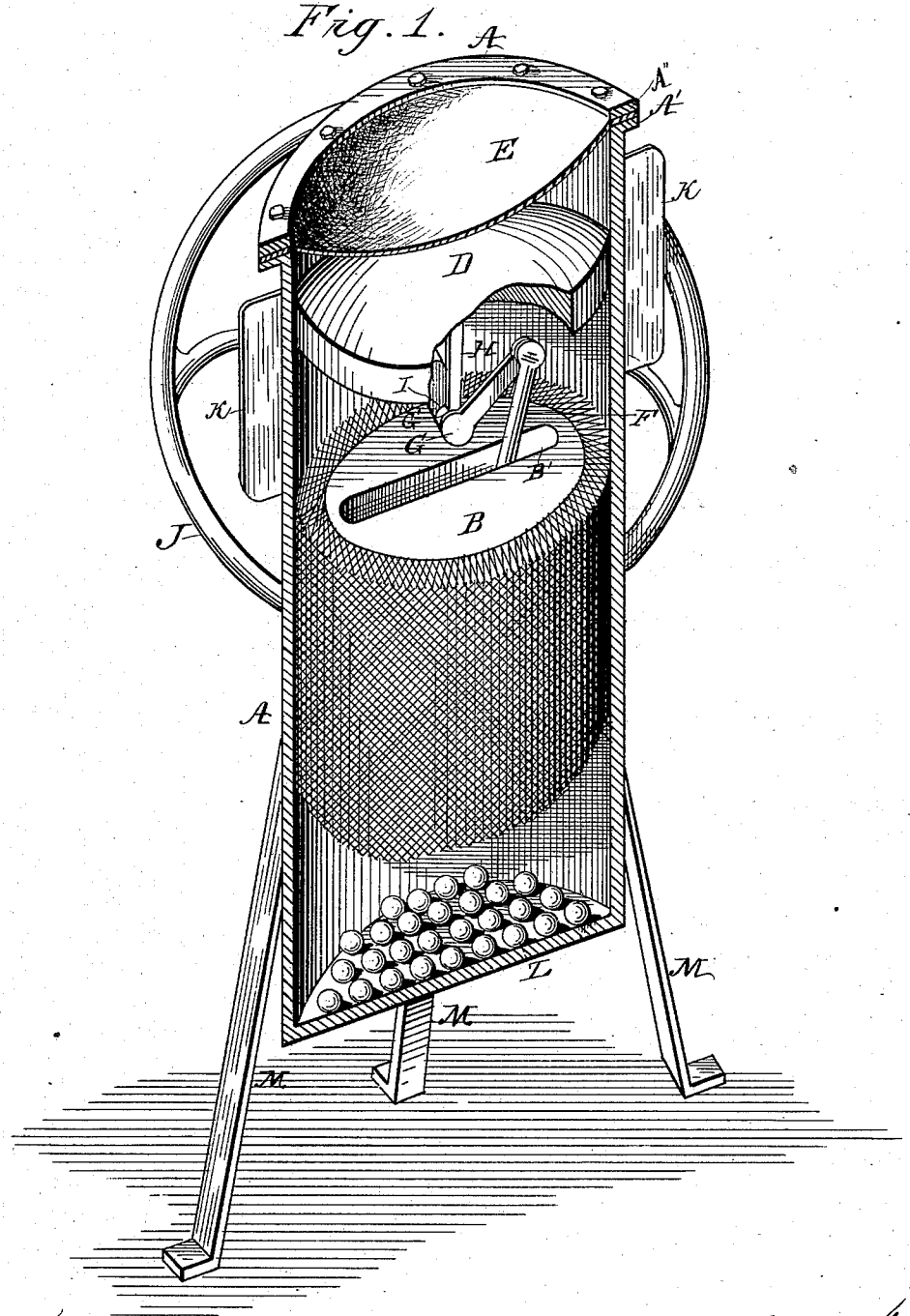
(No Model.) 2 Sheets—Sheet 1.

# T. McDONOUGH.

## HOT AIR ENGINE.

No. 278,446. Patented May 29, 1883.

Fig. 1.




Witnesses:
J. W. Reynolds
Georgie F. Keenan.

Inventor
Thos. McDonough
by his Attorney J. N. Adriaans

(No Model.) 2 Sheets—Sheet 2.

# T. McDONOUGH.

## HOT AIR ENGINE.

No. 278,446. Patented May 29, 1883.

Fig. 2.

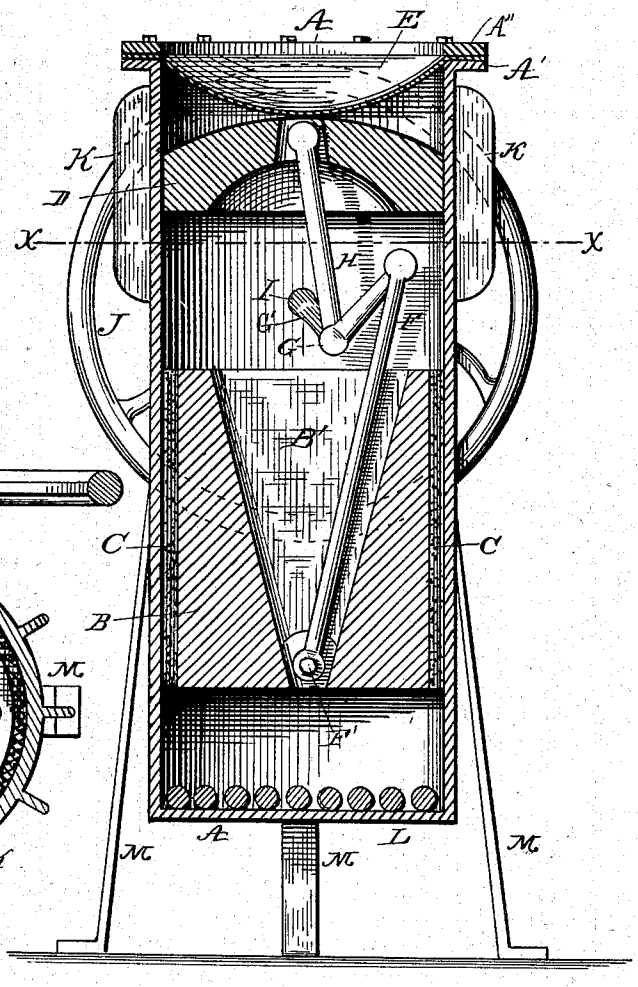
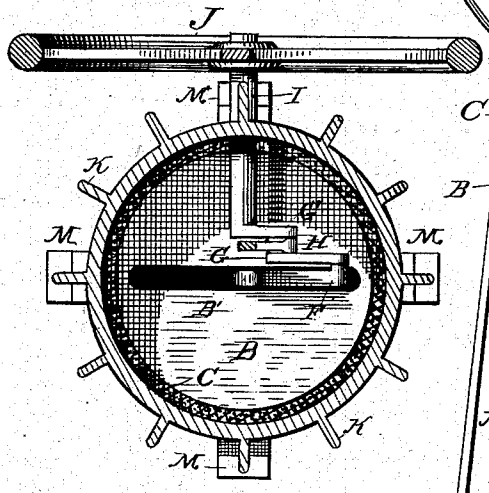



Fig. 3.




Witnesses:
J. W. Reynolds
George H. Graves

Inventor
Thomas McDonough
by his Attorney J. N. Adriaans

# UNITED STATES PATENT OFFICE.

THOMAS McDONOUGH, OF MONTCLAIR, NEW JERSEY.

## HOT-AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 278,446, dated May 29, 1883.

Application filed October 19, 1882. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS McDONOUGH, a citizen of the United States, residing at Montclair, in the county of Essex and State of New Jersey, have invented a new and useful Air-Engine, of which the following is a specification.

My invention relates to improvements in air-engines in which heated air, by its expansive force, causes the vertical reciprocation of a plunger-piston, and thus, by suitable cranks and connecting-bars, imparts motion to the shaft on which the fly-wheel and pulley are mounted; and the objects of my improvements are, first, to increase the efficiency of the motor by lessening the number of moving parts; second, to increase the durability of the machine by dispensing with the wear and tear incident to a large number of moving parts; and, third, to attain these objects with the maximum simplicity of construction. I attain these objects by the means illustrated in the accompanying drawings, in which—

Figure 1 represents an elevation, partly in section, of my engine, illustrating the parts essential to its successful operation and their relation each to the other. Fig. 2 is a sectional elevation through the center of the cylinder; and Fig. 3 is a horizontal section on the line *x x* of Fig. 2, illustrating more clearly the relation between the fly-wheel and the crank and connecting-bars.

Similar letters refer to corresponding parts throughout the several views.

A represents the cylinder of the engine. It is made of No. 24 sheet-iron, and is mounted on legs M M to raise it over a suitable medium for raising the temperature of the air in the cylinder. The cylinder A has a flange, A′, upon which is laid a flexible diaphragm of rubber or corrugated leather, E, which is confined between it and the corresponding flange, A″.

B represents a plunger-piston concentric with but of smaller diameter than the cylinder. Its surface is surrounded by wire C, rigidly wound upon it, so as to partake of its motion. The thickness of the layers of wire is equal to the difference in circumference of the cylinder and the piston. A V-shaped recess, B′, is cut through the center of the piston to permit the oscillation of the connecting-rod F, which is attached at F′ by any suitable means.

D represents a piston-fitting the cylinder A, which is attached to the center of the diaphragm E, so as to impart to and receive from the latter motion synchronously.

F is a rod connecting the plunger-piston B with the crank G, which imparts said motion simultaneously to the piston D by means of connecting-bar H, and to the shaft I by crank G′.

J represents a fly-wheel mounted on the shaft I, in order to give steadiness of motion and overcome the dead-centers of the crank G.

K represents thin ribs radiating from the outer surface of the cylinder, to conduct superfluous heat therefrom. When a water-jacket is used for this purpose these ribs are dispensed with.

L represents metal balls on the bottom of the cylinder, to take up waste heat.

In air-engines as usually made the plunger-piston, which serves to create the difference in temperature of the upper and lower ends of the cylinder, is actuated by a rod moving through the outer piston of the engine in a stuffing, and receives its motion from the driving-shaft by a complicated series of levers. With such an arrangement it is difficult to obtain great velocity, and also to prevent leakage at the stuffing around the plunger-rod and between the packing of the outer piston and the cylinder, without great friction and consequent loss of power. When stationary regenerators are used the efficiency of the motor is seriously impaired, because, being fixed in position, they are only affected by the air flowing through them, and are not, as in my device, exposed alternately in the heated and cooled ends of the cylinder, and hence do not amplify the difference in the temperature upon which the successful operation of the air-engine depends. To obviate these difficulties requires an adaptation of old means in new juxtaposition, such as is illustrated in the accompanying drawings.

It must be understood that in my engine there are two sources of motion—to wit, that of the plunger-piston B, derived from the expansive force of the heated air; and that of the flexible diaphragm E, due to the difference in

temperature to which its inner and outer surfaces are exposed. Both of these motions are directly transmitted to the shaft I and the fly-wheel J—in the former case by connecting-bar F and cranks G G′ and in the latter case by connecting-bar H and crank G′. By reason of the mechanical adjustment of the parts, the dead-centers of the crank G are practically obviated; hence the only dead-centers to overcome are those of the crank G, which occur when the long arm of the crank is perpendicular to the connecting-bar H. Inasmuch as the plunger-piston B is directly connected to the crank G, inside the cylinder, packing for the outer piston, usually employed, is dispensed with, consequent leakage and friction are obviated, and greater velocity attained. As the regenerator-wire C, wound around the piston-plunger B, partakes of its motion and has simultaneously its upper and lower ends in different temperatures, this difference is materially amplified thereby and its effect transmitted to the fly-wheel, which resultant force is far greater than that produced by the stationary regenerator.

There are two causes for the heating of the upper portion of the cylinder—to wit, the conduction of its metal and the surplus heat of the air that has performed its function and is not taken up by the balls L. In order speedily to remove this heat, I make the conduction minimum by employing a cylinder made of No. 24 sheet-iron riveted to a cast iron or steel hot-pot at the bottom, and so finished at its top that the diaphragm may be secured to it. If a piston is used, the top end of the sheet-iron is riveted to the bored cylinder in which it slides. To dispose of the remaining heat I employ thin metal ribs K K, set closely around the upper part of the cylinder, to radiate it into space. These ribs are not riveted to, but have metallic contact with, the cylinder throughout their length.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In an air-engine, the combination of a cylinder, A, with a piston, B, concentric with but of less diameter than the cylinder, said piston having layers of wire wound around its entire surface equal in thickness to the difference of the circumferences of the cylinder and piston, substantially as specified.

2. In an air-engine, the combination of the flexible diaphragm E and piston D, attached thereto, said piston being concentric with and just fitting the inner wall of the cylinder, with the connecting-bar H, crank G, and shaft I, substantially as specified.

3. In an air-engine, the combination of the flexible diaphragm E, having the piston D attached thereto, and piston B, having wires wound on its surface, with the connecting-bars H F, double crank G G′, shaft I, and fly-wheel J, substantially as specified.

4. In an air-engine, the combination of a cylinder, A, having metallic ribs K K radiating therefrom, with the flexible diaphragm E, pistons B D, connecting-bars F H, cranks G G′, shaft I, fly-wheel J, and metal balls L, substantially as specified.

THOMAS McDONOUGH.

Witnesses:
EDWIN C. FULLER,
WM. L. JOHNSON.