(No Model.)

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

HEATER FOR AIR ENGINES.

No. 289,485. Patented Dec. 4, 1883.

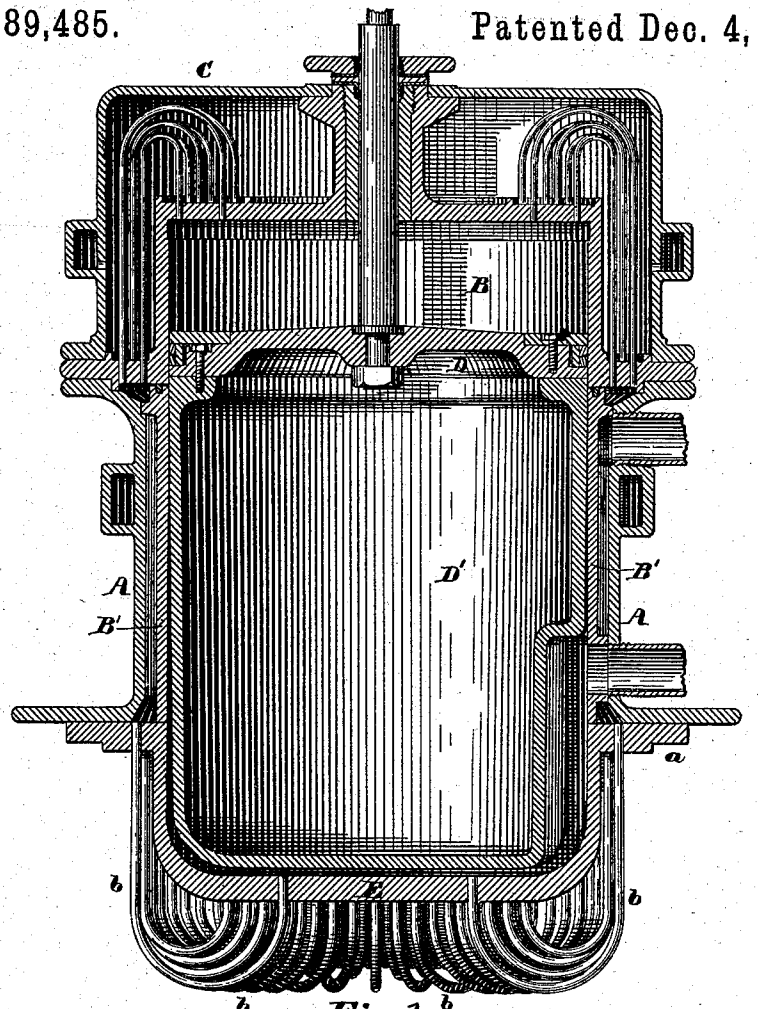


Fig. 1.

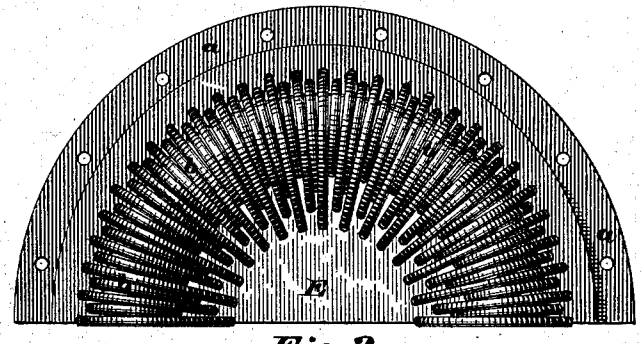
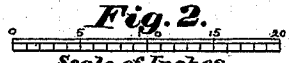


Fig. 2.



Scale of Inches.

Witnesses:
Walter E. Lombard.
E. A. Hemmenway.

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UNITED STATES PATENT OFFICE.

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

HEATER FOR AIR-ENGINES.

SPECIFICATION forming part of Letters Patent No. 289,485, dated December 4, 1883.

Application filed May 16, 1883. (No model.)

To all whom it may concern:

Be it known that we, JAMES A. WOODBURY, JOSHUA MERRILL, GEORGE PATTEN, and EDWARD F. WOODBURY, all of Boston, in the county of Suffolk and State of Massachusetts, have invented jointly a new and useful Improvement in Heaters for Air-Engines, of which the following, taken in connection with the accompanying drawings, is a specification.

Our invention relates to the construction of heaters for air-engines; and it consists of a heater composed of a pan or cup shaped casting having a circular wall, the greater portion of which is vertical, and a closed head at one end and an outwardly-projecting flange at its other end, and a series of bent tubes having arms of unequal length, the short arms of which are inserted in holes through the bottom or head, and the long arms in holes through the flange of said casting, and firmly secured therein in such a manner that the air in passing from the chamber above the displacer-piston through the regenerator to the chamber below said piston must pass through said tubes and be subjected to an intense heat from the hot gases and products of combustion surrounding said tubes.

Figure 1 of the drawings is a central vertical section of the regenerator-cylinder, the displacer-cylinder and piston, the cooler, and heater of an air-engine embodying our invention; and Fig. 2 is a half-inverted plan of our improved heater detached.

In the drawings, A is the regenerator-cylinder, B is the cooler-cylinder, B′ is the displacer-cylinder, C the cooler-cover, and D D′ the displacer-piston, all constructed, arranged, and operating substantially as described in another application of even date herewith, except that the displacer-cylinder B′ does not enter the heater.

E is the heater-casting, made in the form of a flat-bottomed cup or pan, and having an outwardly-projecting flange, *a*, surrounding its upper end, by means of which and suitable bolts (not shown) it is firmly secured to the lower end of the regenerator-cylinder A. A series of tubes, *b b*, each bent, as shown, to a form somewhat resembling the letter **J**, with its long and short arms parallel with each other, are inserted the short arm in holes through the bottom of the casting E and the long arms in holes through the flange *a*, and firmly secured therein, as shown in Fig. 1.

When the heater is in position above the fire-pot and a fire started, the tubes *b b* are completely enveloped by the flame and hot gases, and, as the air displaced by the ascent of the piston D D′ must pass through said tubes in order to reach the hot chamber below the displacer-piston, it follows that said air must be very quickly and thoroughly heated, by virtue of its being divided into so many and small columns surrounded by flame and hot gases.

The tubes *b b* may be firmly secured in the heater-casting E by brazing, by expanding them, or by casting the metal around them, said tubes being set in proper positions in the flask, in connection with the pattern, and remaining in the sand after the pattern is removed.

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

A heater composed of the cup-shaped casting E, provided at its open end with the flange *a*, and a series of bent tubes, *b b*, having their short arms inserted in and secured to the bottom of said casting and their long arms inserted in and secured to the flange *a*, substantially as and for the purposes described.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, on this 14th day of May, A. D. 1883.

JAMES A. WOODBURY.
JOSHUA MERRILL.
GEORGE PATTEN.
EDWARD F. WOODBURY.

Witnesses:
E. A. HEMMENWAY,
WALTER E. LOMBARD.