3 Sheets—Sheet 1

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

Air-Engine.

No. 228,715. Patented June 8, 1880.

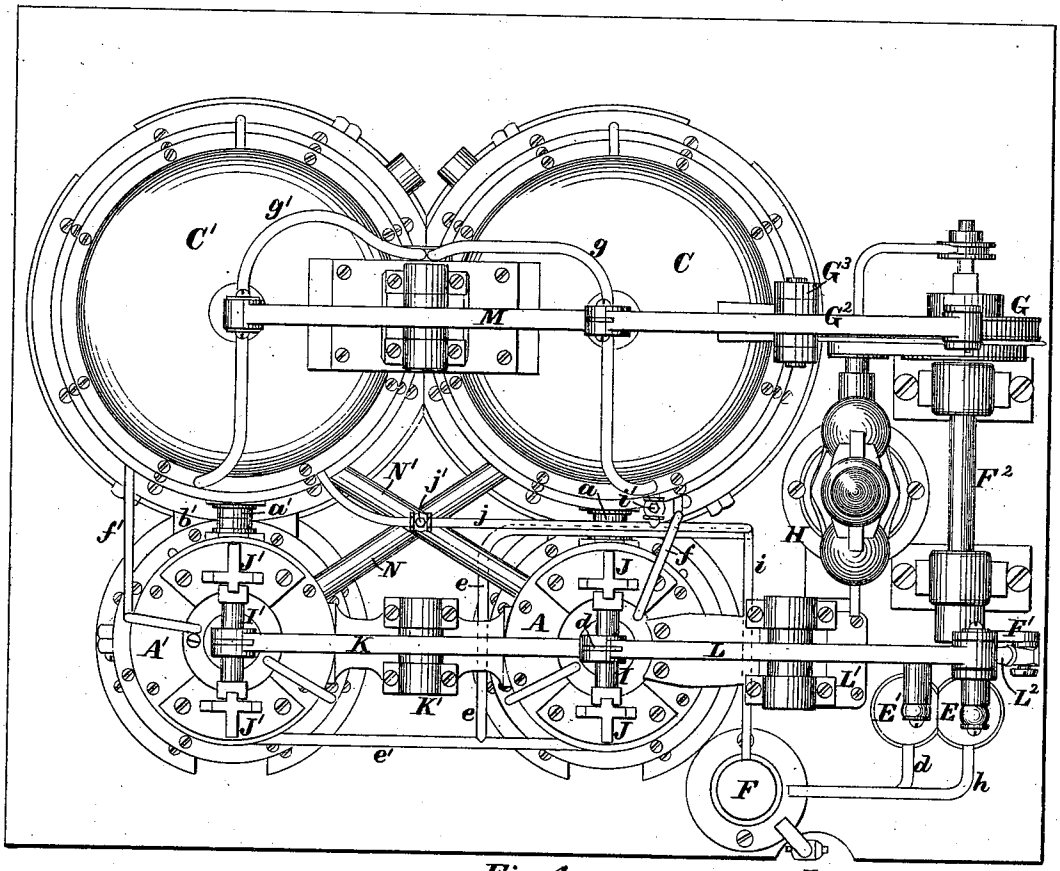

Fig. 1.

Witnesses:

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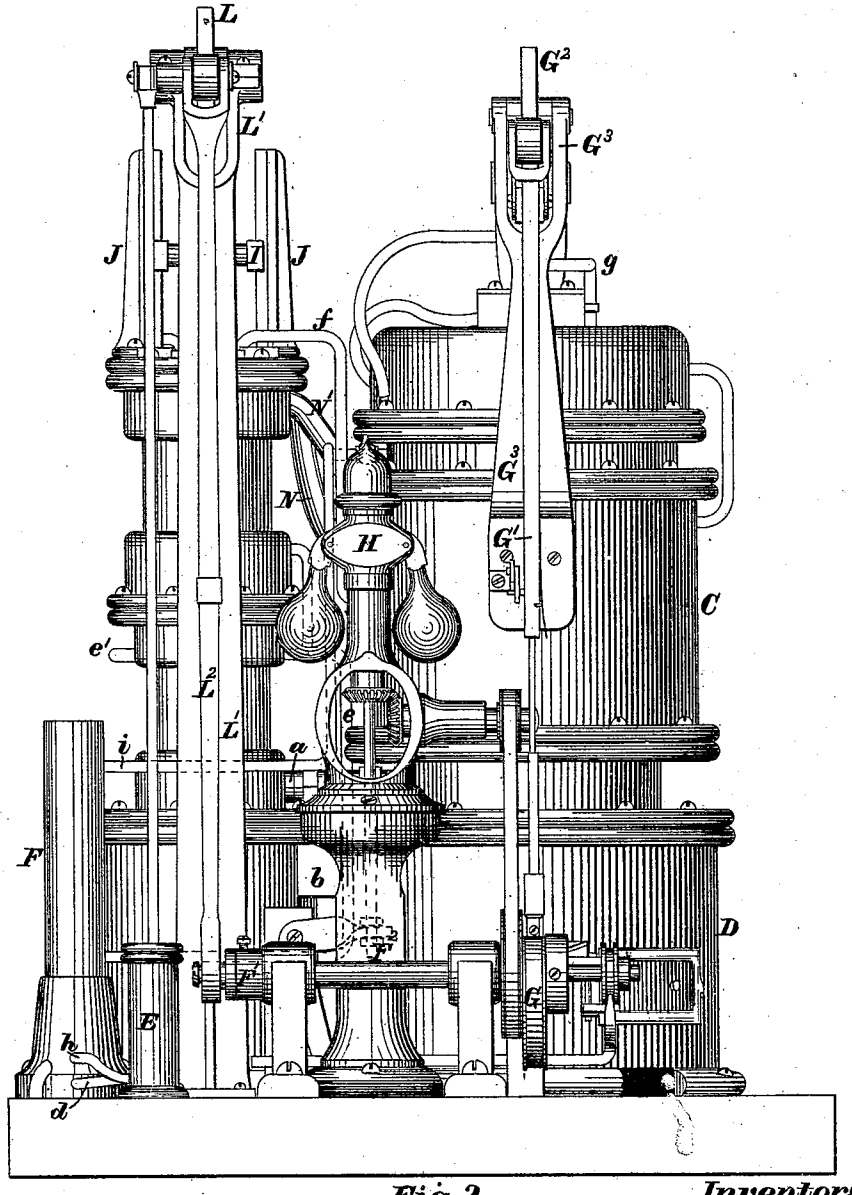

Fig. 2.

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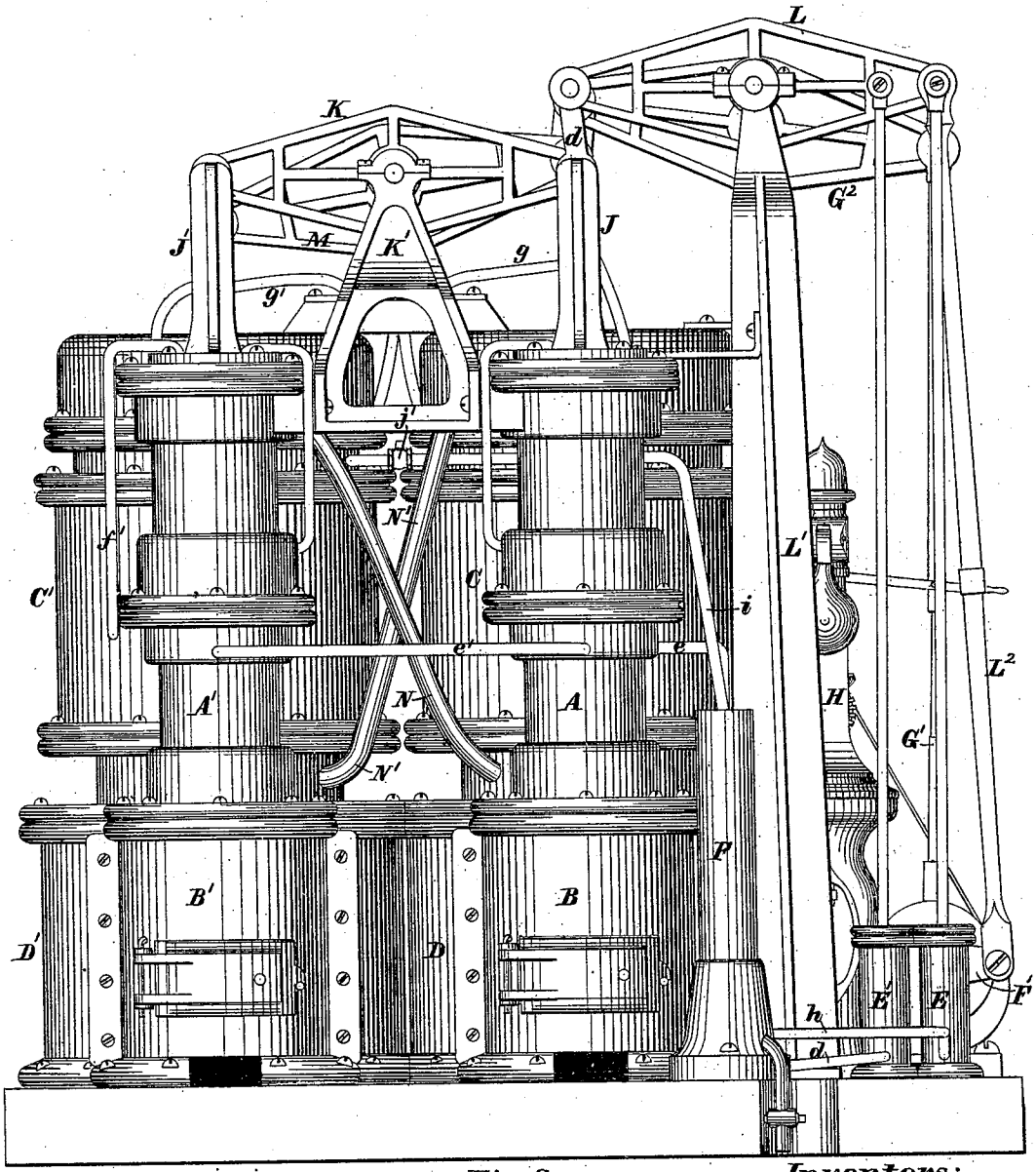

Fig.3.

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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. 228,715, dated June 8, 1880.

Application filed January 23, 1880.

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 D,) 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 reverser-cylinder and operated by compressed air by alternately heating and cooling it.

It consists, first, in the combination of two double-acting working-cylinders and two reverser-cylinders, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, as will be described.

It further consists in the combination of two double-acting working-cylinders, two reverser-cylinders, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, and means of applying heat to each of the reverser-cylinders.

It further consists in the combination of two double-acting working-cylinders, two reverser-cylinders, each having direct communication with the lower end of one of said working-cylinders and with the upper end of the other working-cylinder, and a furnace or other means of applying heat to each of the working-cylinders.

It further consists in the combination of two working-cylinders, two reverser-cylinders, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, and means of applying heat to all of said cylinders.

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

A and A′ are two working-cylinders, each provided with a furnace, B or B′; and C and C′ are two reverser-cylinders, also provided with furnaces D and D′, the cylinders A and C being connected by the air-pipe *a′* and their furnaces B′ and D′ by the smoke-flue *b*, and the cylinders A′ and C′ are similarly connected by the air-pipe *a′* and the furnaces B′ and D′ by the smoke-flue *b′*, said cylinders, furnaces, pipes, and flues being constructed in all respects substantially as described in another application of even date herewith.

E is the air-pump; E′, the water-circulating pump; F, the cooler; F′, the crank secured to one end of the shaft F^2, having mounted upon its other end the adjustable eccentric G, connected by the divided eccentric-rod G′ to the outer end of the beam or lever G^2, mounted by central journals in bearings in the top of the stand G^3; and H is the governor—all constructed, arranged, and operating substantially as described in a second application of even date herewith.

The piston-rods of the two working-cylinders are connected to the cross-heads I and I′, fitted to and adapted to move up and down upon the slides J and J′, respectively, said cross-heads being connected by suitable links with opposite ends of the lever or beam K, mounted by central journals in bearings in the stand K′; and the inner end of said beam is connected, by the link *d*, to the inner end of the beam L, mounted by central journals in bearings in the top of the column L′, and connected at its other end, by the rod L^2, to the crank F′, all so arranged that the alternate reciprocations of the working-pistons, acting through the beams K and L and rod L^2, will cause the shaft F^2 and eccentric G to be rotated, and the eccentric G, acting through the rod G′, causes the beam G^2 to be vibrated about its axis of motion.

The beam G^2, being connected by a link at its inner end with the inner end of the beam M, imparts to it a similar vibratory motion, by which the two reverser-pistons, connected by their respective piston-rods to opposite ends of said beam M, are made to move up and down within their cylinders in direct opposition to each other, operating to reverse the air or change it from one end to the other of said cylinders, as described in other applications of even date herewith.

N is a pipe leading from the reverser-cylinder C, at a point between the heater and regenerator, to the chamber above the piston of the working-cylinder A′, and N′ is a similar pipe connecting the heated end of the reverser-

cylinder C′ with the chamber above the piston of the working-cylinder A, all so constructed and arranged that heated air is supplied by each of the reverser-cylinders to one end of one working-cylinder and to the opposite end of another working-cylinder, by which arrangement we are able to operate two double-acting working-cylinders by the use of only two reversers, which otherwise would be impossible.

The water-pump E′ forces water through pipe *d*, cooler F, and pipes *e* and *e′* into the lower water-space in each of the working-cylinders A and A′ simultaneously, through all of the water-chambers in which it is forced in succession, and then through the pipes *f* and *f′* to the lower water-chambers in the reverser-cylinders C and C′, respectively, and after traversing the several water-chambers in said cylinders in their piston-rods and pistons it is discharged through the pipes *g* and *g′* into the open air.

Air is forced into the reverser-cylinders C and C′ to raise the pressure to the desired standard and maintain said pressure therein by the air-pump E, said air passing from the pump, through pipe *h* and cooler F, into a distributing-reservoir, (not shown, but substantially like what is described in the application first before referred to,) and thence through the pipes *i* and *j* and check-valve *i′* and *j′*.

The operation of our improvements will be readily understood from the foregoing description without further explanation here.

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

1. Two double-acting working-cylinders, in combination with two reverser-cylinders, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, substantially as described.

2. Two double-acting working-cylinders, in combination with two reversers, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, and means of applying heat to each of the reversers, substantially as described.

3. Two double-acting working-cylinders, in combination with two reversers, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, and means of applying heat to each of the working-cylinders, substantially as described.

4. Two double-acting working-cylinders, in combination with two reversers, each having direct communication with the lower end of one working-cylinder and with the upper end of the other working-cylinder, and means of applying heat to all of said cylinders, substantially as described.

5. Two double-acting working-cylinders, each provided with a long piston fitted to and working therein, in combination with two reverser-cylinders communicating with said working-cylinders, substantially as described.

6. Two double-acting working-cylinders, in combination with a long piston fitted to and working in each of said cylinders, two reverser-cylinders communicating with said working-cylinders, and a furnace or other means of applying heat to each of said reverser or working cylinders, substantially as described.

7. Two double-acting working-cylinders, each provided with a long piston fitted to and working therein, in combination with two reverser-cylinders having communication therewith, a furnace or other means of applying heat to each of said working or reverser cylinders, and a stationary packing located at or near the center of the length of each working-cylinder, substantially as and for the purposes described.

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

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JOSHUA MERRILL.
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EDWARD FRANKLIN WOODBURY.

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