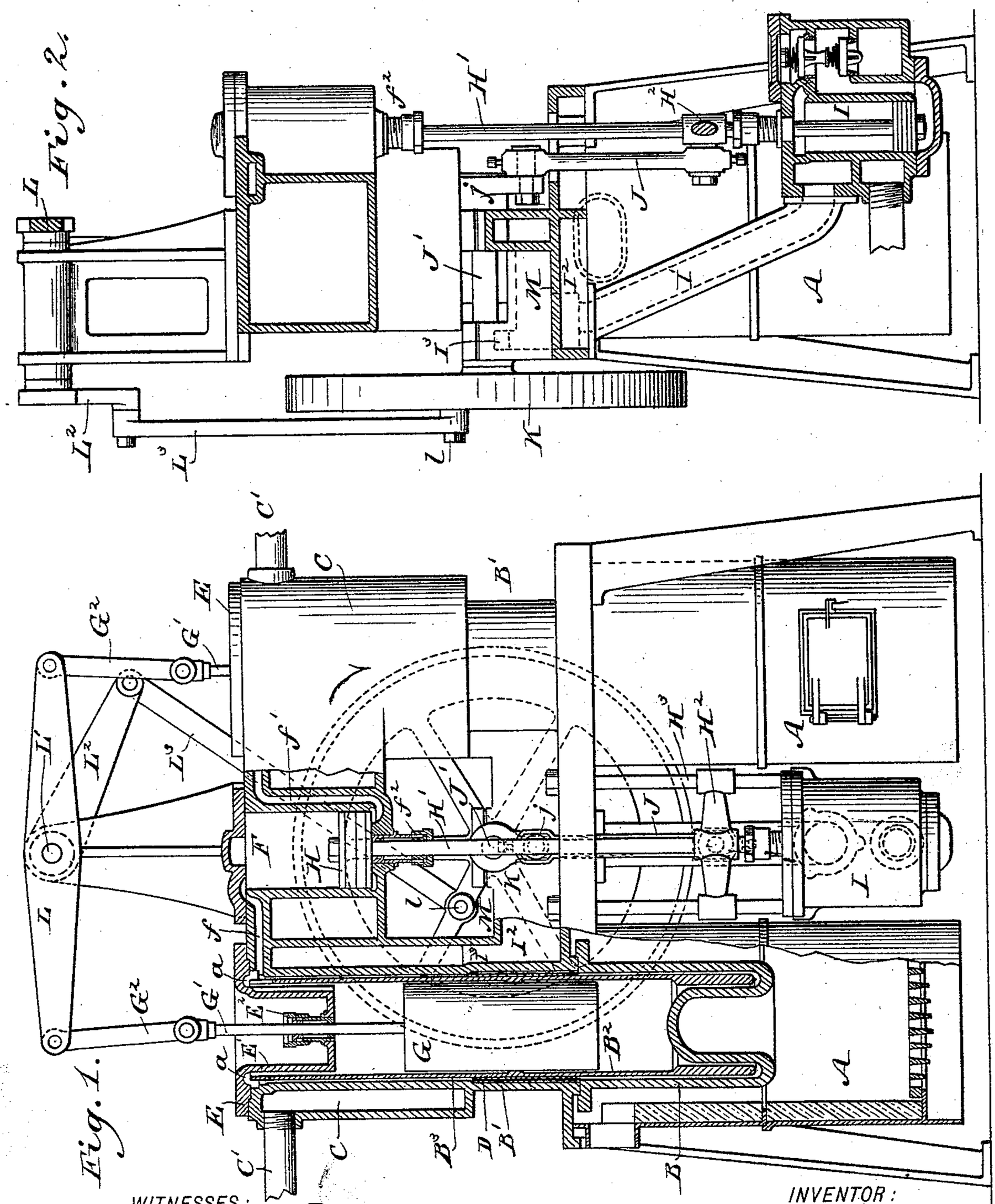
(No Model.) 2 Sheets—Sheet 1.

S. VIVIAN.

HOT AIR ENGINE.

No. 437,320. Patented Sept. 30, 1890.



(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

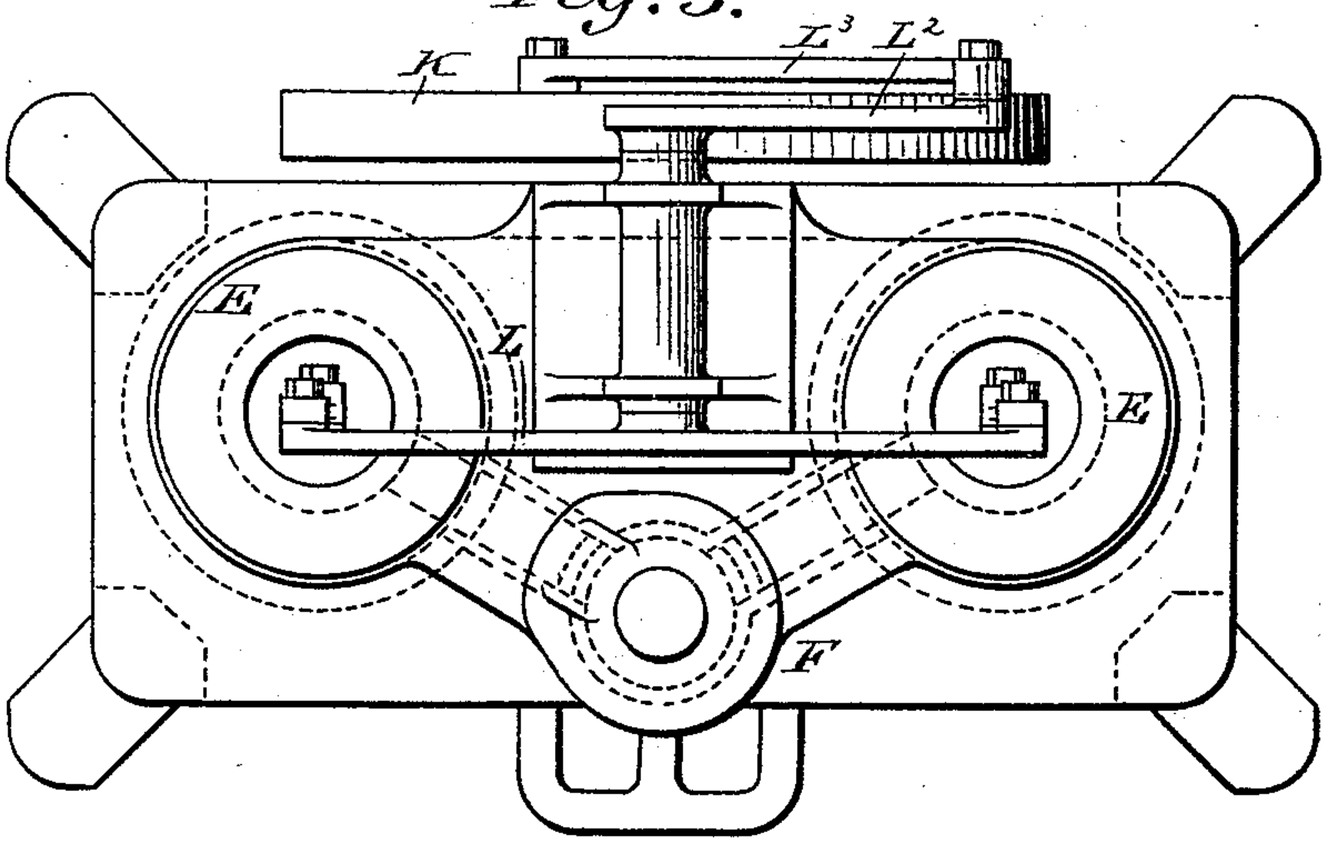


Fig. 4.

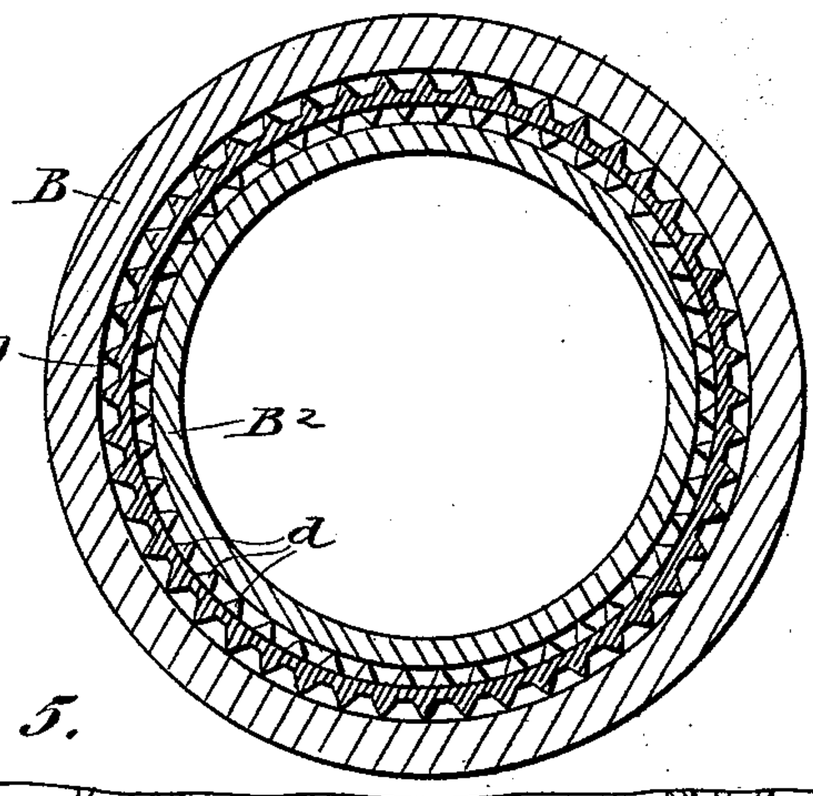


Fig. 6.

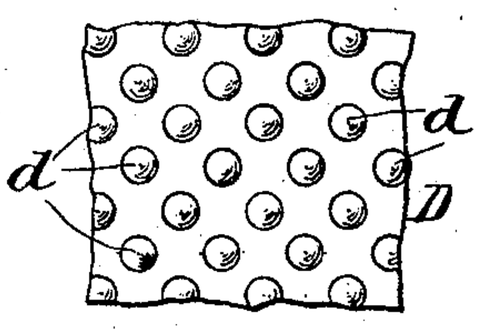
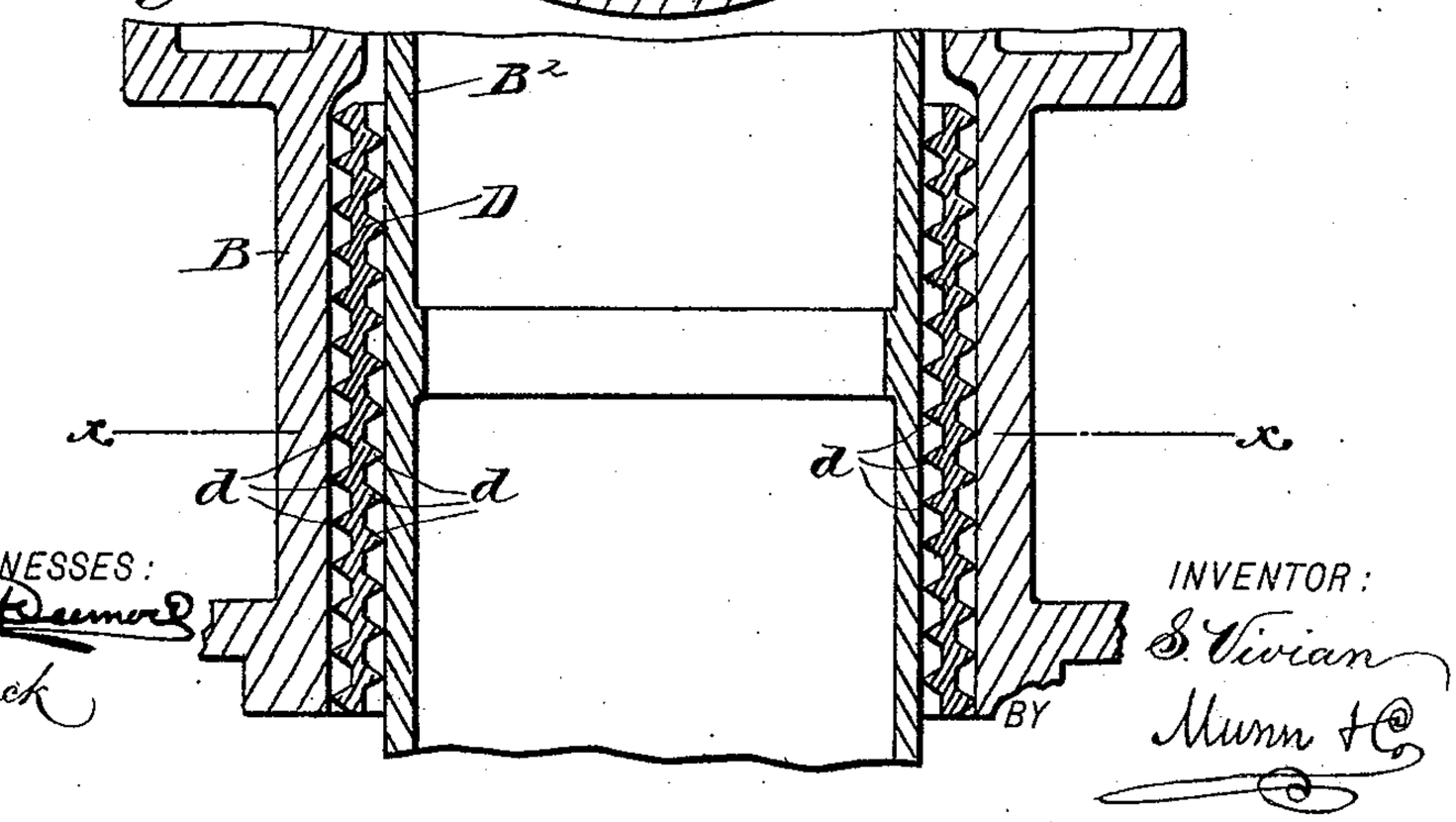


Fig. 5.



WITNESSES:

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UNITED STATES PATENT OFFICE.

SIMON VIVIAN, OF BROOKLYN, NEW YORK.

HOT-AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 437,320, dated September 30, 1890.

Application filed November 1, 1889. Serial No. 328,911. (No model.)

To all whom it may concern:

Be it known that I, SIMON VIVIAN, a subject of the Queen of Great Britain, residing at the city of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Hot-Air Engines, of which the following is a full, clear, and exact description.

This invention relates to that class of hot-air engines wherein the same or substantially the same volume of air is alternately heated and cooled, producing a variation of pressure which actuates the power-piston; and it consists, mainly, in making the engine double-acting, the power-cylinder being inverted and placed together with the crank-shaft between the reversers or heating and cooling cylinders.

The invention further consists in the construction, arrangement, and combination of parts, all as hereinafter described and claimed.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in the several views.

Figure 1 is a front elevation of the engine, partly broken away and in longitudinal vertical section. Fig. 2 is a side elevation of the same, partly in transverse vertical section. Fig. 3 is a plan view of the same. Fig. 4 is a sectional plan view of one of the heating-cylinders, taken on the line $x\,x$ of Fig 5, showing the regenerator therein. Fig. 5 is a vertical section of the same; and Fig. 6 is a view of part of the regenerator, showing the staggered arrangement of the projections thereon.

The engine is constructed with duplicate furnaces A, in each of which is fitted an air-heater B, by which the confined air which operates the engine is heated in the manner usual to hot-air engines. To the upper end of each of the heaters is attached a cylinder B′, around the upper portion of which is fitted a cooler C, supplied with water for cooling the air, as hereinafter stated.

Within each of the heating and cooling cylinders is fitted a telescopic sleeve B^2, so as to provide between the same a space B^3 for the circulation of the air in a thin body to insure a thorough and rapid heating and cooling of the same on its way to and from the heaters and the power-cylinder. Just below the cooler and the space B^3 and surrounding each telescopic sleeve is placed a regenerator D, consisting of a sheet or sheets of metal shaped to the contour of the heater, and having upon both faces projections *d*, as shown in Figs 4, 5, and 6, which projections have a staggered arrangement, as best shown in the latter-named figure, whereby the air on its way to and from the power-cylinder and heaters is forced to take a winding course, and is thereby completely acted upon by the regenerators.

The upper ends of the cylinders B′ are closed by heads or covers E, the under faces of which are recessed above the ends of the telescopic sleeves, thus providing spaces *a* for the passage of the air. Said heads or covers are also constructed with downwardly and inwardly projecting portions E′ of less diameter than that of the telescopic sleeves, and within the same are fitted stuffing-boxes E^2, in which work the rods G′ of pistons G, which work within the telescopic sleeves in the heating and cooling cylinders.

The power-cylinder F, which is inverted, is located between the heating and cooling cylders, is connected at its upper end by a port *f* with the left-hand cylinder, and at its lower end by a port *f′* with the right-hand cylinder, and in its bottom has a stuffing-box f^2, in which works the rod H′ of its piston H, which piston-rod also operates the piston of a pump I, located beneath the power-cylinder in alignment therewith and connected in the usual manner to a source of water-supply.

The piston-rod H′ is connected to a cross-head H^2, guided on vertical ways or rods H^3, and the cross-head is connected by a rod J with a crank *j* on a shaft J′, journaled beneath the power-cylinder and in alignment therewith and with the pump in bearings on a bed-plate M, located between the heating and cooling cylinders. Said shaft J′ carries at its rear end a fly-wheel K, the wrist-pin *l* of which is connected by a rod L^3 with one end of a lever L^2, secured at its other end to a rock-shaft L′, journaled in bearings above and at the rear of the power-cylinder, on which shaft is mounted a walking-beam L, connected at its ends by links G^2 with the rods G′ of the pistons G of the reversers or heating and cooling cylinders.

The pump I is connected by a pipe I′ with a chamber I^2 in the bed-plate M, whereby wa-

ter may be forced into said chamber to cool the bearings of the shaft J′, and ports I^3 lead from said chamber to the bottoms of the coolers C, so that the water may pass into said coolers to lower the temperature of the air, said water finding exit from the coolers through the discharge-pipes C′.

The operation of the engine is briefly as follows: The fly-wheel K is first thrown over by hand or other means in the direction of the arrow shown in connection therewith in Fig. 1, whereby the walking-beam is actuated to depress the left-hand reverser-piston and at the same time raising the right-hand reverser-piston. As said left-hand piston passes downward the heated air below it is displaced and is transferred to the space above the piston, passing in its course through the regenerator, where it is deprived of the greater portion of its heat, and past the cooler, where it is further cooled. As the fly-wheel further revolves the reverser-piston is raised, causing the air to be transferred to the heater, it being raised in temperature as it passes the regenerator by the heat stored therein as the air passes upward to the cooler, and upon reaching the heater B this air is again heated to its initial temperature or higher by the action of the furnace underneath said heater. This alternate raising and lowering of the reverser-piston and the accompanying alternate heating and cooling of the air produce a variation of pressure on the power-piston, causing it to rise and fall and operate the pump below it.

It will be noticed by reference to Fig. 1 of the drawings that when the power-piston is in its lowermost position the reverser-pistons are in substantially an intermediate position in their cylinders.

Having thus fully described my invention, I claim as new and desire to secure by Letters Patent—

1. In a hot-air engine, the combination, with a heater, a cooler around the upper end of the reverser, and a telescopic sleeve extending from end to end of the heater and cooler, of a regenerator surrounding the telescopic sleeve below the cooler and having staggered projections on both faces, substantially as shown and described.

2. In a hot-air engine, the combination, with a pair of heating and cooling cylinders and an inverted power-cylinder between said cylinders and in communication therewith at its top and bottom, of a pump beneath and in alignment with the power-cylinder, a piston-rod working in the power-cylinder and pump, a cross-head on the piston-rod, a crank-shaft journaled beneath and in alignment with the power-cylinder, and connections between the cross-head and crank-shaft, substantially as shown and described.

3. In a hot-air engine, the combination, with a pair of heating-cylinders fitted in furnaces and a power-cylinder between said cylinders and in communication therewith at its top and bottom, of coolers at the upper ends of the heating-cylinders, telescopic sleeve in said cylinders, regenerators in said cylinders below the coolers, having staggered projections on both faces, a pump beneath and in alignment with the power-cylinder and operated therefrom, and a connection between the water-chamber of the pump and the coolers, substantially as shown and described.

4. In a hot-air engine, the combination, with a pair of heating-cylinders fitted in furnaces and a power-cylinder between said cylinders and in communication therewith at its top and bottom, of coolers at the upper ends of the heating-cylinders, telescopes in said cylinders, regenerators in said cylinders below the coolers, having staggered projections on both faces, a power-shaft journaled beneath and in alignment with the power-cylinder, a pump beneath and in alignment with the power-cylinder and operated therefrom, a pipe leading from the pump to a chamber under the bearings of the crank-shaft, and ports leading from said chamber to the coolers, substantially as shown and described.

5. In a hot-air engine, the combination, with a pair of heating and cooling cylinders, pistons working in said cylinders, and an inverted power-cylinder between said cylinders and in communication therewith at its top and bottom, of a pump beneath and in alignment with the power-cylinder, a piston-rod working in the power-cylinder and pump and carrying a cross-head, a crank-shaft journaled beneath the power-cylinder and in alignment therewith and with the pump, a fly-wheel on the crank-shaft, a walking-beam mounted above the power-cylinder and connected with the pistons in the heating and cooling cylinders, and connections between the cross-head and crank-shaft and the fly-wheel and walking-beam, substantially as shown and described.

6. A double-acting hot-air engine which consists of a pair of reversers, each provided with a telescopic sleeve extending from end to end of the reverser and with independent heating and cooling mechanism, a regenerator placed around each of said sleeves between its heating and cooling mechanism, an inverted power-cylinder connected with each of said reversers and operated by each alternately, mechanism operated by said inverted power-cylinder, a crank-shaft journaled between said reversers in bearings on the bed-plate and operated by the piston-rod of said power-cylinder to drive the fly-wheel carried upon said crank-shaft, and devices for keeping said bearings constantly cool, substantially as described, and for the purposes specified.

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Witnesses:
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