2 Sheets—Sheet 1.

A. K. RIDER.
HOT AIR ENGINE.

No. 111,087. Patented Jan. 17, 1871.

Fig. 1,

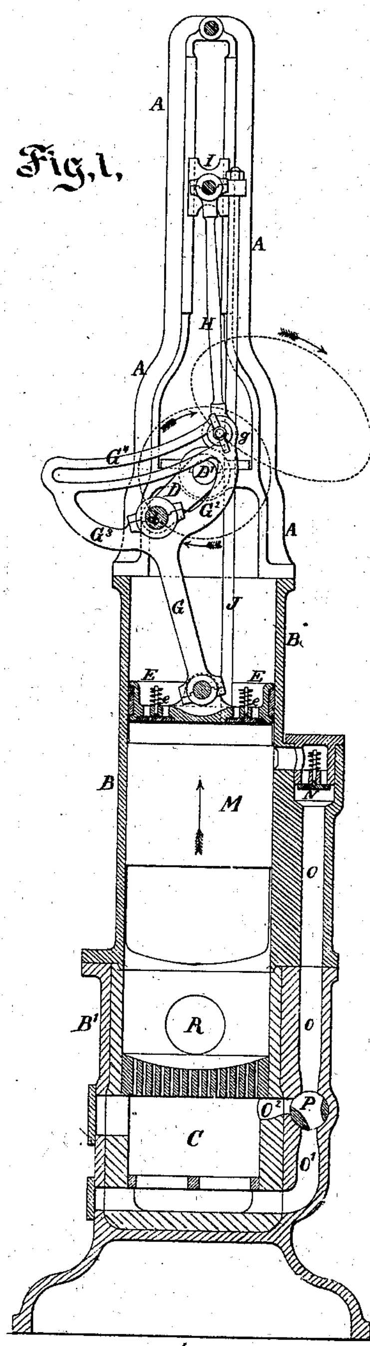


Fig. 2.

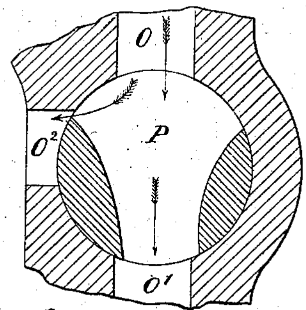


Fig. 3,

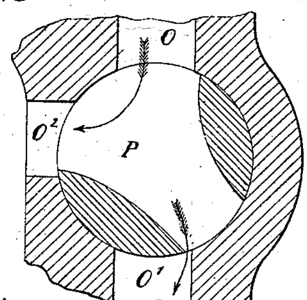
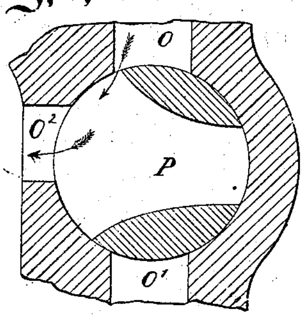


Fig. 4,



Witnesses,
A. Hoermann
C. C. Livings

Inventor,
A. K. Rider
by his attorney
T. D. Stetson

2 Sheets—Sheet 2.

A. K. RIDER.

HOT AIR ENGINE.

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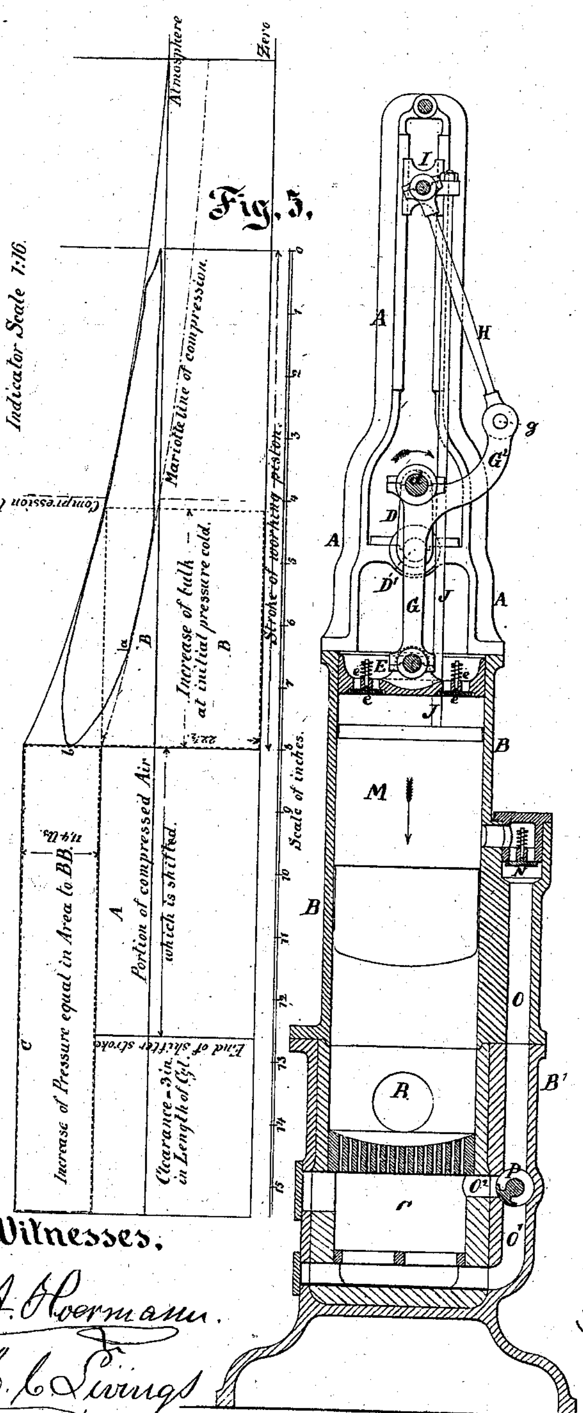

Witnesses.

A. Hoermann.

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Inventor,

A. K. Rider
by his attorney
T. D. Stetson

United States Patent Office.

ALEXANDER K. RIDER, OF NEW YORK, N Y., ASSIGNOR TO HIMSELF, CORNELIUS H. DELAMATER, AND GEORGE H. REYNOLDS, OF SAME PLACE.

Letters Patent, No. 111,087, dated January 17, 1871.

IMPROVEMENT IN HOT-AIR 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, ALEXANDER K. RIDER, of the city and county of New York, in the State of New York, have invented certain new and useful Improvements in Hot-air Engines; and I do hereby declare that the following is a full and exact description thereof.

My invention embraces important improvements in that class of air-engines described in the patents granted by the United States to John Ericsson, dated July 31, 1855, and December 14, 1858.

In this class of engines, which I will term the aspirating or Ericsson engine, two pistons are employed in one cylinder, which performs the double office of air-pump and power-cylinder.

The objects of my invention are—

First, to combine this class of aspirating or double-piston engine with an internal or closed furnace, in which the air is heated by passing through or over the fire, thereby greatly increasing the power and efficiency of this class of engines as hitherto constructed.

Second, to induce the peculiar motions of the inner or shifting piston by simple, inexpensive, and very efficient mechanism.

Third, to make the engine reversible, so that it may be applied as a transportation motor, by means of a mere change of position of certain parts, with suitable changes of valve motion.

Fourth, to more perfectly regulate the speed of the engine under varying conditions of load without waste of fuel. This is done by a peculiar valve and passages peculiarly arranged to be controlled thereby, the valve being adapted to be operated by a governor.

Passing lightly over those parts of the machine which have been long known and in common use, I will devote attention mainly to the features which I believe to be new and peculiar to my engine, and will describe what I consider the best means of putting my invention into effect.

The accompanying drawing forms a part of this specification.

Figure 1 is a central vertical section, showing in a clear light the construction and the relation to each other of the several parts. The section shows but one of the rods which operate the shifter, but it will be understood that there are two, the other being this side of the plane of section.

Figure 5 shows a modification which involves some of the novel points. The remaining figures show details enlarged.

Figure 2 shows the regulating valve in position to increase the fire, and thus indirectly to increase the speed of the engine.

Figure 3 shows the same valve in position to slacken the fire, and

Figure 4 shows the same valve in position to not only slacken the fire, but also to directly retard the engine by throttling it.

The diagram at the side of fig. 5 is an indicator diagram, taken on one of my engines. The several lines with the brief explanation marked thereon may be of service to those familiar with this mode of ascertaining the conditions at different points.

Similar letters of reference indicate corresponding parts in all the figures.

B is the cylinder, which also serves as the air-pump, as above stated. It is formed in the usual manner, attached below to the furnace casing B' by flanges and bolts.

Above the cylinder B is a framing, A, which carries the pillow-block and slides.

E is a piston, which I term the main piston, in which are fitted the self-acting valves *e e*, opening inward, and which has the connecting-rod G' hinged to its upper side in any convenient manner. It is packed with leather or other suitable material to make it tight.

M is a piston, which I term the inner or shifting piston, fitting closely, but easily in the cylinder, and prolonged downward toward the fire, to prevent the heat acting injuriously on the packing of the main piston.

N is a check-valve, to prevent the air from returning to the cylinder.

O is a pipe leading to the furnace, which is for the purpose of carrying down the air.

P is the regulating valve; and

C is the furnace.

The changing piston or shifter M is connected by two rods, J, passing through the main piston E to the cross-head I, which latter works in slides provided in the framing A, and receives motion from connection to the crank and main piston, as will be presently explained.

The connecting-rod G is of peculiar conformation.

Between the main piston E and the crank-pin it is a direct connection, but it is provided with an offset, G^2, which carries the point of attachment *g*, by which the upper connecting-link H transmits motion to the cross-head I, and through the piston-rods J to the inner or shifting piston M.

The position of this offset G^2 and point of attachment *g* may be varied within wide limits, and yet produce very nearly the required effect. It may be beyond or above the crank-pin, as shown, or between the piston and crank-pin, or it may be nearer to or further from the line of the connecting-rod proper, or it may form a right angle with the other two bearings on the connecting-rod; these proportions depending on the stroke given to the shifting piston, the length of the connections and the relative motions required to be imparted to the shifting piston. The proportions given in the drawing are a medium of those which I have tried with success.

When it is necessary to make the engine reversible, as for purposes of locomotion or navigation, the offset is duplicated, one being formed on each side of the connecting-rod.

The offsets G^3 G^2 may then be connected as shown in fig. 1, by a link-slot, G^4, as shown, in such a manner that the upper connecting-link H can be shifted at its lower end to the reverse side, opposite to its former point of attachment, and thus reverse the engine's motion, the valve motion, &c., being correspondingly changed, as will be understood.

This form is shown in fig. 1.

For stationary engines, however, but one offset and point of attachment is necessary, as shown in fig. 5.

In order to obtain the best result, the shifting piston or shifter M should start to come out or toward the main piston considerably in advance of the termination of the inward stroke of the latter, so as be nearly or quite in contact with the main piston at the commencement of its up or outward stroke, and should remain close to the main piston during nearly all of the up or outward stroke, a little before the end of which the shifter should rapidly descend, so as to reach its lowest or extreme inward position a little before the half of the inward stroke of the main piston has been performed. The arrangement of parts described fulfils these conditions.

In engines of this class hitherto constructed, any lead on the shifting piston was considered detrimental, and avoided as much as possible, only a very small amount being permitted, on account of rendering the motion more easy at the end of the stroke.

In my engine, on the contrary, it is purposely made as much as possible with the simple connections adopted, the effect of which may be seen on the indicator-card at the points *a b*, where the rise above the Marriott curve appears.

The lower end of H may be connected to either end of the link G^4, and may be firmly held in either end by means of a suitable key or pinching-screw, or other suitable means. The lower end of H is shifted from one end to the other end of the link G^4, to cause the engine to revolve in the opposite direction. In other words, the engine is reversed by changing the union of the connection H from one end to the other of the link G^4, and making corresponding changes, by ordinary or suitable means, in the positions of the eccentrics or other means which operate the valves, as will be readily understood.

It will be observed that the lower end of the link H, operated by a pin, *g*, traverses in a circuit, the center of which is one side of the central line of the engine, and that the central line is nearly or quite tangential to said circuit. I ascribe to this relation much of the excellence of this motion.

Operation.

Supposing the connection H to be adjusted as represented, and efficiently confined in the end of the link G^4, so that it is free to turn upon a pin, *g*, temporarily but firmly fixed at that point, the crank is ready to revolve in the direction indicated by the arrow. Supposing the engine to be started by hand, or by some other power applied for the purpose, during each revolution of the crank D and consequent descent and rise of the main piston E, the under member, which I call a shifter, and which does not necessarily fit tight in the cylinder, descends further and more rapidly, causing an influx of cool atmospheric air through the valves *e* in the piston E. The exhaust-valve passage R is open during the early portion of this descent. After the shifter has descended to its lowest position, the piston E follows it, to a smaller extent; and, as the shifter rises to meet the piston, it reduces the space between the shifter M and the piston E, and causes the main body of the air which is inclosed between the shifter and the piston to be driven downward through the self-acting valve N, and through the connected passage O, to pass through or over the fire and be heated. The passage of this cool air through, or in contact with, the fire, raises its temperature and increases its pressure very greatly. Now, the shifter having risen until it is nearly in contact with the piston, the latter commences to rise, and both move upward with a motion very nearly coincident. It is in this portion of the revolution that the power of the heated air is given off through the crank D to the shaft D′ and its connections. A sufficient momentum is stored in the fly-wheel, in case of a single engine, to enable it to perform the remainder of its revolution, as will be readily understood.

The passage O communicates, through the peculiar valve P, with two passages O^1 O^2, which lead, the former under the fire-grate, and the latter above it. The valve P is capable of turning easily upon its axis, and, in case it is adjusted to cause the compressed air to pass through the passage O^1, it blows the fire and urges it. In case it is adjusted so as to close the passage O^1 and open the passage O^2, it causes the compressed air to flow into the furnace above the fire, and in this condition its influence in urging the fire is almost inappreciable. Under ordinary conditions the valve will be adjusted so that a portion of the air will flow through the passage O^1 and urge the fire, while another portion will flow through the passage O^2. The relative proportion may be varied by changing the position of the valve P, and thus the fire may be increased or not by the action of the engines, or it may be urged in varying measures at pleasure.

The construction and arrangement of my valve P allows the application of a governor, (not represented,) which may be driven by a band from the main shaft D′ of the engine, and generate a motion corresponding thereto. The action required is precisely that of the ordinary governor, and the connection therefrom to this valve P may be of any ordinary or suitable character, and will require no special detailed description.

There is a peculiarity, however, about the valve P, which, whether operated by the governor or by hand, causes it to perform an important function in addition to that before explained. Its form and its relation to the ports is such, that after it has been turned in the proper direction to a sufficient extent to shut off the air from the channel O^1, and has thus caused all the air to flow through the channel O^2, under the conditions which are the least conducive to the urging of the fire, a still further motion in the same direction will bring into play a new agency for still further or more rapidly reducing the velocity of the engine. The valve will, under such extreme conditions, partially throttle or obstruct the flow of air downward through the passage O. This position of the valve, and this condition of that portion of the mechanism, is clearly shown in fig. 4.

In case of the breaking of a belt, or any other sudden relief of the engine from resistance when laboring heavily and carrying a very hot fire, the engine is liable to attain a dangerously high speed. The shutting off of the air from the passage O^1 under such circumstances will in time reduce the heat of the furnace, and thus restore the proper conditions; but, in the interim, damage may be done. My valve P prevents this by checking the motion of the air through the passage O, under these extraordinary circumstances. In case the valve is operated by a governor, this action will result automatically.

I have omitted to describe the fire-brick lining of the furnace, and many details which will be readily understood by those familiar with this branch of engineering. Among these is the exhaust-valve, the passage to which is represented by R.

Although my engine works, preferably, by exposing the air directly to the fire, or, in other words, forcing it through the fire and causing it to support combustion, some of its novel features may be made available if the air is heated by an external fire by means of heat transmitted through metallic or other suitable surfaces.

I claim as my invention—

1. The aspirating engine, having two pistons E and M, working in the same cylinder A, in combination with the internal or closed furnace C, and with passages for conducting the air from the cylinder to the furnace and again to the cylinder, as herein specified.

2. The connecting-rod G, constructed with an offset, carrying the attachment of the upper link H, substantially as described and for the purpose specified.

3. The two offsets G^2 G^3, on opposite sides of the connecting-rod G, with or without the connecting-slot G^4, adapted to allow of reversing the engine.

4. The valve P and connected air-passages, constructed and arranged substantially as represented, so as to perform the double function of controlling the fire and of throttling the air-passages, as specified.

In testimony whereof I have hereunto set my name in presence of two subscribing witnesses.

A. K. RIDER.

Witnesses:

THOMAS D. STETSON,
C. C. LIVINGS,
A. HOERMANN.