

J. A. WOODBURY, J. MERRILL, G. PATTEN, &
E. F. WOODBURY.

Air-Engine.

No. 228,714.

Patented June 8, 1880.

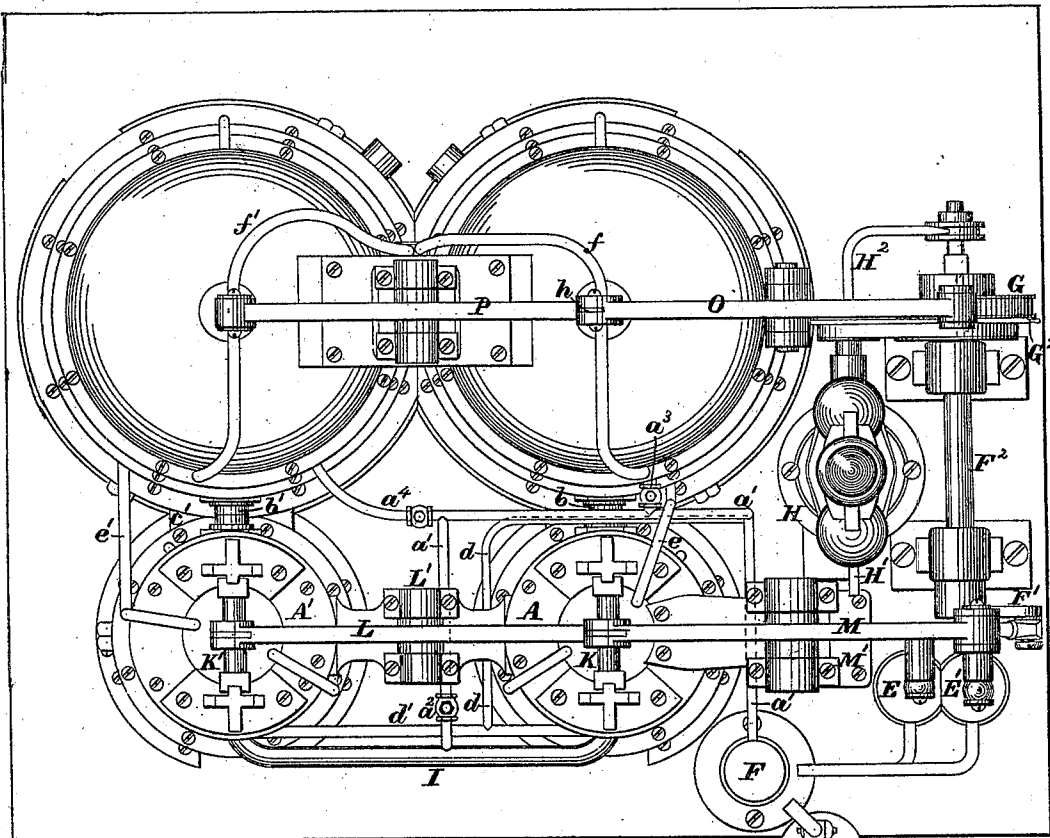


Fig. 1.

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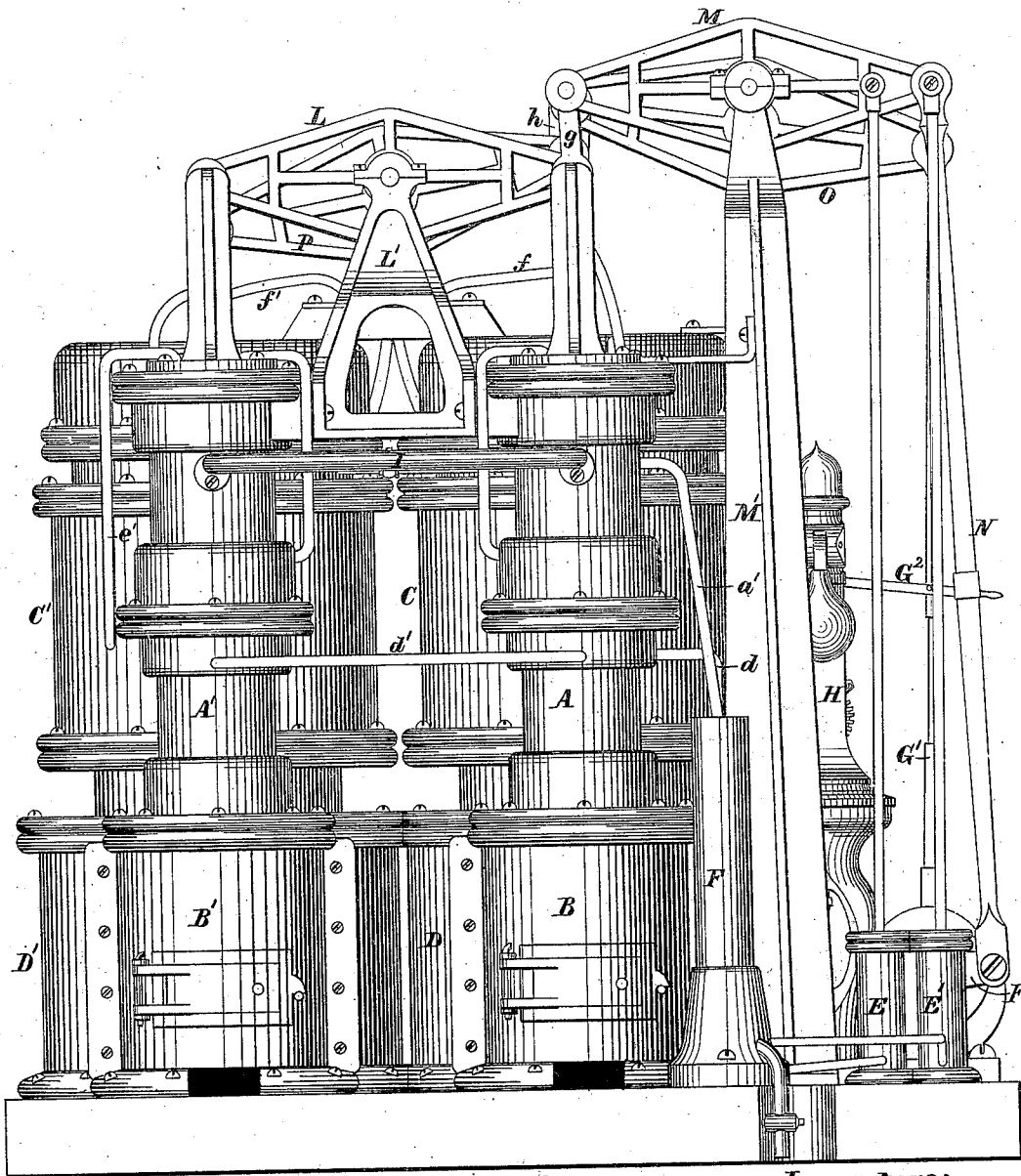


Fig. 2.

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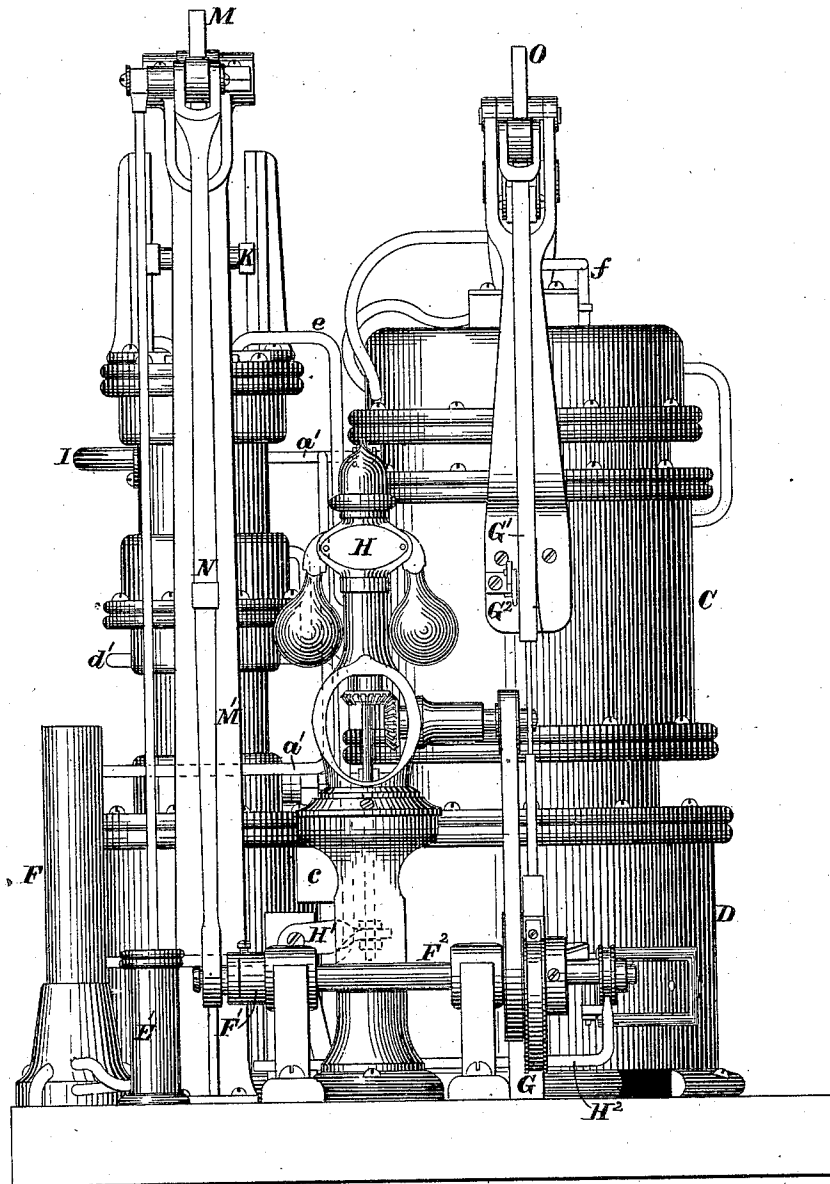


Fig. 3.

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UNITED STATES PATENT OFFICE.

JAMES A. WOODBURY, JOSHUA MERRILL, GEORGE PATTEN, AND EDWARD F. WOODBURY, OF BOSTON, MASSACHUSETTS.

AIR-ENGINE.

SPECIFICATION forming part of Letters Patent No. 228,714, dated June 8, 1880.

Application filed May 1, 1879.

To all whom it may concern:

Be it known that we, JAMES A. WOODBURY, JOSHUA MERRILL, GEO. PATTEN, and EDWARD FRANKLIN WOODBURY, all of Boston, in the county of Suffolk and State of Massachusetts, have jointly invented certain new and useful Improvements in Air-Engines, (Case C,) of which the following, taken in connection with the accompanying drawings, is a specification.

Our invention relates to that class of air-engines in which a working-cylinder is used in combination with a reversing-cylinder, and operated by compressed air by alternately heating and cooling it upon one side of the working-piston, while the air upon the other side of said piston remains at its normal temperature; and it consists, first, in the combination of two single-acting working-cylinders, each provided with a furnace or other means of applying heat to them, and two reverser-cylinders connected therewith and provided with pistons adapted to displace the air from one end and transfer it to the other, and thereby control the movements of the working-piston.

It further consists in the combination of two reverser-cylinders, each provided with a furnace or other means of applying heat thereto, and a piston adapted to displace the air from one end and transfer it to the other end, and two single-acting working-cylinders, each having free communication with said reversing-cylinders, as will be described.

It further consists in the combination of two single-acting working-cylinders having the chambers above their pistons connected by a pipe or other free and open passage, two reverser-cylinders having direct communication with the chambers beneath the working-pistons, and a furnace or other means of applying heat to each of the reversing-cylinders or the working-cylinders.

It further consists in the combination of two working-cylinders, two reverser-cylinders, and furnaces or other means of applying heat to each of said cylinders.

It further consists in the combination of two

single-acting working-cylinders provided with reciprocating pistons and adapted to be charged with air under pressure upon both sides of said pistons, and to be operated by alternately heating and cooling the air upon one side of said pistons, while the air upon the other sides thereof remains at its normal temperature, and a pipe or passage connecting the chambers in the cool ends of said cylinders with each other for the purpose of equalizing the pressure in said cold chambers, as will be described.

It further consists in the combination of two cylinders, each provided with a reciprocating piston, two beams connected together at their contiguous ends by a suitable link or links, and means of connecting one of said beams to the driving or crank shaft, as a means of balancing the pistons and reducing the length of the crank or the throw of the eccentric below what would be required if a single beam were used.

It further consists in the combination, in an air-engine, of two working-cylinders provided with pistons, a walking or vibrating beam connected by suitable links or connecting-rod at each end to one of said working-pistons, and two reverser-pistons adapted to alternately change the air from the heating-chamber to the cooling-chamber, and vice versa.

Figure 1 of the drawings is a plan of an engine embodying our invention. Fig. 2 is a side elevation, and Fig. 3 is a front elevation.

A and A' are two single-acting working-cylinders, each provided with a furnace, B or B'; and C and C' are two reverser-cylinders, provided with furnaces D and D', all constructed substantially as described in another application of even date herewith.

E is the water-circulating pump; E', the air-pump; F, the air-cooler; F', the crank secured to one end of the shaft F²; G, an adjustable eccentric mounted upon said shaft; G', the divided eccentric-rod; G², a lever for operating the engine by hand, and H a governor connected by the lever H' and shipper-rod H² to the wedge for adjusting the eccentric G, all

constructed, arranged, and adapted to operate substantially as described in a second application of even date herewith.

The upper ends of the two working-cylinders 5 A and A' are connected together by the pipe I, through which direct communication is had between the interiors of said cylinders above their pistons, and by means of which and the pipe a', leading from the cooler F and connected with said pipe I, and provided with a 10 check-valve, a², air is forced by the pump E' into the chambers above the working-pistons of said cylinders, and other branches, a³ and a⁴, of said pipe, each provided with a check- 15 valve, as shown, connect with the chambers above the pistons of the two reverser-cylinders, substantially as described in the other applications heretofore cited.

The working-cylinder A and reverser-cylinder 20 C are connected together by the air-pipe b, and their furnaces are connected by the smoke-flue c, substantially as described in the other applications before cited, and the working-cylinder A' and the reverser-cylinder C' 25 are similarly connected by the pipe b', and their furnaces by the flue c'.

The circulation of water for cooling the several parts of the working and reverser cylinders is substantially the same as in the second 30 application before cited, except that the water, after leaving the cooler F and traversing the pipe d, is divided in the pipe d' into two currents, which, moving in opposite directions along said pipe, enter the lower water-chambers 35 in the two working-cylinders at the same time, and, after passing in succession through all of the water-chambers in said working-cylinders, the two currents pass through the pipes e and e' to the reverser-cylinders C and 40 C', respectively, and, continuing on through all the water-chambers contained in said cylinders, are finally discharged from the two flexible pipes f and f'.

The piston rods of the working-cylinders A 45 and A' are connected, by means of the cross-heads K and K' and suitable links, with the opposite ends of the beam L, mounted by central journals in bearings formed for the purpose in the stand L' in such a manner 50 that the pistons of the working-cylinders are moved in direct opposition to each other, and as a consequence the pressure above said pistons always remains uniform, the air above the piston which is moving upward escaping 55 through the pipe I into the chamber above the piston which is making its downstroke.

The inner end of the beam L is connected, by the link g, to the inner end of the beam M, 60 mounted by central journals in bearings at its other end, by the rod N, to the crank F' in such a manner that the alternate reciprocations of the working-pistons and the consequent oscillations of the beams L and M will 65 cause the shaft F² to be rotated, carrying with

it the eccentric G, which is set from seventy-five to ninety degrees in advance of the crank F', and acting upon the rod G² causes the beam O to oscillate about its central journals, and acting through the link h, by which 70 its inner end is connected to the beam P, imparts a similar oscillating motion to said beam P.

The piston-rods of the two reverser-cylinders 75 are connected, by suitable links, one to each end of the beam P, and as said beam is vibrated said pistons are moved up and down in the reverser-cylinders in direct opposition to each other, each acting to reverse the air in its cylinder and cause it to be alternately 80 exposed to hot and cold surfaces, and thereby keep up a constant alternation of pressure beneath the piston of the working-cylinder, with which it is directly connected.

The operation of the engine as far as pertains 85 to the improvements which form the subject of this patent will be readily understood from the foregoing description without further explanation.

What we claim as new, and desire to secure 90 by Letters Patent of the United States, is—

1. The combination of two single-acting working-cylinders, each provided with a furnace or other means of applying heat thereto, 95 and two reverser-cylinders, all arranged and adapted to operate substantially as and for the purposes described.

2. The combination of two reverser-cylinders, each provided with a furnace or other 100 means of applying heat thereto, and two single-acting working-cylinders, all arranged and adapted to operate substantially as described.

3. The combination of two single-acting 105 working-cylinders having the spaces above their pistons connected by a pipe or passage, two reverser-cylinders having direct communication with the spaces beneath the working-pistons, and a furnace or other means of applying 110 heat to the reversers or working-cylinders, substantially as described.

4. The combination of two working-cylinders and two reverser-cylinders with a furnace or other means of applying heat to each 115 of the working and reversing cylinders, substantially as and for the purposes described.

5. In combination with two working-cylinders provided with pistons and adapted to be charged with compressed air upon both 120 sides of said pistons and to be operated by alternately heating and cooling the compressed air upon one side only of each of said pistons, a pipe or passage connecting the chambers in the cool ends of said cylinders, substantially 125 as and for the purposes described.

6. In combination with two cylinders, each provided with a reciprocating piston, two beams connected together by suitable links, 130 and means of connecting one of said beams

to the crank or driving shaft, substantially as and for the purposes described.

7. The combination, in an air-engine, of two working-cylinders provided with pistons connected to opposite ends of a vibrating beam, and two reversing-pistons adapted to alternately change the air from a heating-chamber to a cooling-chamber, and vice versa, substantially as described.

Executed at Boston, Massachusetts, this 10
28th day of April, A. D. 1879.

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