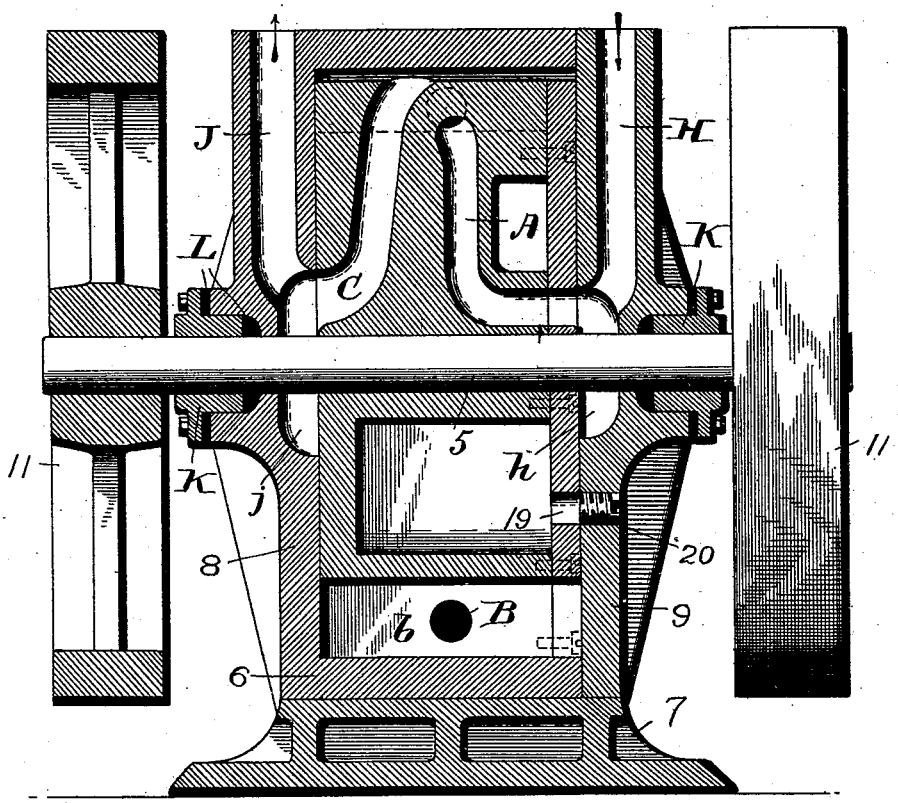

Fig. 2.

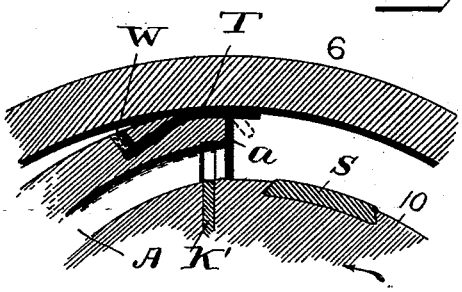

Fig. 5.

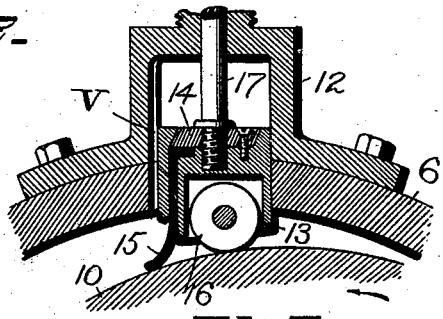

Fig. 7.

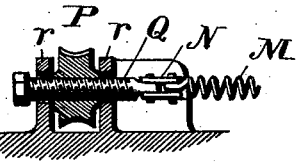

Fig. 6.

Witnesses

Albert Spieden.

Van Buren Hillyard.

Inventor

George H. Graham.

By his Attorneys

R. O. & A. P. Lacey.

(No Model.) 3 Sheets—Sheet 3.

G. H. GRAHAM.

ROTARY ENGINE.

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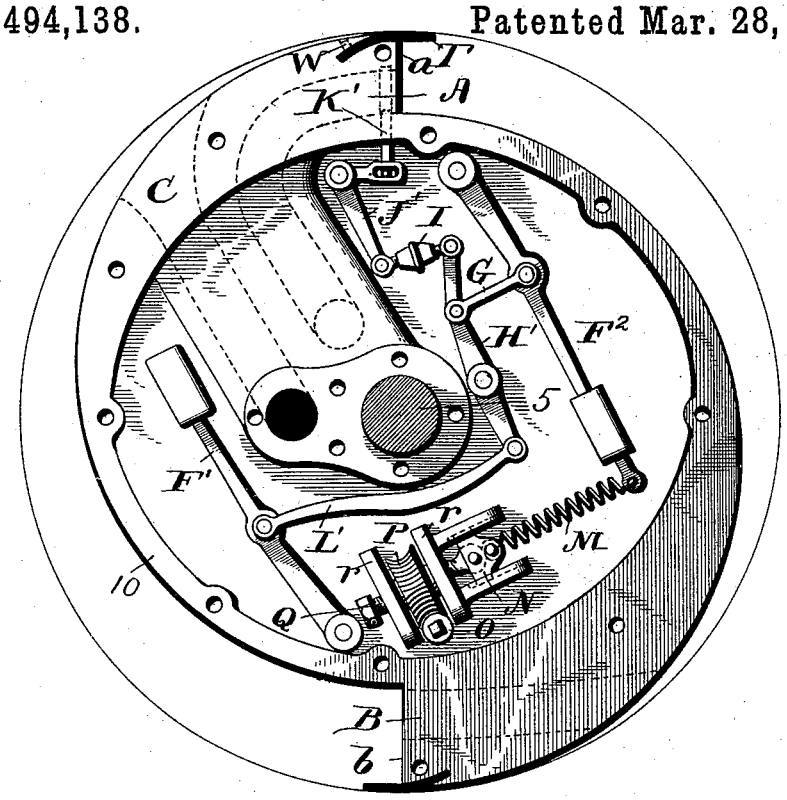

Fig. 4.

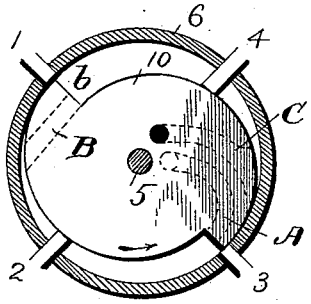

Fig. 8.

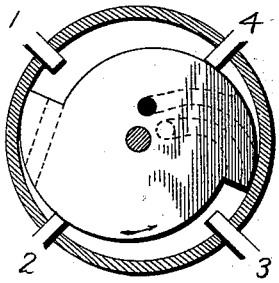

Fig. 9.

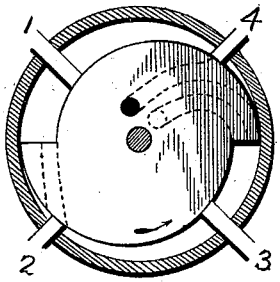

Fig. 10.

Witnesses
Albert Speidel.
Van Buren Hillyard.

Inventor
George H. Graham.
By his Attorneys
R.S. & A.P. Lacey

UNITED STATES PATENT OFFICE.

GEORGE H. GRAHAM, OF RIDGELAND, ILLINOIS.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 494,138, dated March 28, 1893.

Application filed April 18, 1892. Serial No. 429,637. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. GRAHAM, a citizen of the United States, residing at Ridgeland, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Rotary Engines; and I do hereby 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.

This invention relates to rotary engines; and has for its object to provide a compound or double expansion rotary engine, which will be simple in construction, efficient, and utilize the double expansive force of the steam to the best possible advantage.

A further purpose of the invention is the provision of instrumentalities for conveniently altering the force of resistance of the governor to change the speed of the engine, said instrumentalities being located within the piston and operated through an opening in the head of the casing which opening is closed by a screw plug or other convenient means of closure.

A still further purpose and the primary object of the invention is the improvement of the general construction of this class of engines, whereby their usefulness and efficiency are increased to an eminent degree.

The improvement consists of the novel features and the peculiar construction and combination of the parts which will be hereinafter more fully described and claimed and which are shown in the annexed drawings, in which;

Figure 1 is a side elevation of an engine embodying my invention, parts being broken away to show the roller valve and its casing. Fig. 2 is a section about on the line X—X of Fig. 1 looking to the right, showing the steam inlet and exhaust ports in the piston in full. Fig. 3 is a front view of a valve casing and the mechanism for controlling the valve, showing the relation of the same to the cylinder of the engine. Fig. 4 is a side elevation of the piston, the cap plate being removed, showing the governor. Fig. 5 is a detail view of the primary head of the piston on a larger scale. Fig. 6 is a detail view of the governor setting mechanism. Fig. 7 is a detail view of the roller valve and its casing. Figs. 8, 9 and 10 are diagrammatical views, showing the relation of the valves and the piston heads.

The cylinder 6 mounted on the bed or base 7 is closed at its ends by the heads 8 and 9 which are centrally apertured to receive the shaft 5 to which the piston 10 is secured and to which the balance wheels 11 are fastened. The bearings K for the shaft 5 are bolted to the cylinder heads and may be of any desired form. The packing L confined between the bearings and the said heads, prevents leakage of steam. The steam inlet passage H is formed in the head 9 and communicates with an annular chamber *h* on the inner side of the head and surrounding the shaft 5. The steam exhaust passage J provided in the head 8 communicates with the annular chamber *j* formed in the inner side of the said head and surrounding the shaft 5. The steam inlet passage A in the piston communicates with the annular chamber *h* and extends through the primary head *a* of the piston. The exhaust passage C leading into the annular chamber *j* extends through the peripheral surface of the piston just in the rear of the primary piston head. The secondary piston head *b* located diametrically opposite the primary piston head *a* is constructed to present considerable more surface for the action of the steam than the primary piston head, being deeper. A passage B formed tangentially through the piston extends through the head *b* and through the periphery of the piston just in the rear of the said head. The steam after its primary expansion, escapes through the said passage B to be expanded a second time.

The cylinder is provided with four radially disposed valves which are disposed at an equal distance apart around the said cylinder, and which are adapted to slide within casings 12 bolted to or otherwise provided on the said cylinder. The valve heads 13 are recessed on their inner faces to receive rollers 16 which are designed to travel on the piston and relieve friction, and with a slot in one side in which is fitted a packing strip 15, the same preserving a close joint between the valve and piston. The outer face of the head 13 is depressed to receive a plate 14 which overlaps the outer portion of the packing strip 15 and which is held down at one edge by a scarf joint and bolted to the head at the other

edge. The valve stem 17 passes through the plate and screws into the valve head, having a shoulder just above the plate 14 to rest thereon and assist in securing the said plate. The valve head fits snugly within the casing 12 and to equalize the outward pressure on the inner face thereof, passages V are provided in one side of the casing for the escape of steam to the outer side of the said valve head. This construction admits of the valve head being essentially a balanced valve. A lever A′ is pivotally connected between its ends to the head B′ of the valve stem 17, and its ends has a spring connection with the cylinder heads. The heads have lugs C′ near their periphery, through which rods D are inserted and secured at their inner ends by being screwed into the hub portions of the said heads. Heads E are mounted to slide on these rods and are connected with the ends of the lever A′ by rods F F which pass through suitable openings in the lugs C′. The springs *d* mounted on the rods and confined between the lugs C′ and the heads E press the said heads E toward the center of the cylinder and through the rods F F draw the levers A′ in and press the valves close against the piston. A packing strip T is inserted in a channel just in the rear of a piston head and is held therein by binding screw W. The front edge of this strip projects sufficiently far in front of the piston head to preserve a steam tight joint between the piston and the cylinder. A packing or cushion S is provided in the depressed portion of the piston front of the piston heads to receive the blow of the valve and prevent noise and unnecessary wear. The valve the instant it leaves the head, strikes the piston in front of the said head a smart blow. The cushion is provided to relieve the force of the blow. The packing may be of any suitable material and may be laminated or in one piece and is secured to the piston in any convenient manner, preferably by being sprung into a recess formed therein and having under cut edges. The piston is hollow being open on one side which side is closed by a removable cap 19 which is bolted thereto, and receives the governor and the mechanism for setting the governor to control the speed of the engine.

The gate K′ for controlling the inlet port A is connected with a bell crank lever J′, which is connected with the long arm of the equalizing lever H by connecting rod I which is adjustable to change the relation of the gate or cut off K′ to the port A. The weighted levers F′ and F² approximately parallel with each other and with the equalizing lever H′, are pivoted at diametrically opposite points and extend in opposite directions on each side of the shaft 5 and are connected with the equalizing lever by the links L′ and G, respectively. The spring M for controlling the action of the governor, is connected at one end for the sake of convenience to the weighted lever F² and at its other end to a head N which is adapted to slide between parallel ribs X. A threaded rod Q is connected with the head N and passes through two lugs *r r* between which is confined a nut P threaded to correspond with the thread of the said rod Q on which it is mounted, and having a worm gear to mesh with the worm shaft O which is parallel with the shaft 5. The outer end of the worm shaft O is countersunk in the cap plate 19 so as to come flush therewith and is constructed to be engaged by a suitable instrument to be rotated thereby to turn the nut P and move the rod Q in its bearings so as to increase or diminish the tension of the spring M. The head 9 is provided with an opening opposite the worm shaft O which is closed by a screw plug 20 to admit of access to the said shaft for changing the force of resistance of the governor. After the governor has been properly regulated the engine will run at a uniform speed. As the free or weighted ends of the levers F′ and F² fly out the cut off will be projected across the steam port A and shut off the steam and as they move toward the center the cut off will be withdrawn so as to open the port A wider and admit more steam to the engine. The live steam enters passage H, annular chamber *h* and passes through the passage A into the cylinder. Suppose the valves 1, 2, 3 and 4 and the piston to be in the position shown in Fig. 8, the steam entering through port A exerts its expansive force against valve 2 and the primary piston head *a*. As the piston revolves, see Fig. 9 which shows the valves 1 and 3 partly closed for the sake of better illustrating the application of the invention, the high pressure is partly against valve 2 and the said valve 3, while the steam is expanding a second time between the secondary piston head *b* and the valves 4 and 1. When the piston reaches the position shown in Fig. 10 valves 1 and 3 are entirely closed, and the primary expansion is against 3 and secondary against valve 1, while between valves 2 and 3 is inclosed steam once expanded and between valves 1 and 4 steam twice expanded. On a farther rotation of the piston, the primary expansion is still against valve 3, while the once expanded steam from between valves 2 and 3 escapes through passage B and acts against valve 1 and the secondary piston head, while the twice expanded steam inclosed between valves 1 and 4 escapes through the exhaust port C.

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

1. In a rotary engine, the combination with the casing, a hollow piston located within said casing, and having one side arranged to work steam tight against a head of the said casing, and a governor located within the said piston, of a governor controlling mechanism located within the said piston and adapted to be reached through co-incident openings in the said steam tight fitting side of the piston

and the head of the casing, and a plug for closing the opening in the head of the casing, substantially as described.

2. In a rotary engine, the combination with the casing having a lateral opening in one of its heads, a hollow piston having one side open, and having the open side closed by a cap plate, said piston fitting steam tight between the heads of the casing and having an opening in said cap plate to register with a corresponding opening in a head of the casing, of a governor and a governor controlling mechanism located within said piston and the governor controlling mechanism adapted to be actuated through the said co-incident openings, and a plug for closing the opening in the casing head, substantially as described.

3. In a rotary engine, the combination with a casing, a hollow piston arranged to work in the said casing, and a governor placed within said hollow piston, of a spring connected at one end with the governor, a head connected with the other end of the spring and working in guides, and a mechanism for moving said head in the guides to vary the tension on the said spring adapted to be actuated through co-incident openings in a side of the piston and a head of the casing, substantially as set forth.

4. In a rotary engine, the combination with a hollow piston, and a governor located within the said piston, of a spring connected with the governor, a threaded rod attached to the said spring, a nut mounted on the said threaded rod and having a worm gear, and a worm threaded shaft to rotate the said nut to vary the tension of the said spring, substantially as and for the purpose described.

5. In a rotary engine, the combination with a piston having a steam inlet port A formed therein, and a cut off to control the said port, of weighted levers, one on each side of the axis of the piston, an equalizing lever connected with the said weighted levers, and connections between the said cut off and the said equalizing lever, substantially as described.

6. In a rotary engine, the combination with a piston having a steam inlet port A formed therein, and a cut off to control the said port, of weighted levers, one on each side of the axis of the piston, an equalizing lever, the three levers being approximately parallel and links connecting the weighted levers with the equalizing lever, a bell crank lever connected with the cut off and an adjustable connecting rod between the said bell crank lever and the equalizing lever, substantially as described.

7. In a rotary engine, the combination with a piston having a steam inlet port A formed therein, and a cut off to control the said port, of weighted levers, one on each side of the axis of the piston, an equalizing lever, the three levers being approximately parallel and links connecting the weighted levers with the equalizing lever, a bell crank lever connected with the cut off, an adjustable connecting rod between the said bell crank lever and the equalizing lever, a spring connected at one end with one of the weighted levers, and a tension controlling mechanism connected with the other end of the said spring, substantially as described.

8. In a rotary engine, the combination with a cylinder, and four valves equally disposed around the same, of a piston having a primary and a secondary head to use the expansive force of the steam twice, the secondary piston head being of larger area than the primary piston head to admit of the once used steam exerting a force on the said secondary piston head about equal to that exerted in the first instance on the primary piston head.

9. In a rotary engine, the combination with a piston having a primary and a secondary piston head, a steam passage being formed through the said secondary piston head, of a cylinder, and four valves equally disposed around the said cylinder, substantially as described.

10. In a rotary engine, the combination with a piston having a primary and a secondary piston head, a steam passage being formed through the said secondary piston head, the steam inlet port extending through the primary piston head, and having the exhaust port leading through the piston just in the rear of the said primary piston head, of a cylinder and four valves equally disposed around the said cylinder, substantially as described.

11. In a rotary engine, the combination with the cylinder having a casing, of a valve head 13 having a slot in one side and provided with a roller on its inner face, and having a depression in its outer face, a packing strip 15 inserted in the said slot, and a plate 14 fitted in the said depression and bearing down on the upper edge of the said strip 15, substantially as and for the purpose specified.

12. In a rotary engine, the combination with the cylinder having a valve casing, a radially working valve located in and having its stem working through the valve casing, and radial guide rods D exterior to and supported by the cylinder heads, of a lever A′ pivoted midway of its ends to the said valve stem, rods F connected at their outer ends with the ends of the pivoted lever A′ and guided in their movements by lugs on the sides of the cylinder heads, cross heads E mounted to slide on the rods D and connected with the inner ends of the rods F, and springs *d* mounted on the rods D and held between the said cross heads and the lugs, substantially as set forth.

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

GEORGE H. GRAHAM.

Witnesses:
FRANCIS L. GRAHAM,
HERMAN HAAS.