(No Model.) 2 Sheets—Sheet 1.

M. J. O'CONNOR.

VALVELESS ENGINE.

No. 321,842. Patented July 7, 1885.

Fig. 1.

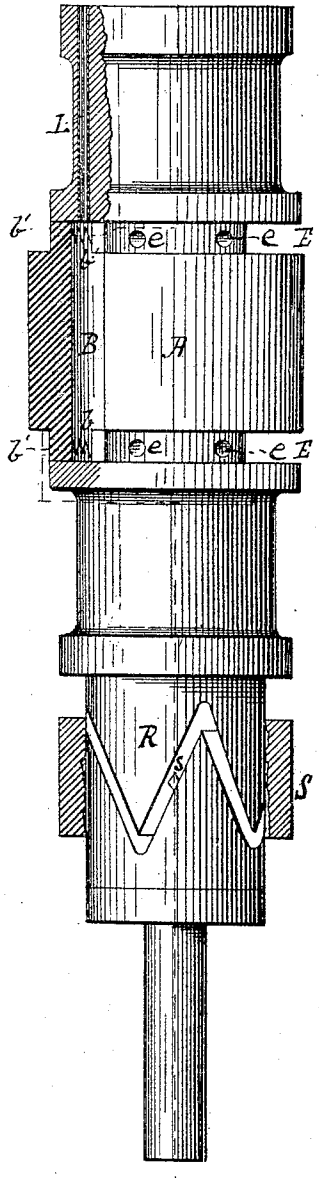
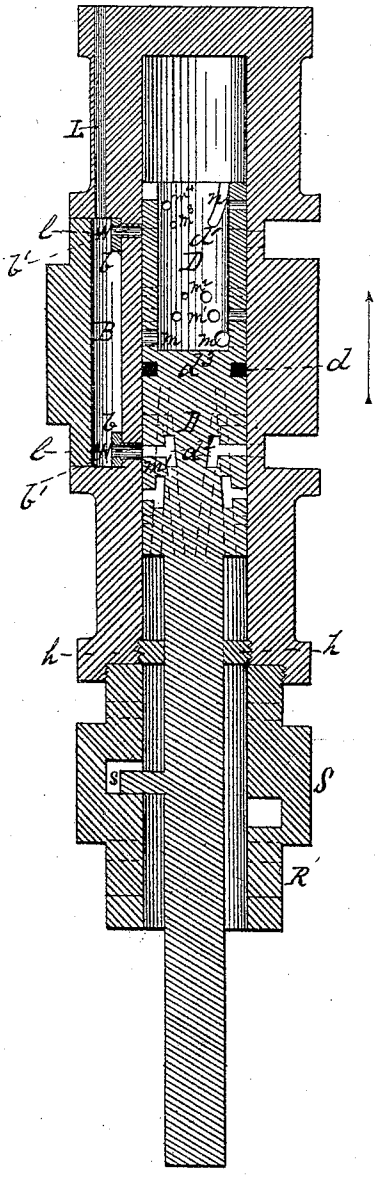


Fig. 2.



Witnesses.
Gob Tauberschmidt
H B Moulton

Inventor.
Michael J O'Connor
by F. P. Ritter & Patty

(No Model.)

2 Sheets—Sheet 2.

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Fig. 4.

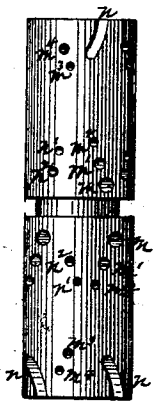


Fig. 5.

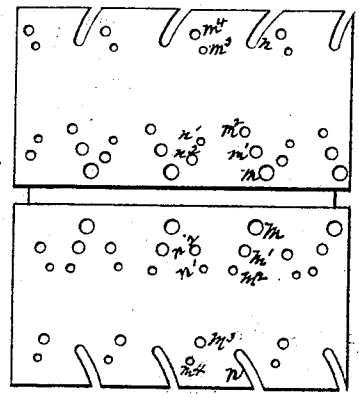


Fig. 7.

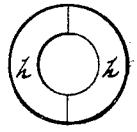


Fig. 6.

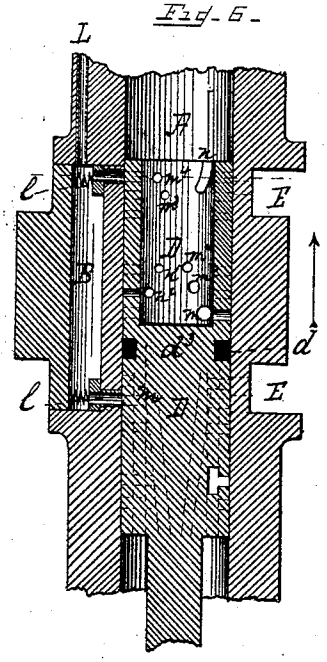
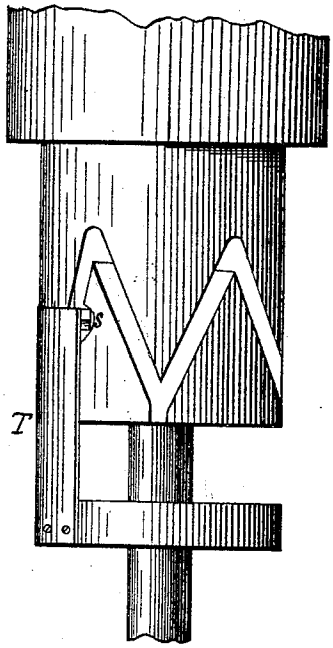


Fig. 8.



Witnesses.

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UNITED STATES PATENT OFFICE.

MICHAEL J. O'CONNOR, OF LOUISVILLE, KENTUCKY.

VALVELESS ENGINE.

SPECIFICATION forming part of Letters Patent No. 321,842, dated July 7, 1885.

Application filed May 2, 1885. (No model.)

To all whom it may concern:

Be it known that I, MICHAEL J. O'CONNOR, a citizen of the United States, residing at Louisville, in the county of Jefferson, State of Kentucky, have invented certain new and useful Improvements in Valveless Engines; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, wherein—

Figure 1 is an elevation, partly in section, of a cylinder embodying my invention. Fig. 2 is a longitudinal section on line *x x*, Fig. 1. Fig. 3 is a transverse section of the cylinder and piston on the line *y y*, Fig. 6. Fig. 4 is a detached view of the piston. Fig. 5 is a diagram or plan of the piston. Fig. 6 is a section of the piston and part of the cylinder, showing the compensating steam-bushing. Fig. 7 is a detail view of the detachable head of the cylinder. Fig. 8 is a view of a portion of the cylinder, showing a modification in the form of the devices employed for rotating the piston.

Like letters refer to like parts wherever they occur.

My present invention relates to that class of engines which may be termed "valveless engines," in so much as the motive power, whether the same be steam or air, is admitted and cut off by the piston and through the motion thereof, independently of other valve; and while said invention is applicable to rotary engines, steam-pumps, and many other uses in the arts, it is especially adapted to the operation of rock-drills, where both rotary and reciprocating motion is required.

The main features of the invention consist, first, in the use of a series or succession of (steam or air) ports in the piston, whereby the motive power which actuates the piston is reinforced from time to time during the stroke, thus insuring uniformity in the applied power; secondly, in providing a (steam or air) port which is opened at or near the close of the stroke, so as to give a final impulse to the movement of the piston; thirdly, the arrangement of the (steam or air) induction and exhaust ports in reverse or crossing spiral lines at regular intervals, so that a free escape of the exhaust-steam is secured, whereby the stroke of the piston within a given range may be controlled by the amount of steam or air admitted, and all equivalents for the devices hereinafter described for accomplishing said objects are regarded by me as within the scope of my invention.

There are minor features of construction of more or less value in a practical machine or engine, as will hereinafter more fully appear.

I will now proceed to describe my invention more specifically, so that others skilled in the art to which it appertains may apply the same.

In the drawings, A indicates the cylinder of an engine, which may be actuated either by steam or air, as the case may be. The middle third of the cylinder is bounded by the exhaust-ports *e*, arranged at equal intervals around the cylinder—corresponding to the number of reciprocations to each rotation of the piston; and these ports may extend clear through the cylinder or into exhaust-passages or belts E, as shown in the drawings. Extending longitudinally of the middle third of the cylinder is the live-steam (or compressed air) channel or box B, having at each end a port, *l*, leading into the cylinder, and said ports have movable bushings *b*, the inner ends of which bear on the piston. The object of these bushings is to compensate for any wear of the piston and insure that the live steam shall not leak between the side of the piston and cylinder. In order to keep these bushings in contact with the piston, springs *b'* may be used, if desired or found necessary. L indicates the live-steam or compressed-air pipe leading to box B. The live-steam box B is separated from the exhaust-passages E by walls.

As a matter of construction the steam-box B and the exhaust passages or channels E may be cored out in casting the cylinder, and the exhaust-ports *e* and live-steam ports *l l* L may be bored in the casting-plugs, being used to close such ports in the outer shell as it may be necessary to close, all of which is familiar to the skilled mechanic.

D indicates the piston, which is substantially two-thirds the length of the cylinder A, and is provided at its middle with a packing-ring, *d*. This piston may be a hollow cylinder, as shown at *d'*, or the same purpose may

be accomplished by longitudinal channels d^2; but in either case there must be a solid head or septum, d^3, in the plane of the packing-ring d for obvious reasons.

The steam (or compressed air) for operating the piston passes from the steam-port l of the cylinder through a live-steam port, m, in the piston, and expands in the hollow piston d', or, passing along the steam-channels d^2 expands in rear of the piston, forcing it to the opposite end of its stroke. At the end of the stroke exhaust-steam ports n in the piston are brought in line with exhaust-ports e, and so continue until near the close of the reverse stroke, while the live-steam ports m of said end of the piston are out of register with the live-steam port l of said side, and remain out of register until the close of the reverse stroke.

Bearing this in mind, the following description of the arrangement of the ports in the piston, and the object thereof, will be readily understood: As the motion of the piston is in a spiral line—that is to say, rotating and reciprocating at the same time—the ports of the piston, in order to register successively with the port of the cylinder, must be arranged in spiral lines, and the number of reciprocations to each rotation will determine the number of such spirals. In the present instance, the number of reciprocations (chosen for illustration) is four. Consequently the circumference of the piston is divided by four equidistant spiral lines on which the live-steam ports m are arranged. Of these M M' M^2, arranged for the first part of the stroke, are large and decrease in succession, as shown, for the reason that most of the steam to operate the piston is taken at this part or half of the stroke, after which there are no live-steam ports until near the end of the piston, when one or more small ports, M^3 M^4, are introduced so as to give a small additional supply or final impulse to the stroke of the piston.

The exhaust-ports n of the piston are also arranged on an equal number of spiral lines in reverse direction, and crossing the spiral lines of live-steam ports m, so that, as the steam-ports m, &c., of one end of the piston register with the live-steam port l of the cylinder on that side, the exhaust-ports n, &c., of the opposite end or half of the piston will register with the exhaust-ports (four equidistant) e of its end of the cylinder, and vice versa, the arrangement of ports being such that the live-steam ports and the exhaust-ports of the same side cannot register simultaneously with the cylinder steam and exhaust ports of the said side.

It will be observed that the leading exhaust-port n is or may be a continuous slot, so that the first part of the exhaust is rapid, while the last or final ports are small, as at n' n^2, and the exhaust-ports cease some distance short of the center of the piston, (or end of the stroke,) so as to insure the close of the exhaust before the opposite steam-ports are opened.

The piston is introduced through one end of cylinder A, and that end of the cylinder may then be closed by a screw or threaded head composed of two separate sections, h h. (See Fig. 7.)

The above is a description of the elements constituting the main features of my invention; but in operation it is necessary to employ some independent device or devices for rotating the piston, and such devices may be a pin or pins and cam-grooves within the cylinder, like devices exterior to the cylinder, or a ratchet mechanism, all of which are well known to the art and need not be herein specifically described. I have, however, shown two similar sets of devices which have special value in this connection—viz., what is shown in connection with Figs. 1 and 2, and a modification thereof shown in Fig. 8.

The device shown in Figs. 1 and 2 is a tube or cylinder, R, having the continuous W or regular zigzag slot, in which works the pin s and the surrounding belt S, (partly broken away in the drawings,) and this may be readily made by core-casting, or by slotting a wrought-metal tube and shrinking and welding the belt S thereon. It is secured to the end of the cylinder in line therewith by a thread on the end of tube R, and a corresponding thread on the end of the cylinder. This is cheap, effective, and available where the length of the devices is not materially objectionable.

The modification, Fig. 8, shows the continuous W or regular zigzag cam-slot cast on one end of the cylinder, and the pin s carried by an arm, T, extending from a collar on the piston-rod. There is no material difference in the operation of the two forms, and the latter is simply a matter of choice where it is objectionable to extend the guide in line with the cylinder, owing to lack of space.

I will now briefly describe the operation of the devices.

Referring for this purpose to Figs. 3, 4, 5, and 6, which, being in juxtaposition, can be more readily observed, it will be noted, Fig. 6, that the piston is at or near the end of its stroke to the left (or down,) and, Fig. 3, that the steam-port l on the right (or upper end) has been closed by the position of the piston, while the four exhaust-ports n of the piston have registered with the ports e of the cylinder, so as to open the exhaust the moment the live steam is cut off. The steam from box B now passes through l on the left (or lower end of box B) into m on the left, and the expansion of the steam in the piston (or in the cylinder at that end) moves the piston to the right (or upward.) (Direction of arrow.) The first movement of the piston cuts off the steam; but its continued movement opens successively ports M' M^2, so that the supply of the steam is intermittently supplied, so as to obtain uniform pressure and movement of the piston.

There is quite an interval following port M^2,

where there is no port; but, finally, near the end of the piston (close of its stroke) one or more small ports, M^3 M^4, are provided, by which a final sharp impulse is given to the stroke of the piston.

During the whole stroke of the piston the pin *s*, moving in the guide-slot, has imparted a rotary motion to the piston, so that the spiral line of the live-steam and the exhaust ports have been caused to register with the corresponding ports in the cylinder.

It will be noted the exhaust-ports of the pistons are equidistant and intermediate of the live-steam ports, and that the live-steam port of the cylinder is located between or intermediate of the exhaust-ports of the cylinder, consequently the exhaust-ports of the cylinder and piston cannot register at the same time that the live-steam ports of the cylinder and piston register.

It will also be noted that the throw of the piston can be regulated within certain limits—as, for instance, if the volume of steam at a given pressure is graded to throw the piston two-thirds of its stroke, and the guide-slot is so arranged as to permit the piston to shift on a two-thirds stroke, the exhausts will be at once opened by the shifting of the piston, and the length of the stroke is thus determined, as at each stroke of the piston it will take its steam through M′ or M^2 instead of M. Again, if the volume of steam is sufficient, the stroke of the piston can be increased, adding another steam-port, leading the first port M or by elongating said port.

In case of the use of compressed air as the motive power, the bushings *b* may be made of rubber, or equivalent material, instead of brass or metal.

Having thus described the nature, operation, and advantages of my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a valveless engine, the combination of a cylinder and a piston having a series of independent steam-ports arranged in succession, whereby the cylinder is given steam at intervals during its stroke, substantially as and for the purposes specified.

2. The combination of a cylinder and piston provided with a steam port or ports arranged to give the piston additional steam near the close of its stroke, substantially as and for the purposes specified.

3. In a valveless engine, the combination, with a cylinder having steam and exhaust ports, of a piston having series of spirally-arranged steam-ports and similar exhaust-ports, arranged alternately, substantially as and for the purposes specified.

4. In a valveless engine, the combination, with a cylinder having steam and exhaust ports, of a piston having independent steam and exhaust ports spirally arranged and crossing each other, substantially as and for the purposes specified.

5. The combination, with the cylinder and piston having spirally-arranged ports, of the slotted guide-tube attached to the head of the cylinder, and the collar and guide-pin, substantially as and for the purposes specified.

In testimony whereof I affix my signature, in presence of two witnesses, this 2d day of May, 1885.

MICHAEL J. O'CONNOR.

Witnesses:
F. W. RITTER, Jr.,
H. A. HALL.