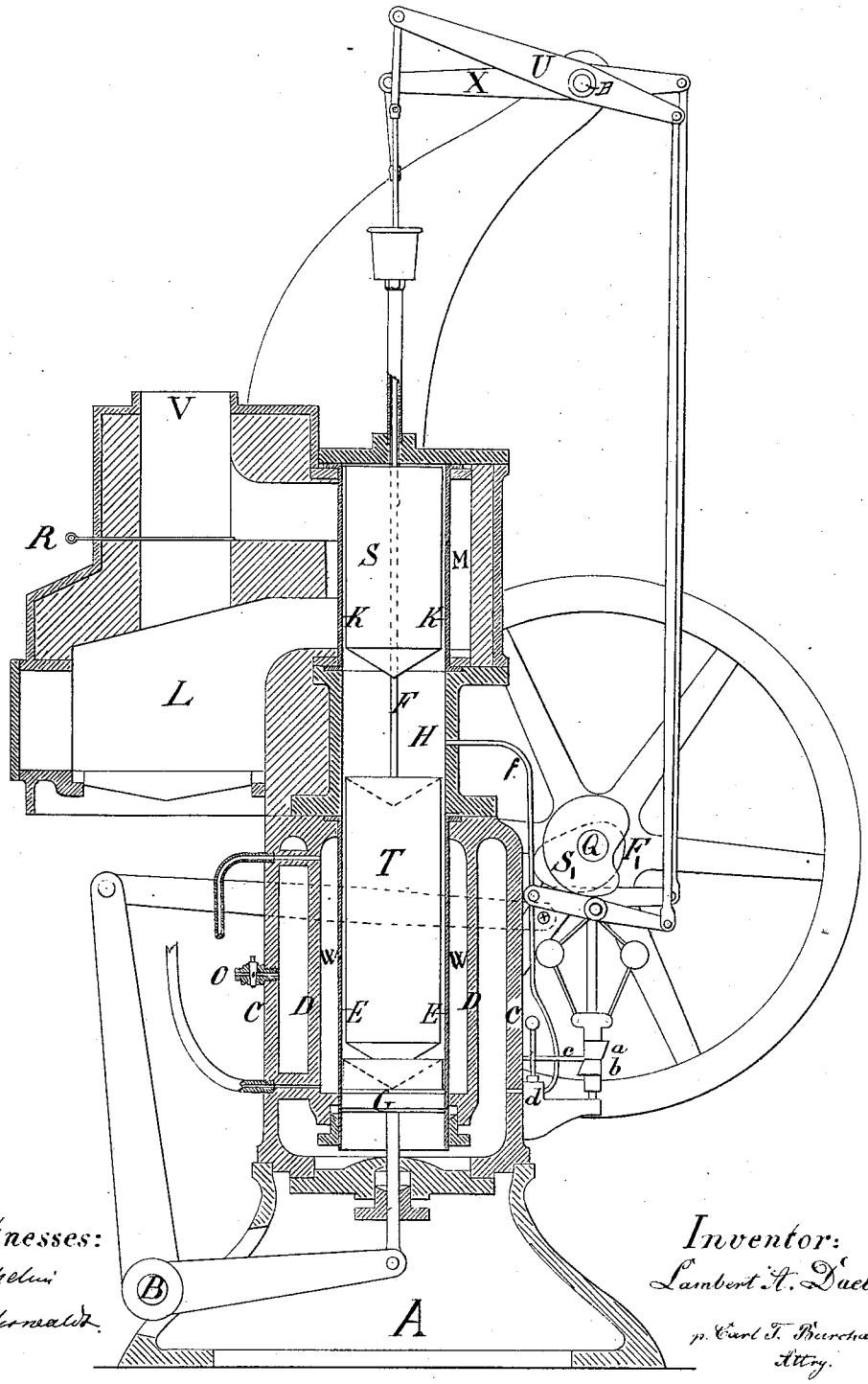
L. A. DAELEN.

CALORIC ENGINE.

No. 336,093. Patented Feb. 16, 1886.



Witnesses:
F. Wilhelmi
W. Odermeldt.

Inventor:
Lambert A. Daelen.
p. Carl T. Burchardt
Atty.

UNITED STATES PATENT OFFICE.

LAMBERT ALEXANDER DAELEN, OF COLOGNE, PRUSSIA, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO JOSHUA MERRILL, GEORGE PATTEN, AND JAMES A. WOODBURY, OF BOSTON, MASSACHUSETTS.

CALORIC-ENGINE.

SPECIFICATION forming part of Letters Patent No. 336,093, dated February 16, 1886.

Application filed November 8, 1875.

To all whom it may concern:

Be it known that I, LAMBERT ALEXANDER DAELEN, of Cologne, Kingdom of Prussia, German Empire, have invented certain Improvements in Caloric-Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same, reference being had to the accompanying drawing, making part of this specification.

The drawing shows a vertical section of the engine.

My invention relates to that class of caloric-engines in which a constant quantity of compressed air without being renewed is heated and cooled alternately, and by virtue of the difference of pressure thereby produced moving a piston, and through it all other parts of the engine.

The first part of my invention refers to the use of two distinctly separate heating and cooling chambers, and two separate air-displacers—one for the hot air, the other for the cold air—with the object to utilize the heat as much as possible. The second part refers to the manner in which the uniformity of speed is attained.

The drawing shows an upright single-acting engine with rotary shaft; but through suitable alterations of the mechanical parts it may be built horizontal, double-acting, with a rotary shaft or direct-acting.

On a wide base, A, supporting a rocking shaft, B, rests a hollow cylinder, C, within which and cast in one piece therewith is the pendent cylinder D, forming with the thin copper pipe E an annular chamber, W, to contain the cooling-water, and provided with an inlet for the fresh cold water at the lower part, and an outlet for the warm water at the top, in any convenient way. The annular chamber surrounding the cylinder D, as well as the space below the lower end of said cylinder, is designed as a reservoir, to be filled with compressed air. The piston-rod of the piston G, working in the above-mentioned copper pipe E, passes through a packing-box in the lower head of the cylinder C, and is attached to a lever or crank on the rock-shaft B. A second lever of this shaft B is connected by a rod to the crank of the main shaft Q, so that through the reciprocating motion of the piston G the shaft Q may be revolved. Connected to the top of the cylinder C by a cast iron cylinder, H, is a second thin copper pipe, K, the inside diameter of which is the same as that of pipe E and of cylinder H. This pipe K is surrounded by brick-work incased in iron castings, but bearing an annular space, M, between it and the pipe K.

On one side of the cylinder H and pipe K is placed the furnace L, in such way that the space M forms part of the flue, through which, by closing the register R, the heat of the furnace L is caused to impinge upon and surround the pipe K before escaping to the chimney V.

In the pipe K or "heating-chamber" is placed a hollow metallic vessel, S, which I term the "hot-air displacer," nearly filling up the heating-chamber K, and a similar hollow metallic vessel, T, termed the "cold-air displacer," is placed in the pipe E or "cooling-chamber." The first is moved up and down by means of two piston-rods, lever U, connecting rod, and cam S′, fixed on shaft Q; the second through piston-rod F, lever X, and connecting-rod and cam F′, also fixed on shaft Q.

To one side of the cylinder C is fastened a centrifugal governor driven by gearing which, through the up and down motion of a conical valve, *a*, acts through an arm (not shown) on the rocker-shaft *c* to rock said shaft, and through it and another arm secured to said shaft *c* (but not shown) in position to engage with the stem of the valve *d* to raise said valve, which, when open, connects the compressed air in the reservoir D with the space H through pipe *f*. The cock O is screwed into the cylinder C for the purpose of attaching to it an air force-pump driven by hand or by the engine for filling the reservoir D with compressed air and to replace the air lost by accidental leakage. Just before the commencement of a stroke the piston G, being moved to the extreme of its upward movement by

the operator giving a partial revolution to the fly-wheel by hand, the hot-air displacer S descends quickly down to the cold-air displacer T, returning as quickly to its former position. By this motion the compressed air contained in the cylinder H is forced twice along the hot surfaces of the heating-chamber K, whereby its pressure is very much increased, and the piston G is forced down, followed closely by the cold-air displacer T. A moment before the piston G arrives at its lowest position the cold-air displacer T is raised quickly to the hot-air displacer S, through which motion the heated air is brought in contact with the surfaces of the cooling-chamber E, and the pressure is so much diminished that the piston G is forced upward through the slightly-increased pressure of the compressed air in the reservoir, due to the downward movement of the piston G, aided by the momentum of the fly-wheel. The cold-air displacer T, descending, now reaches the piston G just in the moment in which the latter is in its highest position, and the before-described motions are repeated. It will be observed that while that portion of the air which is in contact with the upper surface of the piston when it commences to descend has had its heat extracted therefrom by contact with the walls of the cooling-chamber, there is a very much larger body of air above the cold-air displacer T that is heated to a very high temperature, which in its effort to expand reacts upon the tubular column of cold air surrounding the cold-air displacer, and through it upon the piston G, to force it downward. It will also be observed that the piston G in its descent is closely followed by the cold-air displacer T until said piston has nearly reached its lowest position, thus precluding the possibility of any very large proportion of the body of air contained in the cylinder passing over the surface of the cooling-chamber until the cold-air displacer is moved upward just before the piston G reaches its lowest position.

The two air-displacers S and T are made of thin copper.

To regulate the speed of the engine, the governor is made to open as wanted a valve, *d*, by means of the cam *a* and the rock-shaft *e*, and to connect thereby the space H with the reservoir through pipe *f*. This will take place when the engine runs too fast—that is, when the pressure in the cylinder H is too high—and some of the too-powerful air contained in the cylinder H is allowed to escape into the reservoir. It will be seen that the valve *d* remains closed as long as the speed is the correct one.

To start the engine, the operator turns the fly-wheel about its axis by hand or by any suitable mechanism. To stop the engine or equalize the pressure, the valve *d* may be opened by hand.

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

1. The combination, in an air-engine, of a cylinder, a tight-working piston arranged and adapted to be reciprocated in said cylinder, a reservoir for containing air under pressure, connected with the interior of said cylinder upon one side of said piston, and a heating apparatus and a cooling-chamber, both connected with said cylinder upon the other side of said piston, whereby the same body of air is alternately heated and cooled upon one side of the working-piston, while the air upon the opposite side of said piston remains at its normal temperature without exhausting the air from either side of said piston, substantially as described.

2. The combination of separate heating and cooling chambers, two separate displacers, and a working-piston arranged to use the same body of compressed air over and over again and pass it twice between said chambers and the displacers at each double stroke of the piston, substantially as described.

3. In an engine adapted to contain air under pressure upon both sides of its piston, and to be operated by alternately heating and cooling said air, the combination of the pipe *f*, connecting the chambers above and below the working-piston, a valve, *d*, connected therewith, the rocker-shaft *e*, the cam *a*, and a governor, all arranged and adapted to operate substantially as and for the purposes described.

4. In an air-engine, a pipe connecting the chambers at the opposite ends of the working-piston, in combination with a valve adapted to close the passage through said pipe and to be opened, as a means of equalizing the pressure upon the two ends of the piston, as set forth.

5. In an air-engine, a pipe connecting the chambers at the opposite end of the working-piston, in combination with a valve adapted to close the passage through said pipe, and a governor connected to and adapted to open said valve, as a means of regulating the engine, substantially as described.

This specification signed by me this the 25th day of June, 1875.

LAMBERT ALEXANDER DAELEN.

Witnesses:
AUGUST DEVIN,
T. W. BOCKMEULEN.