(No Model.)

2 Sheets—Sheet 1.

H. ROBINSON.

HOT AIR ENGINE.

No. 445,904. Patented Feb. 3, 1891.

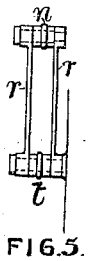

FIG. 5.

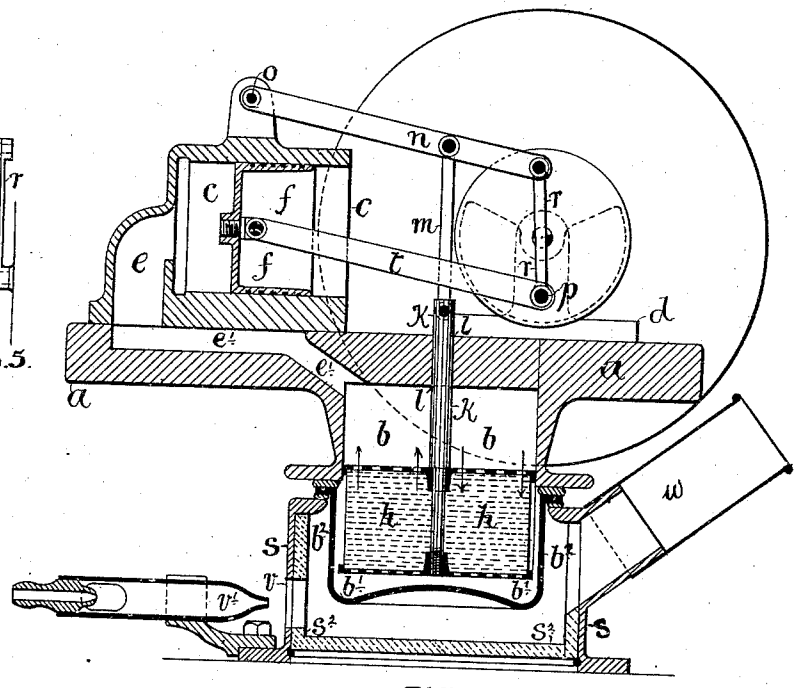

FIG. 1.

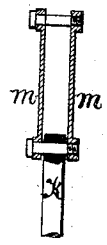

FIG. 4.

FIG. 6.

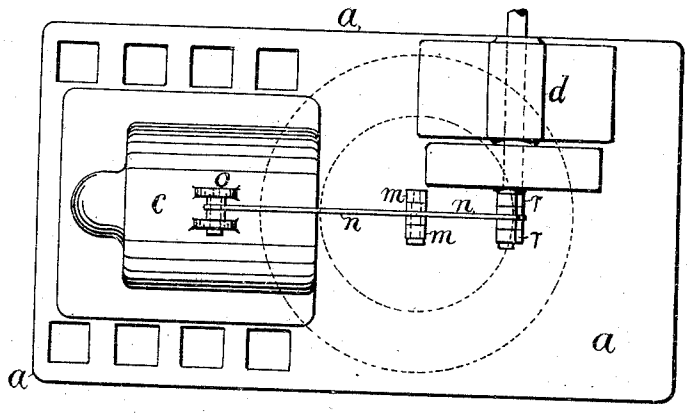

FIG. 2.

Witnesses:
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Robert Everett.

Inventor:
Horace Robinson
By James L. Norris.
Attorney.

(No Model.)

2 Sheets—Sheet 2.

H. ROBINSON.

HOT AIR ENGINE.

No. 445,904. Patented Feb. 3, 1891.

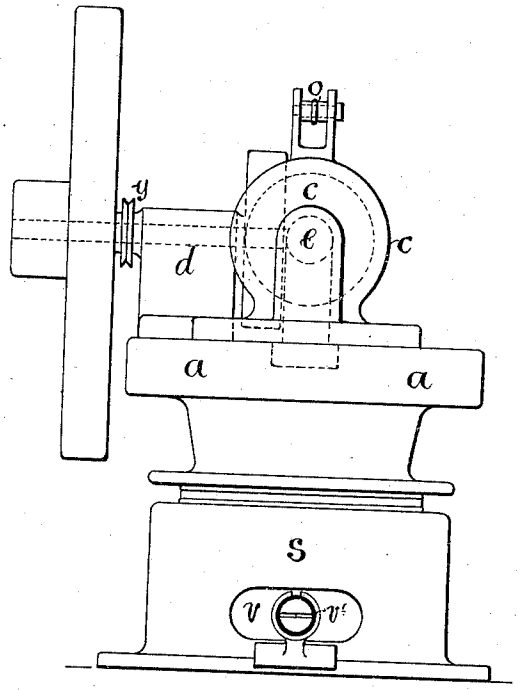

FIG. 3.

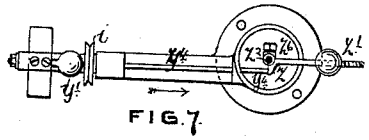

FIG. 7.

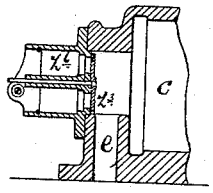

FIG. 11.

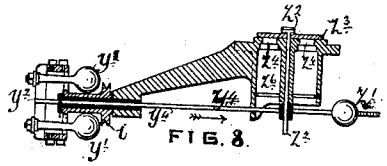

FIG. 8.

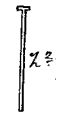

FIG. 10.

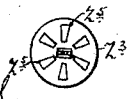

FIG. 9.

Witnesses:
J. A. Rutherford.
Robert Gorrett.

Inventor:
Horace Robinson
By James L. Norris.
Attorney.

UNITED STATES PATENT OFFICE.

HORACE ROBINSON, OF MANCHESTER, ENGLAND.

HOT-AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 445,904, dated February 3, 1891.

Application filed April 25, 1890. Serial No. 349,532. (No model.) Patented in England January 8, 1889, No. 298; in France October 17, 1889, No. 201,391; in Belgium October 17, 1889, No. 88,099; in Germany November 15, 1889, No. 52,196, and in Italy February 26, 1890, XXIV, 27,060.

To all whom it may concern:

Be it known that I, HORACE ROBINSON, a subject of the Queen of Great Britain and Ireland, residing at Manchester, in the county of Lancaster, England, have invented new and useful Improvements in Hot-Air Engines, (for which I have obtained a patent in Great Britain, No. 298, bearing date January 8, 1889; in France, No. 201,391, dated October 17, 1889; in Belgium, No. 88,099, dated October 17, 1889; in Germany, No. 52,196, dated November 15, 1889, and in Italy, Vol. 24, No. 27,060, dated February 26, 1890,) of which the following is a specification.

This invention has for its object the simplification of arrangement and construction combined with increased efficiency in action of that description of hot-air engine in which an air-chamber is employed in which the air is alternately heated and cooled, and the consequent expansion and contraction thereof is utilized to produce motive power.

The improvements refer especially to engines of small power—such, for instance, as the driving of ventilating-propellers, &c., and to those in which an air-chamber is arranged with its axis at or about right angles with that of the working-cylinder.

My improvements consist in extending the upper part of the air-chamber into a table or platform to form a bed for supporting the working-cylinder and crank-shaft bearing or bearings, which shall at the same time, by reason of the mass of metal contained within it and owing to its extended area, be sufficient to absorb and disperse the heat, and thereby dispense with the necessity of the usual water-jacket, hitherto found necessary for cooling the upper end of the air-chamber; also, in constructing the working-cylinder, I arrange it with its rear end closed and in one piece with the cylinder and with a port or passage cast therein communicating with the heating-chamber through a similar port or passage in the table or platform, whereby a direct communication is obtained, the making of several joints is dispensed with, and first cost reduced.

My improvements further refer to a simple arrangement of mechanism for working the regenerator or displacer from the crank-pin without imparting any angular or twisting strain to the connecting rod or piston of the working-cylinder, and whereby such regenerator or displacer is operated with a minimum of friction.

Lastly, my improvements consist in a simple arrangement of governing apparatus for regulating the speed of this class of hot-air engine, consisting of a disk valve provided with "hit-and-miss" apertures in its surface and seating. To this valve a partial rotation upon its (by preference) horizontal axis is imparted, so as to open the apertures by the spindle of the centrifugal governor-balls as they fly outward, pressing against the shorter arm of a suitably-weighted bell-crank lever.

On the accompanying sheets of drawings, Figure 1 is a side sectional view of my improved engine, and Figs. 2 and 3 are plan and end views of the same, respectively.

a is the platform or table forming an extension of the air-chamber *b*. This platform or table serves the part of a bed upon which the working-cylinder *c* and the crank-shaft bearing or bearings *d* are mounted, and at the same time, as before observed, its mass absorbs and its surface disperses away sufficient heat to cool the upper part of the said chamber *b*. The lower part of this chamber *b'* is inclosed by the heater b^2, formed of iron, steel, or other suitable material. The working-cylinder *c* is cast with one end closed and the other open, and the closed end has a port or passage *e* cast in it. This port or passage *e* is in free communication with the port or passage *e'*, cast or formed in the before-mentioned table or platform *a*, leading to the chamber *b*, so that the varying pressure of air in the air-chamber *b* is free to act upon the piston *f*, working in the said cylinder *c*. In this manner a more direct communication is obtained between the working-cylinder and the air-chamber without branch pipes, and whereby the making of several faced joints is dispensed with.

h, Fig. 1, is the displacer or regenerator arranged to work up and down in the air-cham-

ber *b*, and consisting, preferably, of a metal casing—say of iron or steel—with openings at the top and bottom, through which the air will pass, (in the direction of the arrow, see Fig. 1,) this casing being filled with wire-gauze, asbestus, yarn, or other suitably-perforated material, through which the air will pass. I have found tangled wire to answer well.

k, Fig. 1, is the displacer or regenerator rod extending out into the open air through the long hole *l*, as shown, the hole being so long from *l* to *l* that the rod *k* is not only guided by it to and fro, but passes through it practically air-tight and without necessitating a stuffing-box or the use of packing. The said rod *k* is attached by links *m m*, Figs. 1, 2, and 4, or by a single forked link to the arm or lever *n*, the fulcrum of which lever *n* is at *o* upon the top of the working-cylinder. The arm *n* is connected at its front extremity to the crank-pin *p* by a link on each side *r r*, Figs. 1, 2, and 5, so that the strains are central, and no twisting strain is thrown upon the said arm or lever *n*. Fig. 1 shows a side view, Fig. 2 a plan, and Figs. 4 and 5 a front view, of these links. The working-piston *f* is connected by the connecting-rod *t*, Figs. 1 and 2, to the before-mentioned crank-pin *p*. In this manner it will be observed that the connecting-rod *t* is brought quite centrally to the crank-pin *p* and has no other office to perform than to transmit the power.

The air-chamber is heated at its lower part or end either by a furnace or other means; or, as shown in Figs. 1 and 3, the casing *s* (preferably of cast-iron) is formed with a hole *v* in it at one side and a chimney or exit *w* at the other. The said hole *v* is placed in such a position that a gas-flame of the Bunsen type is drawn or enters through it, and the flame impinges upon the heater or lower part of the air-chamber to heat it.

The burner *v'*, being outside the casing *s*, as before mentioned, can be readily lighted. The burner may be flattened, as shown at *v'*, Figs. 1 and 6, to spread the flame.

s^2, Fig. 1, is a lining of asbestus or other non-conductor of heat. As before mentioned, the engine is of that type in which the air is alternately heated and cooled, and its action may be described as follows:

As the regenerator or displacer *h* is raised, the air is heated and expanded and the piston is driven outward. The regenerator or displacer *h* is now lowered in advance of the piston. Its descent cools and contracts the the air, and the piston moves inward. The regenerator or displacer is again raised in advance of the piston, and the cycle is repeated.

Figs. 7, 8, 9, 10, and 11 illustrate various views and details of my improved governing apparatus and show the means of controlling the speed of the engine and stopping it when required. Fig. 7 is a back elevation, and Fig. 8 a sectional plan, of the centrifugal governor *y* and valve apparatus. Fig. 9 is a front view of the disk valve z^3, and Fig. 10 shows a separate view of the valve spindle z^2. Fig. 11 is a side sectional view of the end of the working-cylinder, showing, also, the valve apparatus in position.

The centrifugal governor may consist of a pair of balls *y'*, affixed equidistant from the horizontal axis of the governor to a spring-blade y^2. This governor is revolved (from a grooved pulley *i* on the crank-shaft) by an endless cord passing around its driving-pulley y^3. The disk valve z^3 is capable of being opened and closed by turning partially upon its horizontal axis, and being provided with hit-and-miss apertures or orifices z^5, (see Fig. 9,) which correspond with similar holes or orifices z^4, formed through the valve-seating. The spindle z^2 of this valve passes through to the outside, and is there provided with a bell-crank lever *z*, the longer arm of which is provided with an adjustable weight *z'*, while between the shorter arm of such bell-crank lever and the spring-blade y^2 of the governor a sliding rod y^4 is interposed. In this manner any movement of the said spring-blade either inward or outward is instantly communicated to the bell-crank lever, and thus the disk valve z^3 is opened and closed.

z^6, Figs. 7, 8, and 11, is the small chamber, which is filled with cotton waste or other material to subdue the sound of the escaping air.

The action of this improved governor and valve apparatus is as follows: When the parts are in position, as shown in Figs. 7 and 8, the valve z^3 is so situated that the holes z^5 in it are not over the holes in z^4 in the seat, and therefore the air cannot escape, the weight *z'* tending to keep the valve shut. When, however, the speed of the engine rises, the governor *y* moves the sliding rod y^4 in the direction of the arrow, (see Figs. 7 and 8,) pressing the same against the shorter arm of the bell-crank lever *z*, and thus turns the spindle z^2. The valve z^3 is turned with the spindle, and the holes z^5 of the valve are thus brought more or less over the holes z^4 in the valve-seat, so that the air escapes, and the pressure behind the piston is thus diminished and the speed of the engine is prevented from rising unduly. The weight *z'* is also raised by the action of the governor when the speed is tending to fall. The weight, &c., overcome the tendency of the governor and more or less turn the valve, thus closing it. The engine thus maintains its speed.

To stop the engine when desired, the weight *z'* is held up. This turns the disk valve z^3, permitting the air to escape, and so the engine is brought to a standstill.

What I do claim, and desire to secure by Letters Patent, is—

1. In an air-engine, the combination, with the air-chamber *b*, of the platform or table *a*,

forming an extension of said chamber and adapted to support the working-cylinder and crank-shaft bearings and serve as an absorber and dispenser of heat, substantially as described.

2. In an air-engine, the combination, with the air-chamber *b* and platform *a*, having an aperture *l*, of the working-cylinder and piston, the crank-pin *p*, the lever *n*, connected to the crank-pin by links *r r* on each side, the connecting-rod *t* between the piston and crank-pin, the displacer *h*, having a rod extended through the aperture *l*, and the links *m m* for connecting said rod with the lever *n*, substantially as described.

3. In an air-engine, the combination of the air-chamber *b*, the platform or table *a*, forming an extension of said chamber, and the cylinder *c*, mounted on said platform and having one end open and its other end connected through the port *e* with the air-chamber, substantially as described.

4. In an air-engine, the combination of the casing *s*, having an opening *v* at one end and the chimney *w* at its other end, the burner *u'*, located outside said casing opposite the opening *u*, the air-chamber *b*, the displacer *h*, having a rod *k*, the table or platform *a*, forming an extension of the air-chamber and having an aperture for passage of the displacer-rod, and the working-cylinder, piston, and crank-shaft bearings supported on said table, substantially as described.

In testimony whereof I affix my signature to the foregoing specification.

HORACE ROBINSON.

Witnesses:
WALTER GUNN,
EDMUND WILSON.