F. A. Calvert,

Rotary Steam Valve.

No. 43,568. Patented July 19, 1864.

Fig 2.

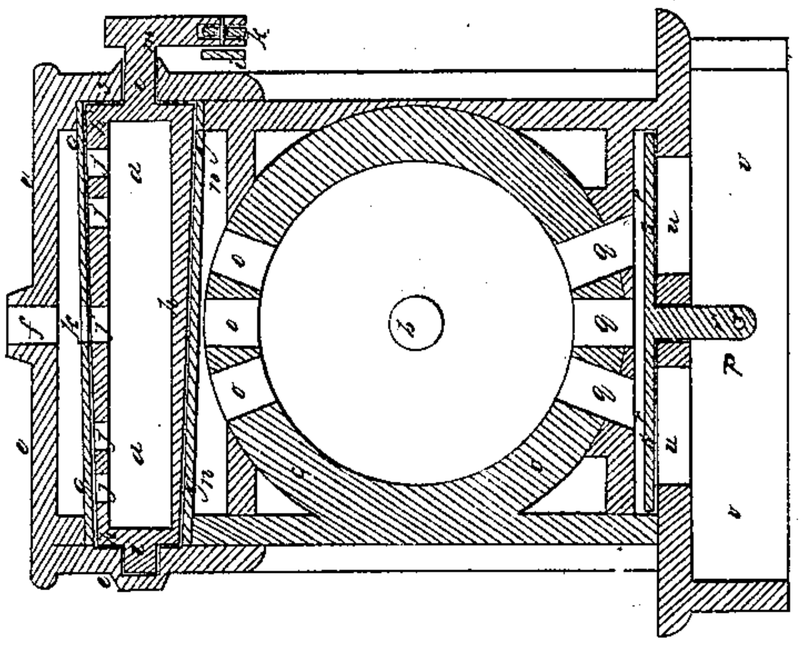


Fig 4.

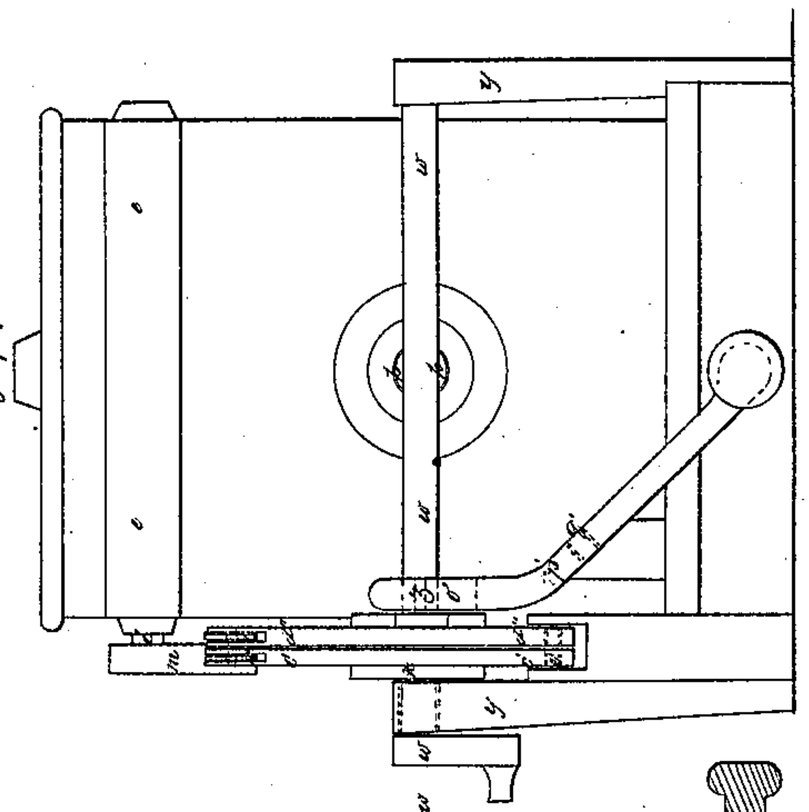


Fig 3

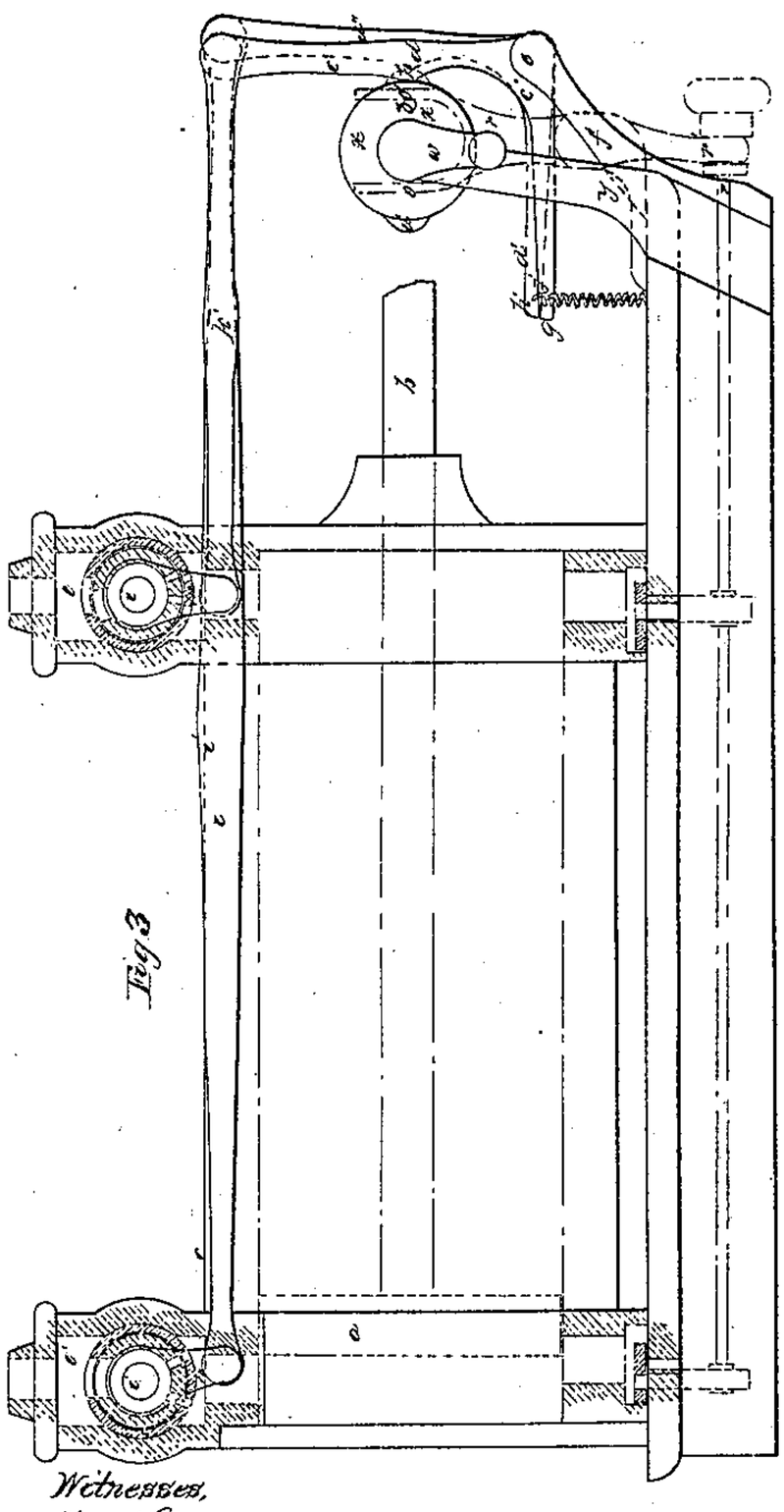
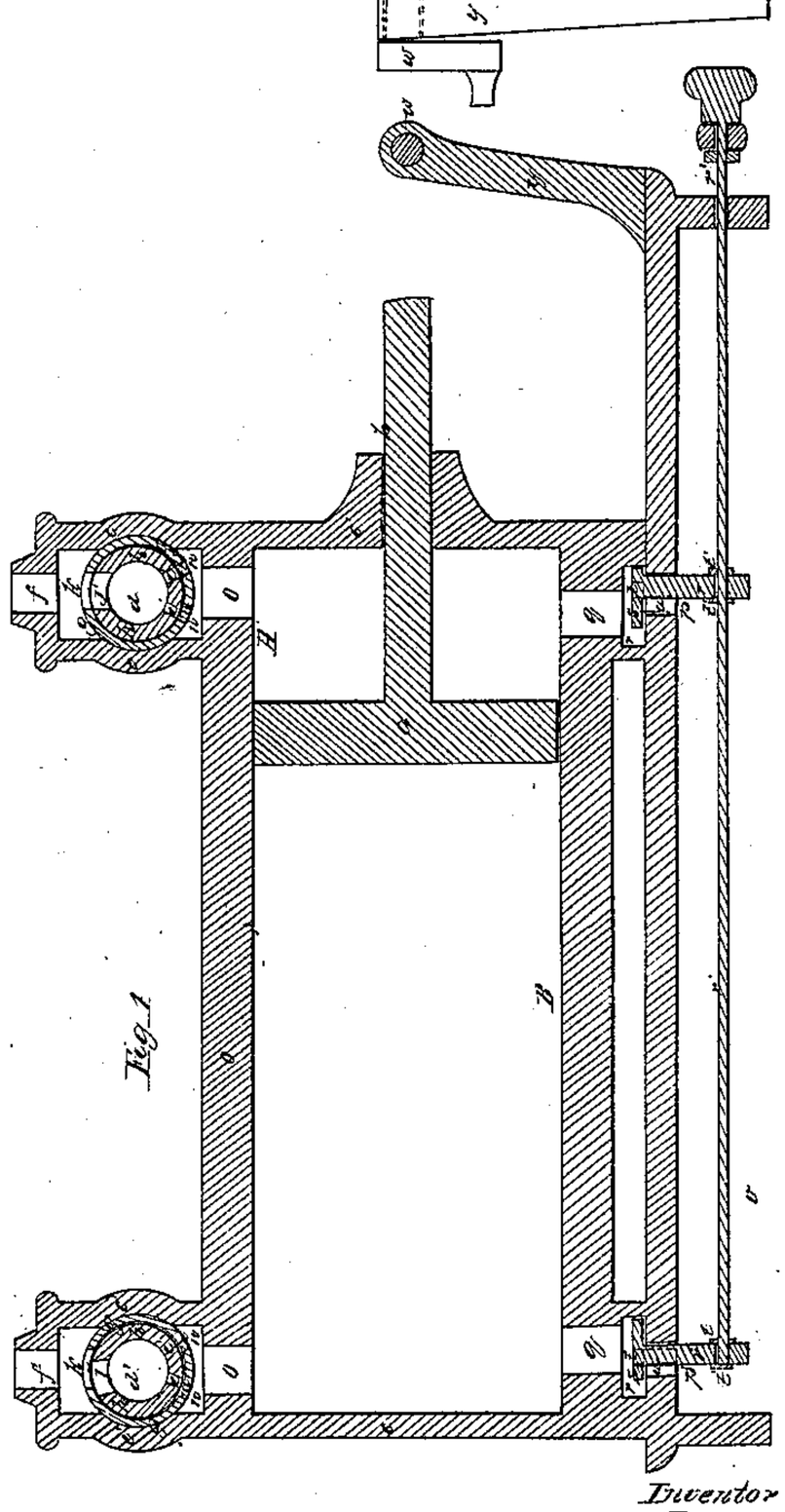


Fig 1



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UNITED STATES PATENT OFFICE.

F. A. CALVERT, OF LOWELL, MASSACHUSETTS.

IMPROVEMENT IN STEAM-ENGINES.

Specification forming part of Letters Patent No. **43,568**, dated July 19, 1864.

To all whom it may concern:

Be it known that I, F. A. CALVERT, of Lowell, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare that the following description, taken in connection with the accompanying drawings, hereinafter referred to, forms a full and exact specification of the same, wherein I have set forth the nature and principles of my said improvements, by which my invention may be distinguished from all others of a similar class, together with such parts as I claim and desire to have secured to me by Letters Patent.

In steam-engines as heretofore constructed it has necessarily followed, from the manner of working the steam and the arrangement of the parts with relation to each other, that the power—that is, the steam—should be applied at such a position of the piston as to overcome the more or less perfect vacuum which would otherwise be formed in the cylinder; but when a vacuum occurs in the cylinder the piston is at or near the end of its stroke, and consequently the crank of the engine is at or near its "dead-point" or center, where the least possible leverage can be obtained, and the piston in the most disadvantageous situation to receive an impetus from the steam. Thus, in high-pressure steam-engines the ports and valves for the admission and exhaustion of steam are generally so arranged as that the steam is admitted back of the piston while a full head of steam is yet acting in front of the piston. Thus a large percentage of the effective force of the steam has been unavoidably lost and the expense arising from the consumption of fuel increased accordingly, while the same difficulty has occasioned an unsteadiness and irregularity of motion, which has been only partially overcome by the momentum of the fly-wheel. The speed also at which an engine could be run has been limited from the same cause, because if impetus were given to the piston at very quick intervals by the frequent and sudden admission of steam, there would, as the case may be, either such wear and tear of the parts as to soon render the machinery inoperative or most of the power neutralized and a very limited useful effect obtained.

My invention has for its ultimate object the following desideratum—viz., the keeping of the piston evenly balanced, as it were—that is, always perfectly free and ready to receive an impetus from any force of steam that may be applied to it, at whatever part of its stroke it may be, without any counteracting or drawing-back power, caused by back-pressure or vacuum, acting upon it. I effect this result by supplying hot air or vapor to the cylinder just when the piston reaches the extreme end of the stroke, so as to allow the piston to move as freely back and forth as though it were loose in the cylinder, instead of being tightly fitted therein. This effect being produced, it will be evident that the full force of the steam can be instantly, and in any position of the crank of the engine, applied to the piston, or as suddenly cut off therefrom, without danger of giving too sudden a jerk thereto, so that steam can be admitted and cut off at any intervals of time, however short they may be, and at such pressure as the speed of the engine may require, and during such positions of the crank as will give the most leverage or effective force, this following from the fact that the piston is invariably in readiness to receive its blow or impetus at whatever point of its stroke it may be, a result which, previous to my invention, has never before been accomplished.

There are a variety of arrangements of mechanical devices by which the purpose of my invention may be accomplished; but in order that the operation of an engine constructed in accordance with my new improvements may be fully understood, I will now proceed to describe in detail one form of apparatus constructed upon my improved plan.

In the accompanying plate of drawings, Figure 1 is a central longitudinal vertical section of the steam chests, cylinder, &c., of a stationary engine. Fig. 2 is a transverse vertical section through one of the steam chests. Fig. 3 is a side view of the cylinder, steam-chests, &c. Fig. 4 is an end view of the steam-chest, &c., showing the mechanism for operating the induction and eduction valves.

a in the accompanying drawings is the piston; *b*, the piston-rod; *c*, the cylinder; *e* and *e'* steam-chests placed at opposite ends of the cylinder *c*. *d* and *d'* are induction-valves for

the admission of steam to the cylinder *c*, placed in the steam-chests *e* and *e'*, respectively.

The admission or steam-induction valves *d* and *d'* are constructed and arranged as follows: *f* is an aperture for the admission of steam from the boiler to the steam-chest, in which is placed, as before stated, the induction-valve.

g is a tapering cylindrical shell, firmly secured in the steam-chest.

h is a hollow tapering cylinder placed within the shell *g*, so as to turn freely therein upon bearings *i i*. In the cylinder *h* are apertures *j j* and *j'*, one of which, *j'*, communicates with the aperture *k*, formed in the shell *g*, when the two are in apposition, as represented in Figs. 1, 2, and 3. *l l l*, &c., are a series of apertures formed in the opposite side, or nearly so, of the cylinder *h* to the ports *j j* and *j'*, and which communicate with the ports *m m*, &c., of the cylindrical shell *g* when the valve is turned so as to admit of the same. The area of the apertures *l l l*, &c., in the bottom portion of the cylinder *h*, should be of about the same amount as that of the apertures *j j* and *j'* in the upper portion thereof, in order that the pressure of steam upon the valve may be equalized, leaving it perfectly free to move in either direction. *n* is a chamber formed below the shell *g*, into which the ports *m m*, &c., of the same open, and which is in communication with the cylinder *c* by means of the ports or apertures *o o o*, &c.

Having thus described the arrangement of the two admission or steam-induction valves, *d* and *d'*, I will now proceed to explain how the exhaust or steam-eduction valves are constructed, &c.

p and *p'* are two eduction-valves, one of which is placed at or near each end of the cylinder *c*.

q q, &c., are a series of holes or ports in the bottom portion of the steam-cylinder, opposite, or nearly so, to the ports *o o o*, &c., in the top portion thereof. These ports *q q*, &c., communicate with a chamber, *r*. In this chamber *r* is a sliding plate, *s*, having apertures *t* and *t*.

u u are apertures or ports in the bottom of the said chamber *r*, communicating with a hot well, *v*, below the cylinder. This plate *s* is operated in such a manner in a rectilinear direction as to establish and shut off at proper intervals of time the communication between the cylinder and hot-well, for the purpose of accomplishing the exhaustion of the steam from each end of the cylinder. The plate *s* is also so arranged with respect to the devices, to be hereinafter described, for imparting a rectilinear motion to the same, that, for the purpose of destroying the vacuum in the cylinder for which it is designed, as well as for exhausting, it can be moved in a vertical or up-and-down direction without interfering with its travel in a rectilinear direction.

The particular mechanism which I have employed and represented in the accompanying drawings for the purpose of imparting the necessary motion to the induction and eduction valves, and also to accomplish the objects aimed at in the present invention, is as follows, viz:

w is the crank-shaft of the engine, turning in bearings *y*. On this crank-shaft *w* is placed a cam, *x*, with projections *a'* and *b'* diametrically opposite to each other, but in different vertical planes, and which, as the shaft *w* revolves, respectively abut against right-angular levers *c'* and *d''*, turning upon a fulcrum at *e''* of the standard *f'*, the ends *g'* and *h'* of the same being attached to spiral springs *i'* and *j''*. To the top ends of the right-angular levers *c'* and *d''* are respectively attached the connecting-rods *k'* and *l'*, the other ends being secured so as to swing thereon to the cranks *m'* and *n'* of the bearings *i* of the admission-valves *d* and *d'*.

The above-described mechanism by itself, it is evident, is sufficient to operate the admission steam-valves. The particular manner in which they are operated is to be hereinafter described.

For the purpose of operating the exhaust or steam-eduction valves, I employ the following mechanism in addition to that already described, viz:

z is a tappet, placed upon one surface of the cam *x*, and which by its (the cam's) revolution abuts against, successively, the sides or prongs *o' o'* of the forked-shaped lever *p'*, turning upon a fulcrum, *q'*. The lower end of this lever *p'* is attached to the rod *r'*, so as to cause the same to be moved in a rectilinear direction when the lever *p'* is operated by the abutting of the tappet *z* against either one of the two prongs *o' o'*. To this rod *r'* are attached by forked stems *r''* the plates *s*, the nuts *t' t'*, &c., on the rod *r'*, or other suitable mechanical devices, serving to keep the stems *r''* in proper position to be acted upon in a horizontal direction by the motion of the rod *r'*, while the stems *r''*, because of their forked shape, allow of a vertical or up-and-down motion to be imparted to the plates *s* and raise them from their seats when necessary to destroy the vacuum, as will be hereinafter described.

To admit steam to the piston through the induction-valve *d* from the steam-chest *e*, the necessary communication of the ports *l l*, &c., with the ports *m m*, &c., is established (Fig. 1) by the reciprocating rotary motion imparted to the valve by the revolution of the cam *x*. The projection *a'* of the cam *x* as it revolves abuts against the right-angular lever *c'*, causing it to turn upon its fulcrum, and thereby rotating the valve *d* by means of the connecting-rod *k'* sufficiently to open the communication with the cylinder and allow of the passage of steam to the same. This projection *a'* is so arranged upon the cam *x* that it will keep the valve open a sufficient length of time to allow of

the passage of any desired amount of steam. The longer the projection the more time the valve will remain open, and consequently the more steam in proportion will enter the cylinder. The right-angular lever c', when not acted upon by the cam x, is retracted by the spring i. And for the admission of steam at the opposite end of the cylinder the induction-valve d' is operated substantially in the same manner by means of the connecting rod l', right-angular lever d'', and projection b'.

At the moment, or nearly so, when the piston has reached the end of its stroke in the cylinder the exhaust-valve nearest the same is closed, and the one at the opposite end of the cylinder is at the same time opened, and both so remain during the whole time occupied by the piston in again moving through the cylinder, when they are reversed, they being continually thus operated while the engine is running.

This opening and shutting of the exhaust-valves is accomplished by means of the tappet z abutting against the prongs o' of the forked lever p', which thereby serves to turn the said lever back and forth upon its fulcrum, and as its lower end is attached to the rod r'—to which the plates s are secured, as above described—the plates are moved back and forth in a horizontal direction upon their seats. The plates s are so arranged with regard to the ports of the exhaust-valves that when one valve is opened the other is closed by the horizontal movement of the said plates, as will be evident upon an inspection of the drawings.

The cylinder as above described, and represented in the drawings, together with its valves, both induction and exhaust, is intended for a double-acting engine, and the peculiar operation of my improvements in the exhaust-valves, whereby the objects aimed at in the present invention are secured, is as follows, viz, the general operation, so far as relates to the admission to and exhausting of steam from the cylinder, being substantially the same as now occurs in engines worked upon the expansive principle, and I will not, therefore, describe it any further in detail:

The piston, after having reached the end of its stroke in the cylinder, at which time the crank of the engine is at its dead-point, commences to recede from the head of the cylinder nearest the same, and it is evident a "vacuum" would be formed between the piston and said cylinder-head unless some means were employed to prevent it. Now, to destroy that vacuum without being obliged to admit steam from the induction-valve to the piston, as is now the case in engines, the disadvantages and deteriorating effects of which have been hereinbefore particularly alluded to and set forth, the plate s of the said exhaust is raised from its seat, its peculiar arrangement hereinabove described permitting of the same, because the pressure of the vapor, hot air, &c., in the hot-well below, is greater than that of what little steam or hot air as may be left in the cylinder upon the top of the plate s, and thus opening the ports u consequently admits sufficient hot air or vapor to the piston as will supply the vacuum as fast as it would otherwise be formed. This admission of the hot air or vapor from the hot-well below, as above described, continues to take place until steam is admitted to the piston, to whatever extent the piston may have traveled previous to such admission of steam.

It is evident that by my improved exhaust-valves the arrangement of the cylinder and its induction and exhaust valves may be so made as to enable the full power of the steam to be applied to the piston at the time when the crank of the engine is at its most advantageous position, and it may be remarked that when the piston has reached the end of its stroke, and before steam is admitted to the same, the space between the piston and the head of the cylinder is necessarily filled with hot air or vapor from the hot well or chamber below the cylinder, and that this body of air or vapor pervades the entire space and cannot escape; consequently the quantity of steam necessary to be admitted to the cylinder is lessened by just the amount of air or vapor therein, and therefore the air or vapor will be compressed by the steam when admitted, and react upon the same—that is, both receiving from and giving pressure to the steam in exact ratio to the pressure of steam applied, whatever this force of steam may be. Thus, if steam be admitted to the cylinder at sixty pounds to the inch, the air or vapor between the piston and the head of the cylinder will be compressed by the steam admitted until it reacts with the same force—viz., sixty pounds to the inch upon the steam, and therefore upon the piston.

Having thus described my improvements, I shall state my claim as follows:

What I claim as my invention, and desire to have secured to me by Letters Patent, is—

Supplying warm air or vapor to the cylinder previous to the admission of steam thereto by means of such an arrangement of mechanical devices as will permit both the ingress and shutting off of such supply of air or vapor at the proper time to accomplish the desired result, as set forth.

F. A. CALVERT.

Witnesses:

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ALBERT W. BROWN.