(No Model.)

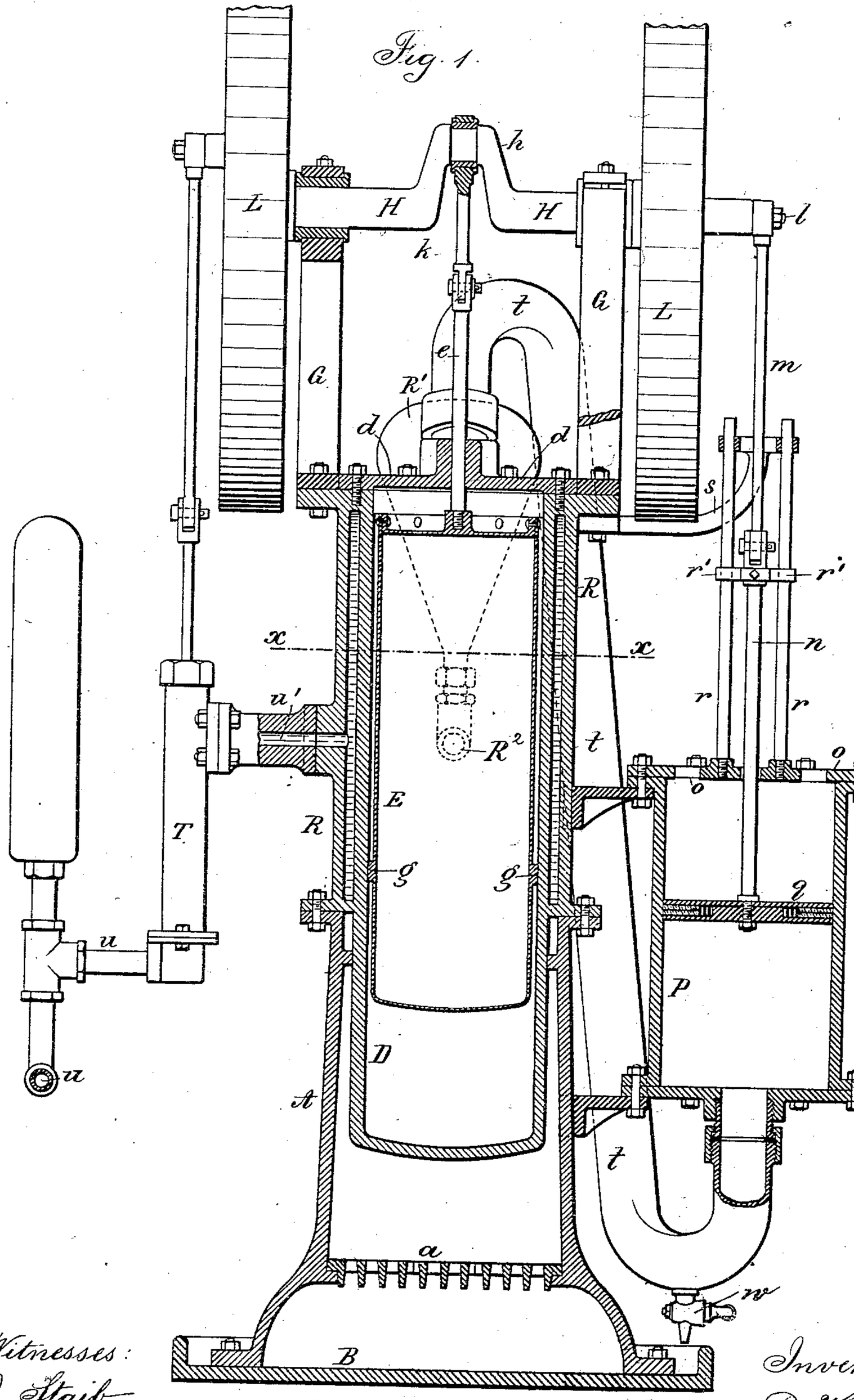
2 Sheets—Sheet 1.

# A. P. HURD.

## HOT AIR ENGINE.

No. 325,805. Patented Sept. 8, 1885.

Fig. 1.




Witnesses:
I Stair
Chas H. Smith

Inventor
Alfred P. Hurd.
per Lemuel W. Serrell atty.

(No Model.)

2 Sheets—Sheet 2.

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## HOT AIR ENGINE.

No. 325,805. Patented Sept. 8, 1885.

Fig. 2.

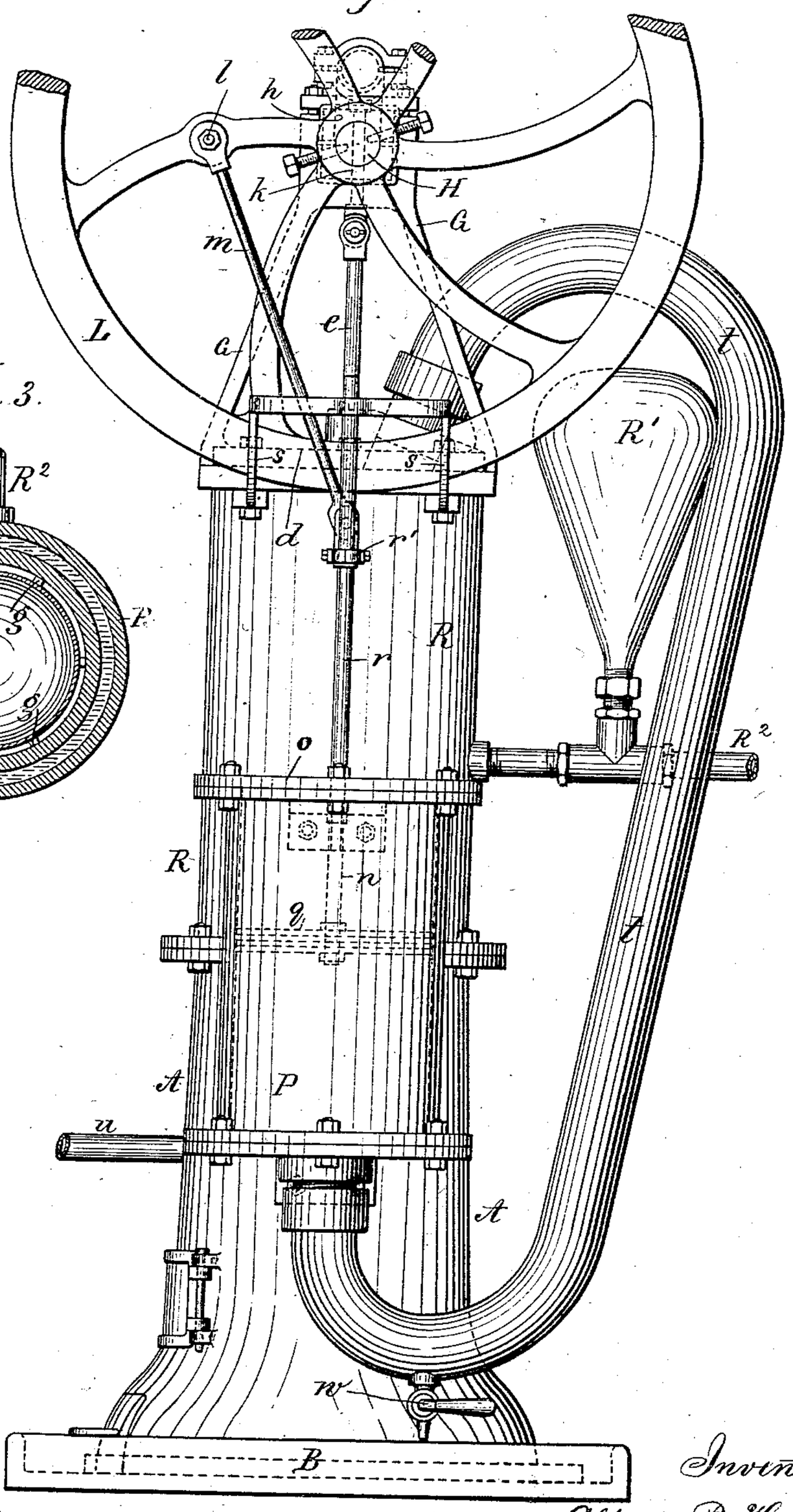
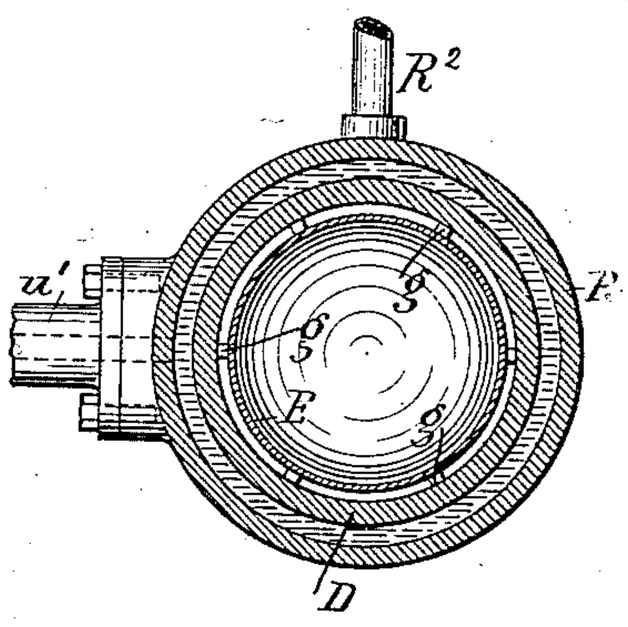



Fig. 3.




Witnesses:
I. Stair
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Inventor:
Alfred P. Hurd
per Lemuel W. Serrell

# UNITED STATES PATENT OFFICE.

ALFRED P. HURD, OF NEW YORK, N. Y., ASSIGNOR TO THE J. L. MOTT IRON WORKS, OF SAME PLACE.

## HOT-AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 325,805, dated September 8, 1885.

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

*To all whom it may concern:*

Be it known that I, ALFRED P. HURD, of the city and State of New York, have invented an Improvement in Hot-Air Engines, of which the following is a specification.

Engines have heretofore been made in which the air is confined and subjected to the action of heat to increase its volume and pressure, and thereby cause it to exert more force upon a piston when in a warm condition than it does when cooled.

In my improvements I have simplified the construction and rendered the engine more efficient than the air-engines heretofore made.

In my engine there are two cylinders with rods and connections to cranks upon fly-wheels or a shaft, which cranks are at ninety degrees apart. In the heating-cylinder there is a long displacer or plunger of sheet metal connected to the displacer-rod. This displacer does not fit closely the cylinder; but there is an air-space around it. The gas-burners or fire is at the lower end of this cylinder, and a water-jacket preferably surrounds the upper end of this cylinder. The displacer acts to transfer the air from one end of the cylinder to the other end. When the displacer is at the bottom end of this cylinder, the air is displaced from the heat and cooled by the water-jacket and contracts, and when the displacing-plunger rises the air is brought into contact with the heat and expands. From the top of the heating-cylinder there passes a pipe to the bottom of the power-cylinder, in which is an ordinary piston. As the air becomes heated it expands and acts upon the piston in the power-cylinder to raise it. The power-piston is at its half-stroke upwardly as the crank of the other cylinder turns the dead-center and begins to descend; hence the displacer transfers the air from the hot portion to the cool portion, and by the time the power-piston completes its upward stroke the air has contracted to atmospheric pressure, and the pressure, still lessening as the air cools down, allows the superior atmospheric pressure, acting outside the power-piston, to drive it down, and the displacer commences to raise and transfer the air from the cooled portion to the heated portion, and the expansion is again taking place to drive up the power-piston as soon as its crank turns the center, and so on the operations are repeated.

In the drawings, Figure 1 is a vertical section of the power and heating cylinders, piston, and displacer. Fig. 2 is an elevation of the engine at the power-cylinder side, a portion of the fly-wheel being removed; and Fig. 3 is a sectional plan of the heating-cylinder at the line *x x*.

The vertical case A is upon a suitable base, B, and within the same are grate-bars *a* for fuel; or there may be gas-burners or other sources of heat. Within this case there is the heating-cylinder D, closed at the bottom, and having a movable head, *d*, with a gland or box, through which the displacer-rod *e* passes; and E is the displacer upon the lower end of the rod *e*, having guide-lugs at *g*, to keep the displacer central in the cylinder D.

Above the case A there are standards G, that support the shaft H, having a crank, *h*, and connecting rod *k* to the piston-rod *e*.

There is a fly-wheel, or, preferably, two fly-wheels, L, and upon one of these there is a crank-pin, *l*, and a connecting-rod, *m*, to the piston-rod *n*, that passes through the head *o* of the cylinder P, and is connected to the piston *q*. There are guide-bars *r* and a cross-head, *r'*, for the piston-rod *n*, and these guide-bars *r* are sustained at their upper ends by arms *s*, that extend out from the top part of the cylinder D. The head *o* is open or perforated for the atmosphere to pass in upon the piston *q*, and from the bottom of the cylinder P there is a pipe, *t*, preferably of copper, extending up to the head of the cylinder D, and opening into such cylinders.

Around the cylinder D there is a water-jacket, R, and the pump T is operated by a connecting-rod to a crank on one of the fly-wheels L. The water-supply pipe *u* leads to the pump, the pipe *u'* conveys the water from the pump into the jacket R, and the water passes from the jacket R through the air-vessel R' to the pipe $R^2$, leading to the reservoir or place of delivery.

As the air becomes heated in the cylinder D by the fire or flame outside the cylinder, it expands, and it passes by the displacer E freely and goes through the pipe *t* and acts upon the piston *q* in the cylinder P. The parts are

timed so that the piston *q* is at about half-stroke when the displacer E is at the top of the cylinder D, as indicated in the drawings. The displacer E now descends, and by the time the piston *q* reaches the top of the power-cylinder P the displacer E has transferred half the heated air from the bottom of D to the top. The atmospheric air now begins to contract by the chilling action of the water-jacket R and of the atmosphere outside of the pipe *t* and the cylinder P, and the piston *q*, descending, forces the air back into the cool upper part of the cylinder D, and it contracts to its minimum volume, and the displacer, rising, again transfers the bulk of the air from the top of the cylinder D to the lower part, where it expands and acts upon the piston *q* as it rises, and the operations are repeated.

The cock at *w* is for drawing off oil and for admitting air whenever necessary. It is to be understood that the pressure of air within the engine is about the same as the external pressure of the atmosphere when the power-piston is at the ends of its stroke, and that the pressure increases to its maximum as the power-piston rises, and then it decreases again, and that the minimum pressure is when the power-piston is at the middle of its descending stroke.

I find it preferable to make the displacer of sheet-copper, with guides *g* to keep it at the proper distance from the cylinder D. The sheet-copper is light, and it readily absorbs heat when in the lower part of the cylinder P, and it gives out the heat to the air to heat up the same and aid it to expand, as aforesaid.

I do not claim an engine in which the confined air is alternately expanded and contracted, and acts upon a piston to revolve a fly-wheel and move the displacer, and also acts in a chamber for elevating water, as these have been used. My present improvements are made for rendering more efficient this class of engines.

I claim as my invention—

1. The combination, with the vertical power-cylinder and piston, of piston and connecting rods, a shaft, fly-wheel, cranks at r ht angles, connecting and displacer rods, a displacer, a heating-cylinder in which the displacer is moved up and down, a head through which the displacer-rod passes, and a pipe connecting the upper end of the heating-cylinder with the lower end of the power-cylinder, substantially as set forth.

2. The heating-cylinder closed at its lower end and having a head at the upper end, in combination with the inclosing-case, pump, and the water-jacket, and through which the water is pumped, a displacer within the heating-cylinder, a rod to the same passing through the cylinder-head, the cranks, shaft, fly-wheel, power-cylinder, piston, and rods, and the pipe extending from the top of the heating-cylinder to the bottom of the power-cylinder, substantially as set forth.

3. The combination, in a hot-air engine, of a vertical power-cylinder and piston, a heating-cylinder, a displacer within the same, the connecting-rods, cranks, shaft, and fly-wheel, and a pipe extending from the bottom of the power-cylinder to the top of the heating-cylinder and a cock in such pipe, substantially as set forth.

Signed by me this 30th day of December, A. D. 1884.

ALFRED P. HURD.

Witnesses:
GEO. T. PINCKNEY,
WILLIAM G. MOTT.