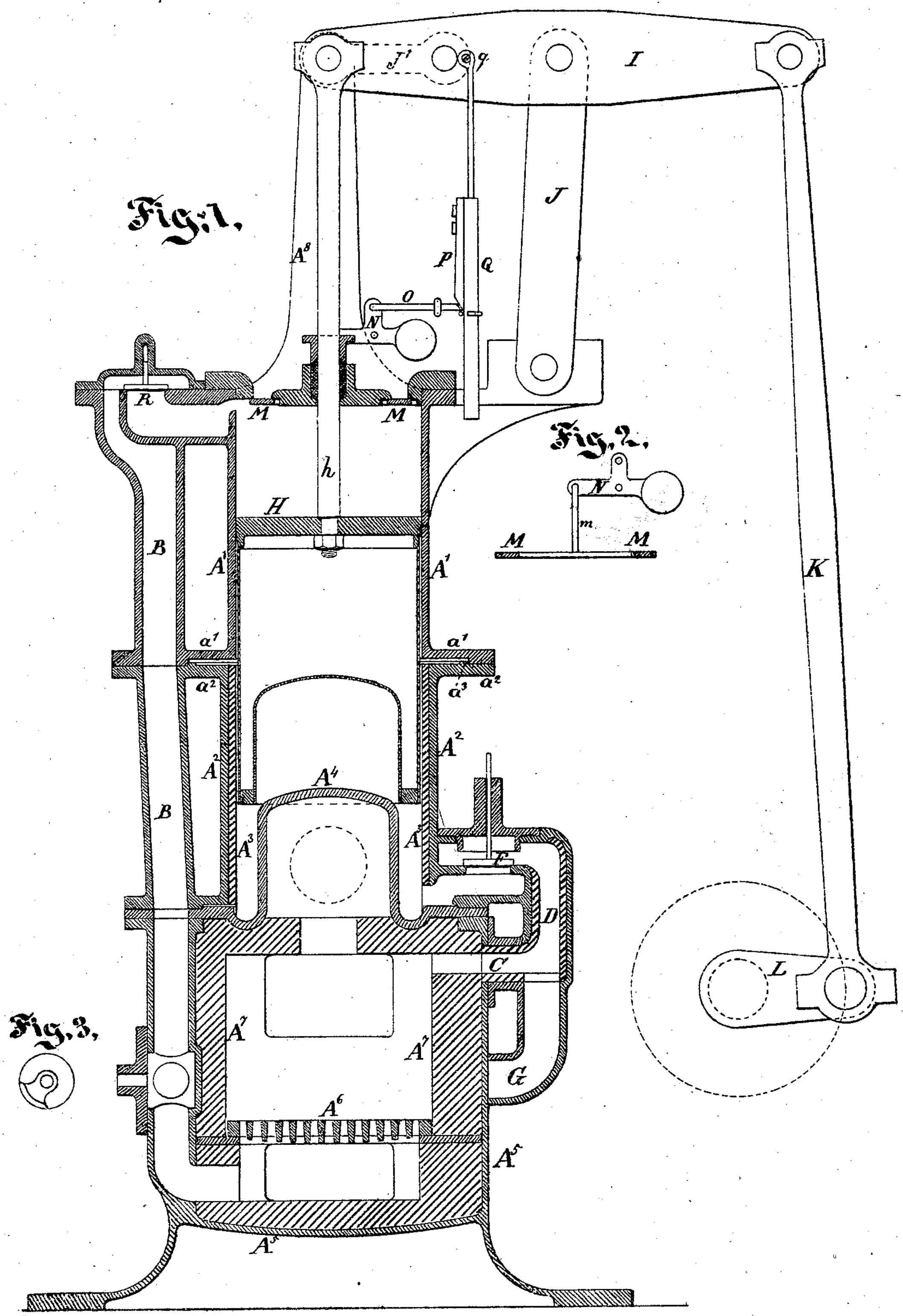
2 Sheets--Sheet 1.

A. K. RIDER,

Improvement in Air Engines.

No. 120,325. Patented Oct. 24, 1871.



Witnesses,

C. C. Livings

A. Hoermann

Inventor,

A. K. Rider,

by his attorney T. D. Stetson

2 Sheets--Sheet 2.

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Fig. 4.

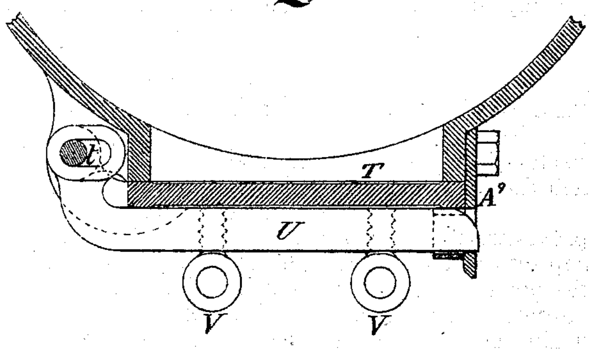
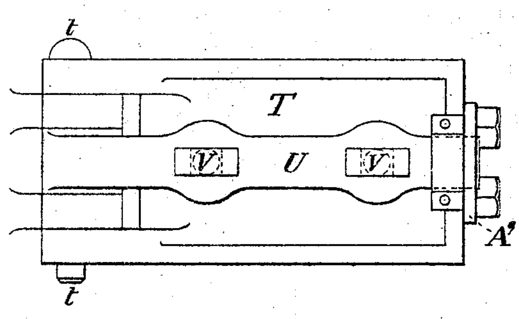


Fig. 5.



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UNITED STATES PATENT OFFICE.

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

IMPROVEMENT IN AIR-ENGINES.

Specification forming part of Letters Patent No. 120,325, dated October 24, 1871.

To all whom it may concern:

Be it known that I, ALEXANDER K. RIDER, of New York city, in the State of New York, have invented certain new and useful Improvements in Hot-Air Engines, of which the following is a specification:

My invention relates to provisions for making the cylinder serve as a pump by the aid of the same piston which yields the power; a positive motion of the valve which admits the cold air; a non-conducting lining within the cylinder; a non-conducting lining for the air-pipes and other parts; provisions for heating and reheating the air in the working cylinder after it has been introduced therein; provisions for introducing the air into the top of the furnace and taking it out again through the same aperture when the heat is too great; means for arresting the conduction of heat from the hot to the cool end of the cylinder; a peculiar construction and arrangement of the door and means for securing it; an arrangement by which a working-beam is employed, mounted on movable links with a parallel motion; and a lining of the entire furnace with fire-brick, except a portion of the top, which latter comes under the domed bottom of the working cylinder.

The engine is adapted to stand upright in a small space, and is intended to work rapidly and to serve as a quick-acting and highly-efficient engine for all general purposes—small manufactures, pumping, &c.

The following is a description of what I consider the best means of carrying out the invention.

The accompanying drawing forms a part of this specification.

Figure 1 is a central vertical section through the entire engine, with its furnace and connections forming parts of the same. Fig. 2 is a section through the induction-valve, showing, also, one of the levers which are attached. Fig. 3 is a view of the controlling-valve, which is operated by a shaft passing through the casing adjacent. It is here shown as detached and turned one-fourth around. Fig. 4 is a horizontal section through the door and casing. Fig. 5 is a front view of the door, with the bolt, hinges, and fastening.

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

The cylinder forms a portion of the frame-work of the machine, it and its adjuncts being provided with a broad spreading base. Suitable brackets and pipes may, if preferable, be cast in one with the adjacent main castings. These parts, taken together, form the fixed frame-work of the machine. I will designate these parts by the single letter A, when necessary, and the several details by A^1 A^2, &c.

A^1 is the nicely-finished main cylinder. It is provided at its base with broad flanges a^1, which are thicker near their periphery than at their inner edges, and they match to nearly-corresponding flanges on the part below. The part below is marked A^2, and the flange thereon is marked a^2. The flanges, when properly faced and applied together, make a tight union, either by the direct contact of the metal or by the interposition of a suitable cement; but such contact and union is only at and near the outer edge. The main breadth of the flanges are held a little distance apart. There is a lip, a^3, on the upper face of the flange a^2, which matches against a shoulder on the inner boundary of the bearing surface of the flange A^1, and holds the parts stiffly in position laterally. There may be any number of bolts and nuts or other ordinary or suitable means for holding the bearing parts of the flanges a^1 a^2 strongly together. The lower casting A^2 is necessarily maintained at a high temperature. The upper casting A^1 should be cooler. It follows that there is a constant tendency to conduct the heat upward from the hot casting A^2 to the cooler casting A^1. This I do not attempt to altogether prevent; but my construction retards it by compelling the heat to travel outward on the flange a^2; thence across and preferably through a non-conducting cement into the outer edge of the flange a^1; thence inward on the flange a^1; and finally upward into the body of the metal of the cool cylinder A^1. The long distance which it is, by this construction, compelled to traverse makes the transmission of the heat very slow. The hot cylinder A^2 is of a larger internal diameter than the main cylinder A^1, and contains a lining, A^3, which is of a highly non-conducting character. The material which I prefer, and believe to be peculiarly adapted for this and the other non-conducting linings, will be described further on. The non-conducting lining in this position, whatever be its material, serves the important function of maintaining a very high temperature within the lower or hot cylinder while imparting a considerable lower temperature to the metal A^2. This is due partly to the fact that there is a lining in a separate piece from the metal A^2, and partly to the fact that the lining-piece is a highly non-conducting material. If the lining was a conductor equal in quality to cast-iron, it would still serve to some extent as a shield to arrest the conduction of the heat by reason of its thickness, and more especially of the joint or crack between itself and the outer piece. Every such joint tends to arrest the conduction of the heat; but the non-conductor which I employ is far superior to cast-iron for this purpose. The piston is thick, and its lower portion is highly non-conductive. It may not be necessary to describe the preferable materials. I propose to use fire-brick, fire-brick dust, fire-clay or other clay, finely-pulverized ashes, fine ashes, or any compounds of these or other non-conducting materials, within a casing of cast-iron or other suitable material; but I give the preference, for lightness and other reasons, to a thin shell of good sheet-iron riveted up in the proper form and filled with lightly-packed pulverized charcoal. The bottom is deeply recessed, as shown, and adapted to match to a correspondingly-formed bottom-piece, A^4, which is easily detached and renewable at pleasure. A^5 is the shell of the furnace, which, spread out below, forms a broad substantial base of the engine. The framing for the pillow-block or bearing of the main shaft, which bearing is not represented, may be cast in one with or bolted or otherwise fixed to this casting A^5; or it may be fixed to the top casting A^1, or to both these parts, or mounted independently, at pleasure. A^6 is the grate, and A^7 a thick non-conducting lining of fire-brick, which covers the whole interior of the furnace, including the base of the heater A^4, except a small space in line with the center of the heater, as shown. The intensely-heated gases from the interior of the furnace play up and down through the narrow passage thus provided and heat the interior of the heater A^4; but the fire-brick protect such interior from the main portion of the radiant heat of the fuel, and thus promote its durability.

Under ordinary conditions, when the engine is being worked at or near its full power the air flows down through the pipe B into the bottom of the furnace; thence up through the grate and fuel; thence laterally out through the passage C into the passage D; whence it passes the valve F, which is raised by the action of the engine at the proper time, and is thence discharged tangentially into the narrow annular space around the base of the heater. The air thus conducted travels actively several times around as the piston rises, and effectually licks off the heat, which would otherwise become excessive, and promotes the efficiency of the engine by absorbing the heat thereof into the air. It may be remarked that the air, however intensely heated in the furnace, is liable to become partially cooled in its passage through and retention in the passage D and its connections. This active circulation in the base in direct contact with the heater may be said to reheat the air.

There is a condition in which the machine is liable to work at intervals in some kinds of work. It may work in this condition a large portion of the time where the air is carried in a cold or nearly cold state into the passage D and thence into the base of the working cylinder. This is when the engine is yielding too much power.

There may be a regulator of any ordinary or suitable character, not represented, attached to the engine to regulate the speed by any approved means. When the heat is greatly in excess of that required the governor so operates a valve, F, Fig. 1, that the air is no longer discharged, either in whole or in part, through the grate, but is all sent past the furnace in a cold or nearly cold state. The passage through which this is effected is shown in part in Fig. 1, marked G. The air thus delivered circulates inward and outward with each fluctuation in its pressure through the passage C, and thus mingles itself more or less with the hot products of combustion and becomes itself partly heated.

In the engines previously known all the air is carried under these conditions directly through the upper portion of the furnace; in such case it is all subjected to the influence of the fire and to contact with the intensesly-heated surfaces. It also acts to some extent as a stimulant to the fire by blowing upon its upper surface.

My arrangement avoids this, and the only introduction of the cool air into the furnace is due to the fluctuations in its pressure. When the pressure is the greatest the compression of the air in the furnace allows a portion of the air in the passages D G to flow inward through the passage C and increase the quantity in the furnace. When, a moment later, the lifting of the valve F and the passage of a portion of the compressed air into the working-cylinder has lowered the pressure, then the expansion of the air in the furnace drives out a corresponding quantity in passage C to mingle in the cold air and be carried over into the cylinder.

Inviting attention now to the work at or near the top of the machine, it will be seen that the piston-rod h is connected directly to the beam I without the intervention of any links; that the beam is mounted by its center on stout links J, which receive and resist the up-and-down force and allow the effect of the piston to be transmitted through the connecting-rod K to the crank L in the obvious manner, while the links J are free to turn and allow the beam to accommodate itself to the true rectilinear motion of the piston-rod. There are parallel-motion rods J′ fixed at one end in the beam and the other end to the stiff brackets A^8, which project upward from fixed work below, the functions and proper proportions of which are familiar without detailed description. The space in the main cylinder A^1 above the piston H serves as the pump. At each descent of the piston H the air is received through a liberal annular aperture controlled by a valve, M, which may be a ring of metal covered with any suitable material to fit tightly and act noiselessly. I have in my experiments found leather to do well in this position, and have also employed double cut leathers as the packing in my piston H. The ring-valve M is held up to its seat during a portion of the revolution by the pressure of the air below; but it is important to hold the valve wide open during the early portion of the up-stroke of the piston. There are two supporting-rods, *m*, and one at each side of the engine. These rods are fixed to the ring-valve M and are pivoted upon one end of the loaded lever N. There are two of these levers N, one over each side of the machine, connected to the two rods *m*. The loaded end of the lever N is just sufficiently weighty to balance or a little more than balance the valve M. An arm projects upward from each lever N, to which arm is pivoted a horizontal rod, O, which is guided so that it stands in a horizontal position, and is capable only of a sliding motion backward and forward. As the valve M rises and sinks by means of these rods O the valve is held forcibly open during a portion of the up-stroke of the piston. On the down-stroke of the piston H the valve M sinks and allows the cool air to be inducted freely; before the piston has completed its down-stroke an adjustable piece, P, mounted in a slide, Q, connected with the working-beam I at a point, *q*, as shown, is moved downward and stands opposite the end of the slide O on each side of the engine—that is to say, there are two of these slides Q and two of the adjustable pieces P corresponding to the two slides O. When the piston commences to rise and drives upward the air below the valve M it tends to move the valve upward and close it; but this movement is prevented by the contact of the slides O against the pieces P. During all the early portion of the ascending motion of the piston H the air above it is allowed to escape freely past the valve M; but when a certain portion, usually about one-third, of the up-stroke has been performed, the pieces P have moved up sufficiently to liberate the slides O, and now the levers N are allowed to tilt and the valve M to close. After this change of condition the air above the piston becomes compressed by the further ascent of the piston and is ultimately delivered through the valve R into the passage B, and thence passes where it is made efficient in driving the engine, as before explained. By reason of the adjustability of the pieces P the period at which the valve M is allowed to close may be made earlier or later, at pleasure.

It is important that the aperture of the door of the furnace be conveniently opened and closed with little labor, and that the closing may be made very tight. I have provided for this by means of a stout sliding bar, peculiarly mounted, and provided with screws for pressing against the door after the bar or bolt is secured. T is the door, turning on the hinge *t*. U is a stout bolt provided with a slot, which embraces the pin *t* and permits a sufficient end motion to allow it to serve as a bolt. When the door T is to be opened or shut the bolt U is drawn backward to liberate it from the keeper A^9; but when the door is closed and it is desired to secure it tightly it is necessary simply to move the stout bar or bolt U bodily so as to engage with the keeper A^9, and then to turn the screws V V, which are tapped through the bolt U and act directly against the door T. The inner face of the door T may be lined with a non-conductor.

I have provided a non-conducting lining within the pipe D and pipe C as well as within the hot portion of the cylinder. All these non-conducting linings may be made by holding ashes, pulverized, or other good non-conductor, in position by a casing of sheet-iron or the like; but this is not the best plan. I have discovered that in this position a good lining can be made with a mixture of about equal weights of calcined plaster and ground glass; the glass may be in the condition in which it is prepared in the market for the manufacture of fine abrasive surfaces. The plaster may be the ordinary calcined material. On being thoroughly mixed in the proportions here designated and moistened with a proper quantity of water the plastic material may be made to adhere to the inner surface of the main cylinder A^2 and to the inner surface of the pipe D and C. It will harden and form a very tenacious coating, while its non-conducting qualities are remarkable.

I esteem this manufacture of lining an important feature in my invention. The contour of the inner faces of the parts of the lining of all the parts may be formed and preserved by molding with any suitable removable material.

Although I have shown only one flange, a^1, and one flange, a^2, adapted to cause the heat to traverse out and back once in its transmission from the hot cylinder A^2 to the cool cylinder A^1, I propose in some instances to employ a greater number by introducing rings with corresponding broad flanges between these flanges, so as to cause the heat to traverse out and in as many times as may be desired. The quantity of air contained in the thin spaces provided between the flanges will produce no appreciable effect in the working of the engine, and the elasticity of the parts will not, I think, be sufficient to induce any appreciable mischief.

I claim as my improvements in air-engines—

1. The mode of operation of the valve M to allow the escape of air during a portion of the stroke and to close and compel the delivery of the air through the valve R during the remainder of the stroke, so as to make the main cylinder A^1 and main piston H serve as the compressing-pump for delivering a smaller volume of air than the capacity of the cylinder, as specified.

2. The adjustable pieces P or their equivalents, operated by the engine, and serving to hold open the induction-valve M during a variable portion of the return stroke, substantially as herein specified.

3. The construction and arrangement of the heater A^4 and the adjacent parts, and tangential passage through which the air is delivered, so that the air shall traverse around in the space provided for the purposes specified.

4. The passages G, D, and C, arranged, as rep-

resented, relatively to the valve F and to the working parts of an air-engine, so that the cool air shall be only partially introduced into the top of the furnace, as specified.

5. The broad flanges a^1 a^2 bearing at or near their outer edges, as represented, to prevent the conduction of the heat between the parts while maintaining a firm union thereof, as specified.

6. The tightening means V, mounted on the sliding bolt U, and the whole arranged to traverse on the hinge-joint t and to secure and liberate the door T, substantially in the manner as herein specified.

7. The beam I, links J, connecting-rod K, parallel-motion links J^1, and brackets A^8, arranged, as represented, relatively to each other and to the piston-rod h, and to the valve-operating means Q q P N, for the purposes set forth.

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

A. K. RIDER.

Witnesses:
C. C. LIVINGS,
A. HOERMANN.

(2)