2 Sheets—Sheet 1.

J. B. WARD.

Hot-Air Engine.

No. 198,827. Patented Jan. 1, 1878.

Fig. 1.

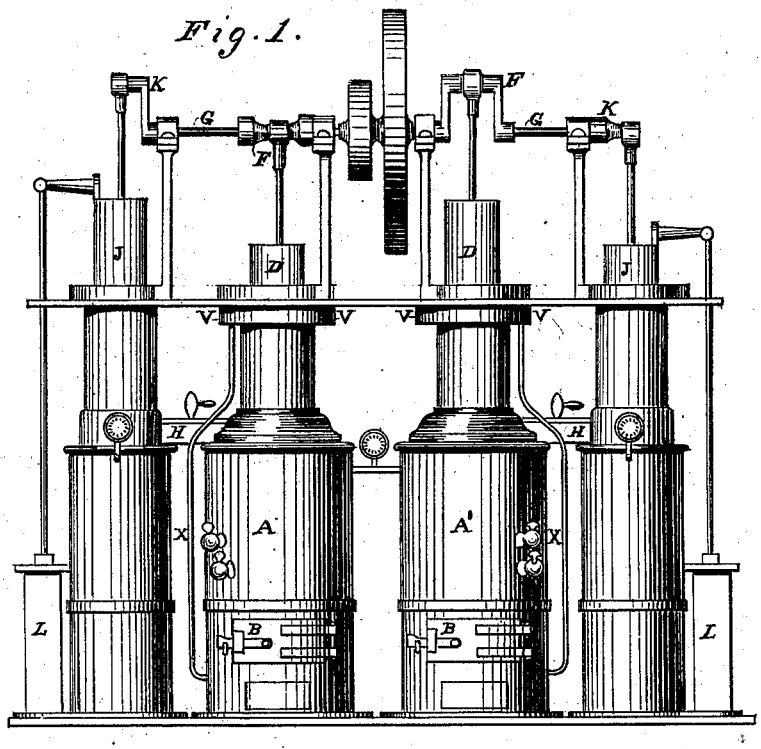
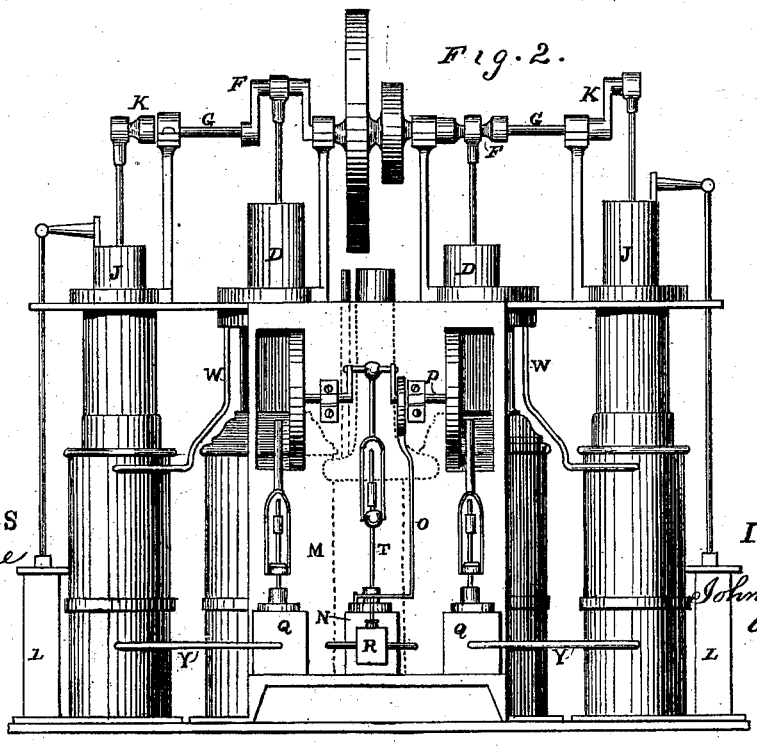


Fig. 2.



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2 Sheets—Sheet 2.

J. B. WARD.

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No. 198,827. Patented Jan. 1, 1878.

Fig. 3.

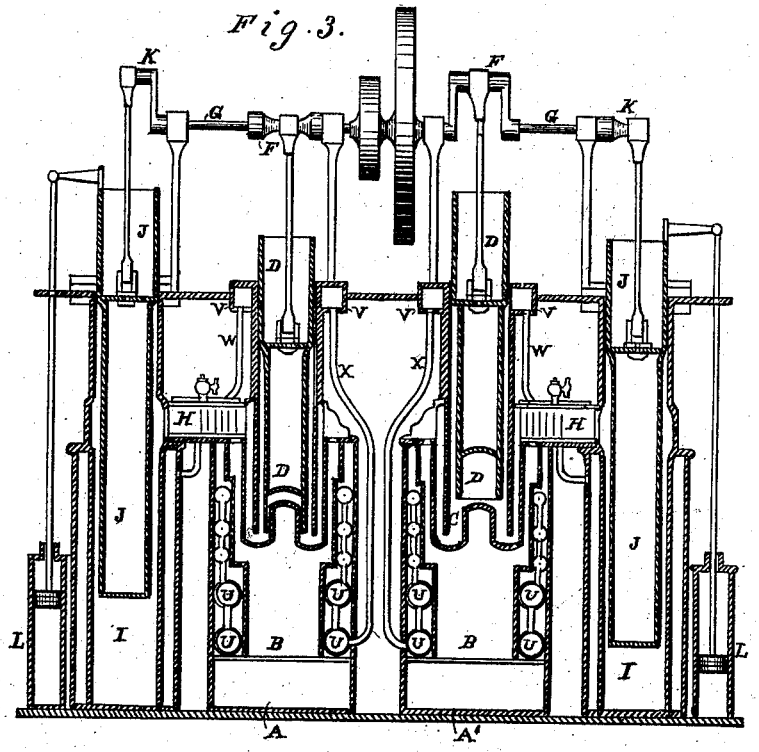
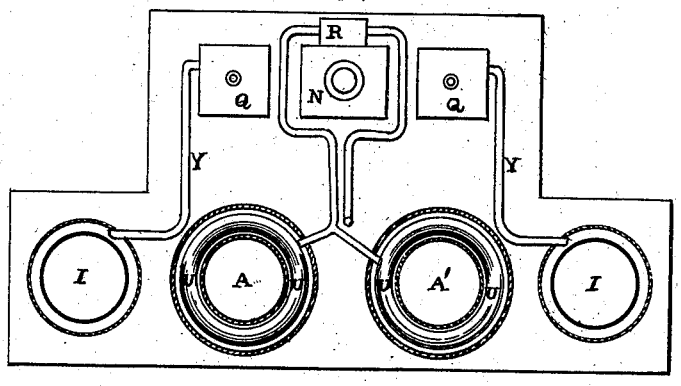


Fig. 4.



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UNITED STATES PATENT OFFICE.

JOHN B. WARD, OF SAN FRANCISCO, CALIFORNIA.

IMPROVEMENT IN HOT-AIR ENGINES.

Specification forming part of Letters Patent No. **198,827**, dated January 1, 1878; application filed November 6, 1877.

To all whom it may concern:

Be it known that I, JOHN B. WARD, of the city and county of San Francisco, and State of California, have invented an Improved Hot-Air Engine; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings.

My invention has reference to hot-air engines; and the distinctive feature of my engine is as follows: The air is compressed in supply cylinder or cylinders by an independent power outside of the air-engine before it is admitted into the main cylinder, and the motive agent of the independent power is generated by the surplus heat in the furnace of the air-engine. Incident to this arrangement I have made several other improvements, which are fully explained in the following specification.

Referring to the accompanying drawings, Figure 1 is a front view; Fig. 2 is a rear view. Fig. 3 is a vertical section, and Fig. 4 is a horizontal section.

Let A A′ represent two ordinary upright hot-air engines, each of which has a furnace or fire-place, B, a hot-air or expansion chamber, C, and a hollow bucket-shaped piston, D, all arranged in the ordinary manner of constructing hot-air engines. These engines I place close together, and connect each of their pistons D with a separate crank, F, on a crank-shaft, G, which extends across above the cylinders.

Each engine is connected by a tube, H, with an upright supply-cylinder, I, which is also provided with a bucket-shaped piston, J. The piston-rods of these pistons are connected with and operated by cranks K K at the extremities of the crank-shaft G.

Each supply-cylinder is made of an inside and an outside cylinder, so as to provide a space between them, into and through which a constant circulation of cold water is maintained through the medium of a pump, L, which is operated by a connection with the piston of the supply-cylinder.

The air which is to be used in the engines is compressed in the inside chamber under the pistons J by the steam-engine, to be hereinafter described, so that this cylinder is both a supply-cylinder and a regenerator, and the tube H admits the compressed air to the working-cylinder at each stroke of the pistons J.

Directly in rear of the engines A A′, I construct a frame, M, at the base of which I place a small upright steam-cylinder, N.

The piston-rod T of this engine is connected by a pitman, O, with a crank on a shaft, P, which is mounted in bearings across the frame above it.

On each side of the steam-cylinder an air-pump, Q, is placed, the pistons of which are operated by cranks on the ends of the shaft P.

Instead of using two hot-air engines, I can construct one large jacket or case, in which two upright cylinders are placed, each of which will have a separate piston, and extend the furnace under both cylinders, thus making one fire furnish heat for both cylinders, and simplifying the operation of running the machine.

To supply steam to operate this steam-engine, I construct a coil or other form of pipe, U, inside of the furnace of the air-engine, above and around the fire-place, and connect it with the steam-chest R of the engine, and this pipe I keep filled with water, as hereinafter described, so that the heat of the furnace will generate steam sufficient to drive the engine, and through it operate the air-pumps Q.

Each air-pump is connected with the interior chamber of one of the upright supply-cylinders I by a pipe, Y, so that the steam-engine compresses the air under the pistons J to the desired limit, while the operation of the piston J alternately forces the air thus compressed through the tube or passage N into the annular space around the main piston D, whence it passes under the pistons, and is expanded by the heat of the furnace, so as to drive the piston D upward.

The reverse motion of the piston D forces the air back into the cylinder I, when it is cooled before it is again admitted into the working-cylinder.

Around the upper end of each of the cylinders A A′, I construct a water chamber or jacket, V. I then connect each of these water-chambers with the water-jacket of the supply-cylinder I which is next to it by a pipe, W.

The pistons D move in stuffing-boxes inside

of these chambers, and the object of surrounding them with water is to utilize the heat generated by the friction of the moving pistons and the heat of radiation to heat the water, which is subsequently conveyed by the pipe X into the coiled pipe in the furnace, to be converted into steam to supply the steam-engine. I thus utilize all of the heat possible.

The hot air, as it returns from the working-chamber into the regenerator-cylinder, is cooled by the surrounding water-jacket, so that the water is heated thereby; thence I convey it to those points where it will take up the heat generated by friction and radiation, and then I convey it into the coil in the furnace, where it is readily converted into steam, without materially detracting from the heat of the furnace.

This arrangement is calculated to obtain the best possible result from a given amount of heat. It enables me, first, to obtain a positive and continuous application of power to the driving-shaft, so that one cylinder assists in driving the other; secondly, I compress and maintain the air-pressure in the supply-cylinders by a power entirely independent of the hot-air engines, so that the full power of the expansion of the air is rendered available for working purposes; thirdly, steam to drive the steam-engine is generated by the surplus heat, and the heat which would otherwise be wasted, thus at once utilizing all of the capacity of such an engine; fourthly, I provide a portable hot-air engine with a power apparatus for compressing the air, which apparatus forms an actual part of the engine. This power I can regulate by opening or closing the throttle-valve, so as to increase or diminish the power applied for compressing the air in the supply-cylinder, and thus regulate the energy of the hot-air engine.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination of the furnace of a hot-air engine, provided with a steam-coil, U, and the steam-cylinder N, connected with said air-engine by the steam-coil, whereby said steam-cylinder is supplied with steam generated in the furnace of the air-engine, substantially as herein shown and described.

2. The combination of the furnaces of hot-air engines, having steam-coils, the steam-cylinder N, to which the steam-coils are connected, and regenerating or supply cylinders I I, connected with the air-engines by tubes H, substantially as herein shown and described.

3. The combination of the furnace of a hot-air engine, provided with steam-coil U, the steam-cylinder N, air-pump Q, conducting-pipe Y, and supply-cylinder I, substantially as and for the purpose herein shown and described.

4. The combination, with the furnace of a hot-air engine, provided with the steam-coil U and the supply-cylinder I, of the water-chamber V, arranged around the stuffing-box in which the main piston moves, said chamber having pipes, W X, communicating, respectively, with the water-jacket of the supply-chamber and the steam-coil, substantially as and for the purpose herein shown and described.

In witness whereof I have hereunto set my hand and seal.

JOHN B. WARD. [L. S.]

Witnesses:
FRANK A. BROOKS,
HENRY J. DODD.