F. A. Calvert,

Reciprocating Steam Engine,

No. 39,715. Patented Sep. 1, 1863.

Fig: 1.

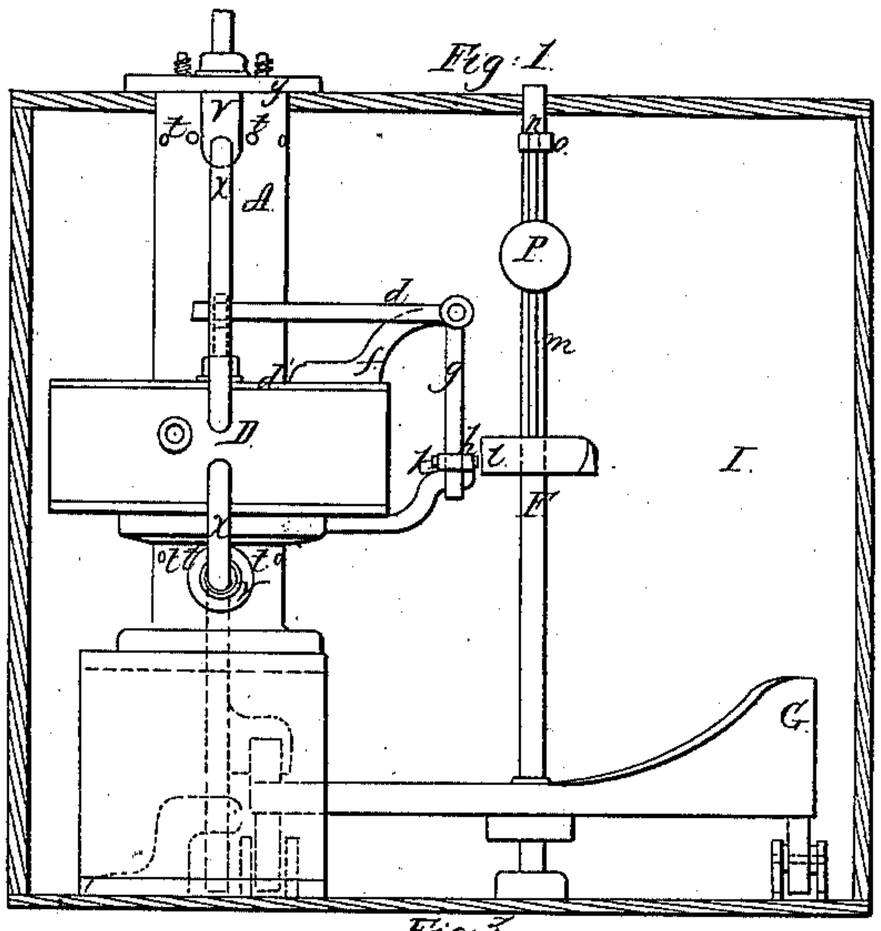


Fig: 2.

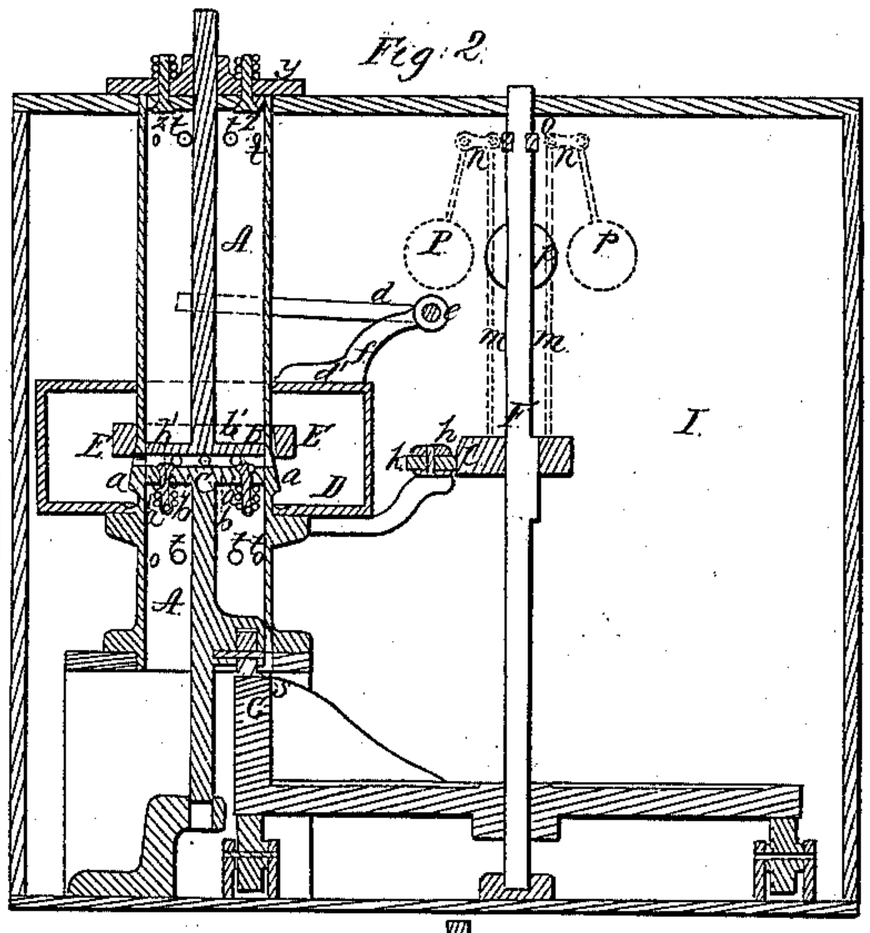
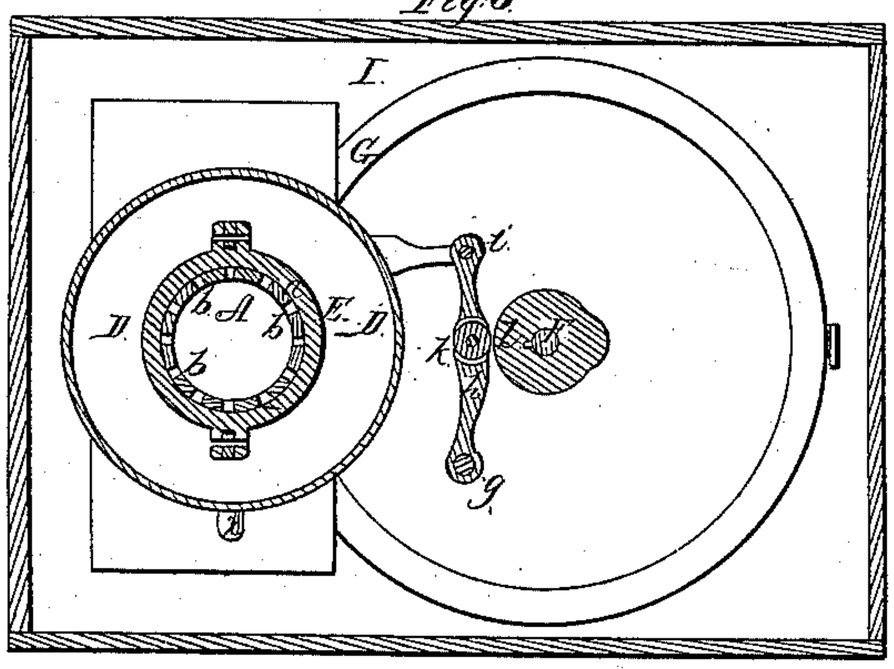


Fig: 3.



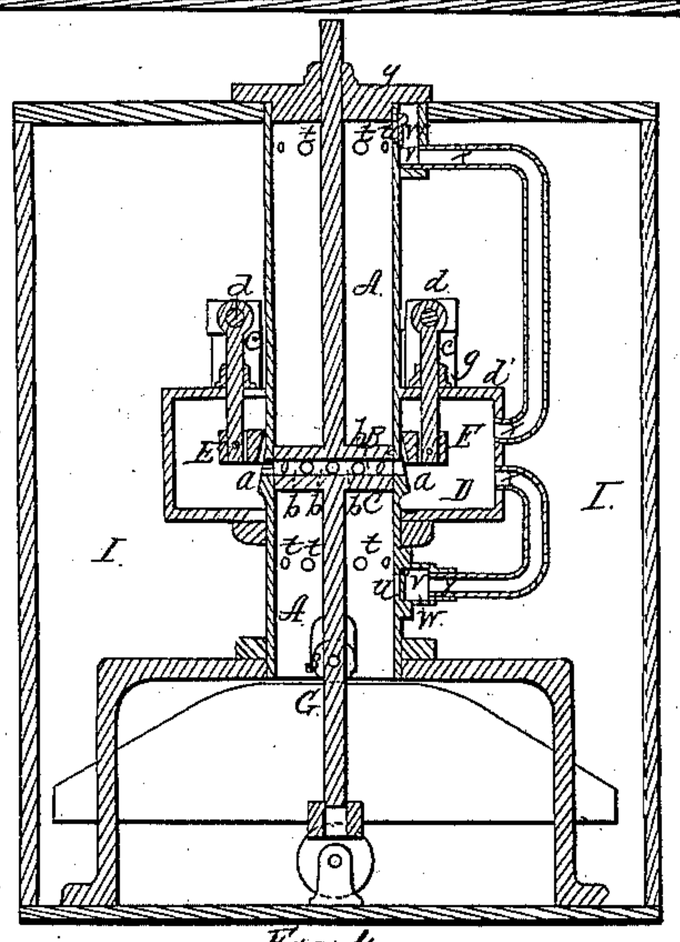


Fig: 4.

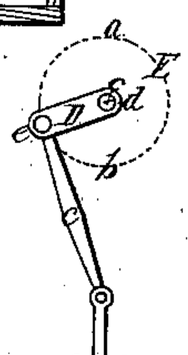


Fig: 5.

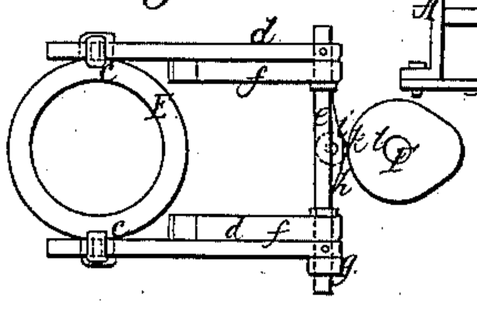
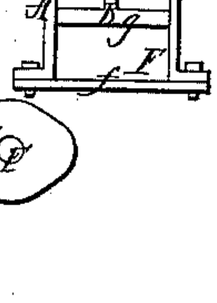


Fig: 6.



Witness:
S. R. Hale Jr.

Inventor:
F. A. Calvert
by his attorney
R. H. Eddy

UNITED STATES PATENT OFFICE.

FRANCIS A. CALVERT, OF LOWELL, MASSACHUSETTS.

IMPROVEMENT IN STEAM-ENGINES.

Specification forming part of Letters Patent No. **39,715**, dated September 1, 1863.

To all whom it may concern:

Be it known that I, FRANCIS A. CALVERT, a resident of Lowell, in the county of Middlesex and State of Massachusetts, have made an invention of a new and useful engine to be propelled or operated by the percussive and expansive power of either steam, air, or gas; and I do hereby declare the same to be fully described in the following specification, and represented in the accompanying drawings, of which—

Figure 1 is an elevation, and Fig. 2 a vertical section, of it. Fig. 3 is a horizontal section taken through the steam-chest and the annular valve thereof.

The nature of my invention consists as follows—that is to say, in the combination of an auxiliary piston and its operative mechanism with the cylinder and the primary piston provided with a steam-chest, valve, and valve-actuating apparatus, to operate substantially as hereinafter specified; also, in the combination with the steam-chest and the cylinder of a means by which steam, vapor, or gas in the cylinder shall not only be caused to cushion the piston at or about the termination of each stroke thereof, but be transferred or forced into the steam-chest; also, in the combination of a hot-vapor chamber with the engine, when made in manner and arranged in such chamber substantially as hereinafter described; also, in the combination and arrangement of certain valves and valve-passages with the cylinder and its pistons, the same being for the purpose or purposes to be hereinafter specified.

In order that the purpose and operation of the auxiliary piston may be clearly understood, reference may be had to Fig. 6, which is a sketch of a cylinder, A, piston B, connecting-rod C, and crank D, such as are in use in ordinary steam-engines. In this figure the circle of revolution of the crank is shown at E. The two points of this circle, where the power of the steam can be applied to the crank with the greatest amount of leverage or to the best advantage, are at *d* and *e*. In this engine the stroke of the piston is complete when the crank is at either of the dead-points *a b*. The steam is let into the cylinder at or about at such times and before it can act on the piston with the greatest useful effect. The crank, if the piston be ascending, must have arrived at the position *e*. Thus, the piston during the "up stroke" will have passed over the length *f g* of the stroke before the steam can be used to the greatest practical effect, and consequenty there would be a large space, F, of the cylinder—that is, all the space below the piston—filled with steam. If, when the crank is at the position *e*, the lower end of the cylinder could be raised upward within the cylinder and to the piston and there held firmly and the steam be next let in between it and the piston, it will be seen that the steam on its admission will act to the best advantage in propelling the crank. The auxiliary piston of my improved engine is intended to act as such a movable lower end or bottom to the cylinder, and, as it moves upward with the primary piston until the latter may have reached the desirable position for the application of the steam and there is stopped and remains at rest during the further ascent of the primary piston, it will be seen that the steam-space (marked F in Fig. 6) becomes practically obliterated by the action of the auxiliary piston.

In the operation of the motive power on the piston of my engine, whether that power be steam, gas, or compressed or heated air, the said power is intended to act, at first, with great effect percussively and, in a small quantity, possessing a very high elastic force. After having thus acted on the piston, the amount of the motor introduced into the cylinder is retained for a while within it and is allowed to expand, and by its expansive force to aid in propelling the piston.

In the drawings, A denotes the cylinder, B the primary piston thereof. This cylinder is open at its lower end, and contains also a secondary or auxiliary piston, *c*, the two pistons being arranged within it as shown in Fig. 2. Surrounding the cylinder is an annular steam or motor chest, D, to which the steam or motor is to be properly supplied by either one or more pipes leading from a boiler or generator. Within the chest D there is an annular valve, E, which encompasses the cylinder, is made with a slightly conical internal surface to fit on a corresponding conical seat, *a*, applied to and extending around the outer surface of the cylinder. The valve-seat has a series of ports or holes, *b b b*, each of which extends through and into the cylinder. This valve is furnished

with a valve-operating apparatus, which may be thus described: Fig. 4 is a transverse section taken through the cylinder. Fig. 5 is a top view of the valve mechanism. The valve is supported, as shown in the said Figs. 4 and 5, by two vertical rods, *c c*, which play through stuffing-boxes or guide-holes of the cap *d* of the chest D. Two arms, *d d*, from a shaft, *e*, project horizontally through eyes of the rods *c c*, the said shaft being sustained by brackets *f f*, projecting from the cap of the chest. Furthermore, an arm, *g*, extends downward from the shaft *e*, and through an eye on one extremity of a horizontal lever, *h*, whose fulcrum *i* is at its opposite extremity. A friction-roller, *k*, within the lever, has its periphery resting against a cam or tappet, *l*, carried by an upright shaft, F, the said cam or tappet and the shaft having what is termed a spline or "feather" connection, and the cam being suspended by rods *m m* from the inner ends of two bent levers, *n n*. The fulcra of these levers are supported by a cross-piece, *o*, affixed to and extended from the shaft F, as shown in Fig. 1 or more properly by dotted lines in Fig. 2. The longer arm of each lever has a ball or weight, *p*, fixed to it. These weighted levers revolve with the shaft, and with the cam constitute a "governor" for regulating the operating of the valve. As the balls of the governor fly apart from one another the cam will be depressed. The greater the velocity of revolution of the shaft the more the balls will be thrown outward or asunder by centrifugal force, the shaft being supposed to obtain its rotary motion indirectly from the main shaft of the engine, propelled or rotated by the primary piston.

The cam or tappet *l* is to be so constructed that it will diminish the raising of the valve more and more as the balls of the governor may be thrown asunder. It is also to be further constructed in such manner as to raise the valve and close it suddenly, the period of time the valve may be raised being longer or shorter in accordance with the amount of steam that may be required to produce the necessary percussive effect to insure, as near as possible, a constant velocity of the main shaft of the engine. There is also another cam, G, fixed on the shaft F, the said cam being formed as shown in Figs. 1 and 4. The auxiliary piston C is provided with a friction-roller, *s*, whose periphery rests directly on the operative surface of the cam G. Within a short distance of each end of the cylinder a series of holes, *t t t*, is made through the sides of the cylinder. Between each series of the holes and the next adjacent end of the cylinder a hole, *u*, leads laterally out of the cylinder and into a box, *v*, within which there is a valve, *w*, covering the said hole. The said box is affixed to the outer end of the cylinder and has a conduit, *x*, leading from it to and opening into the chest or chamber D. The head *y* of the cylinder has one or more openings, each being provided with one or more spring-valves, arranged as shown at *z z* in Fig. 2. The auxiliary piston C has one or more passages, *a'*, made through its head, each of the said passages being provided with a vacuum-valve, *b'*, to open upward. The whole engine so made is to be placed in a vapor-box or chamber I. Furthermore, the said engine may have applied to it another cylinder containing a primary and an auxiliary piston, made and furnished with a steam-chest and valve and valve-operating mechanism, as hereinbefore described, they being so arranged as to be worked by the cams *l* and G. In this latter case the primary-piston would be connected with another crank of the main shaft, the two cranks being supposed to project from opposite sides of the shaft. Under these circumstances both engines would be placed within a chamber, I. I herein mention this arrangement of two engines, as such is shown substantially in Patent No. 2,625 of British patents for the year 1861, such patent having been granted to me and being illustrative of my present invention. At the period of admission of the steam or motor into the cylinder the main-shaft crank, usually connected with the primary piston, should be in or nearly in that position where the full leverage or greatest useful effect of the steam may be exerted on it. The duration of the admission of the steam or motor to the cylinder will be regulated by the action of the governor and the cam while the engine may be in the act of giving motion to a load, but should the load be suddenly thrown off the increased velocity of the piston would cause the cam to be elevated out of action on the rest of the valve-operating mechanism, in which case the valve will be inoperative and no admission of steam to the cylinder will take place.

In the operation of my engine the percussive action of the steam or motor is to be applied so as to produce on the primary piston a result similar to that of steam in a steam-gun or air in an air-gun on a ball or bullet in the act of being discharged through and from such gun. During the admission of the steam the auxiliary piston should be stationary. The upper or primary piston having been propelled by the steam will rise in the cylinder. Should the expansive force of such propelling steam in the cylinder be reduced below the pressure of the atmosphere, the vacuum valve or valves in the lower or auxiliary piston will rise off it or their seats and admit vapor from the vapor-chamber or hot-well I, to rush into the cylinder to preserve the equilibrium on the ascending piston until it may have passed by the upper exhaust-ports, *t t*. During the remainder of the stroke of the piston the steam, which may be above those parts, will be compressed in the upper part of the cylinder so as to "cushion the piston." In case the condensation of the said steam by the momentum of the piston should impart to the steam a greater pressure than that of the steam

in the steam-chest, the flap-valve *w* of the passage *u* will open and allow part of the steam to pass into the steam-chest. The remainder of the steam during the descent of the piston will escape into the hot-well I through the holes *t t*. During the ascent of the primary piston the auxiliary piston should be held at rest, after which it should fall in the cylinder and remain stationary during the descent of the primary piston. In descending, the primary piston will be cushioned by the steam which may be between the auxiliary piston and the lower exhaust openings, *t t t*, the overpressed steam being forced back into the steam-chest. The steam which may be between the two pistons during the descent of the upper one will exhaust through the lower orifices, *t t*. While the upper piston may be in the act of rising up to a position to receive the next percussion of steam the lower piston should follow it. The object of the lower piston, therefore, is not only to obviate the necessity of supplying the cylinder with steam until the crank may have attained its proper position for receiving the full force or greatest useful effect of it, but to preserve this effective force by avoiding any undue expansion of the steam prior to its being brought to act on the piston at the period when the crank may have attained the position above mentioned.

Another advantage of my invention is that little or no packing becomes necessary to the piston or pistons, as the effect of the steam is so sudden when first allowed to impinge on the piston-head that its blow thereon will have taken place before any great amount of steam can have passed by the piston. By making one or more shallow grooves around the piston-head and in its periphery water will condense or collect in such grooves and operate as a packing to prevent the escape of steam.

Having thus described my improved engine, what I claim as my invention, is as follows:

1. The combination of the auxiliary piston and its operative mechanism with the primary piston and the cylinder, made as described, and provided with a steam-chest, a valve, and a valve apparatus, to operate substantially as and for the purpose specified.

2. In combination with the steam-chest and the cylinder, made with reduction or exhaust openings arranged in it, as described, a means, substantially as explained, for cushioning the piston and introducing the overpressed cushioning steam into the steam-chest.

3. The combination of the vapor-chamber or hot-well I, the cylinder, its steam-chest, valve and valve apparatus, the primary and auxiliary pistons, and the mechanism for elevating and depressing the auxiliary piston, the whole being constructed and arranged substantially in manner and so as to operate together as specified.

4. The combination of one or more induction-passages and their valve or valves with the cylinder, the main and auxiliary pistons, and as applied to the head of the cylinder and to that of the auxiliary piston, substantially as and for the purpose or purposes above specified.

F. A. CALVERT.

Witnesses:
R. H. EDDY,
F. P. HALE, Jr.