P. SHAW.

HOT AIR ENGINE.

No. 90,128. Patented May 18, 1869.

Fig. 2.

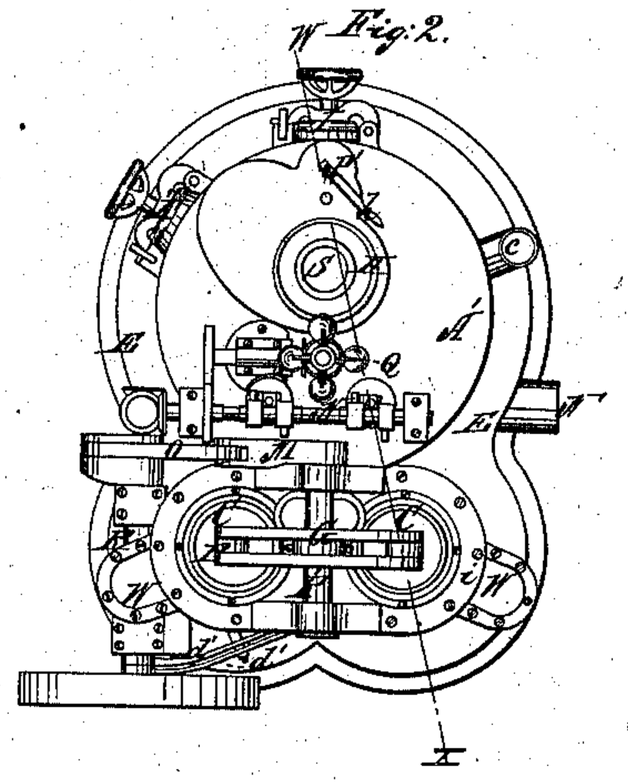


Fig. 3.

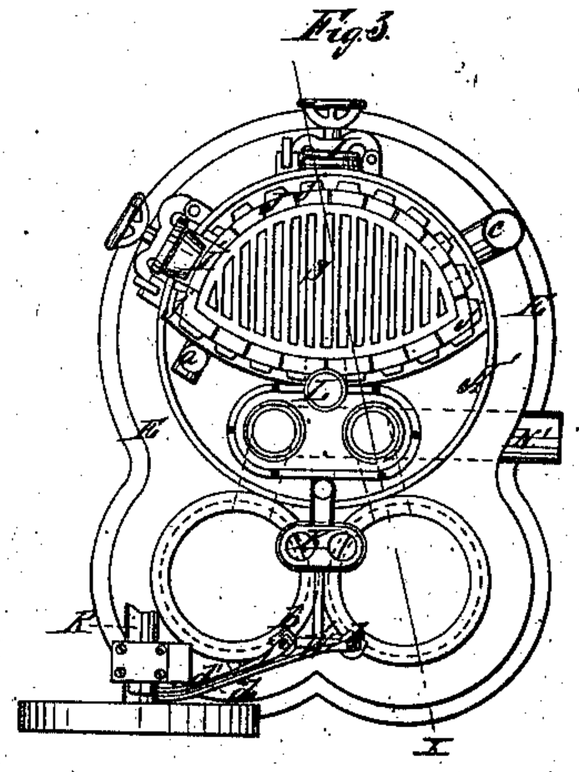


Fig. 4.

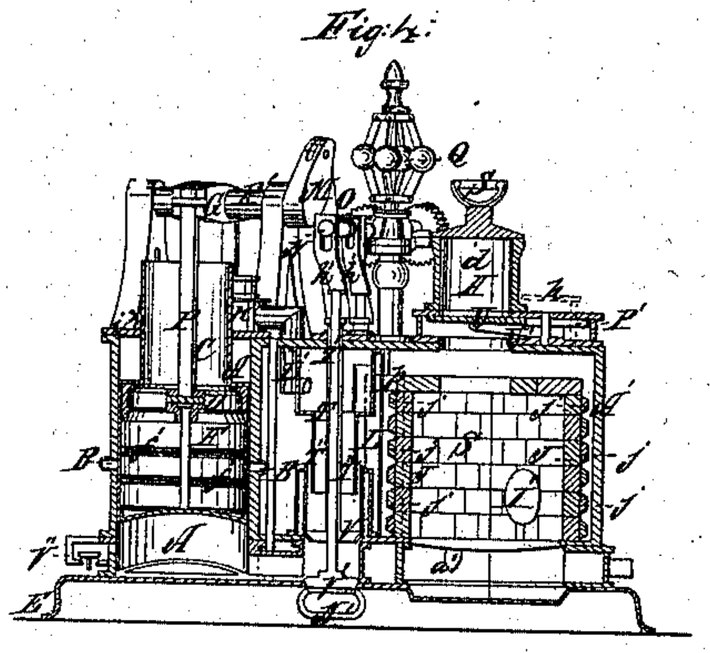


Fig. 5.

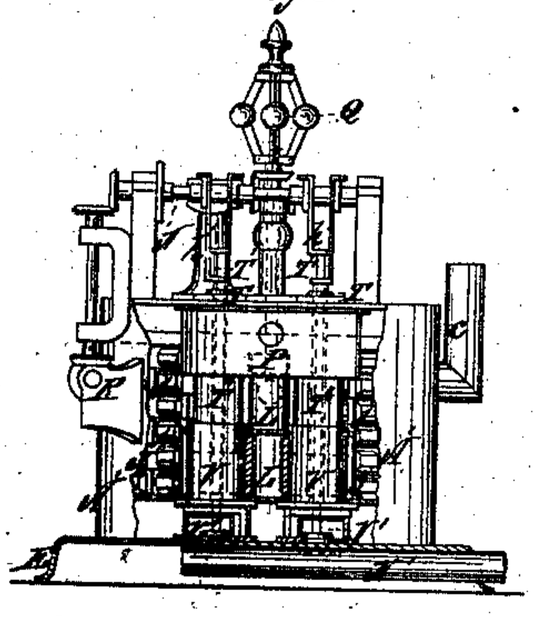


Fig. 1.

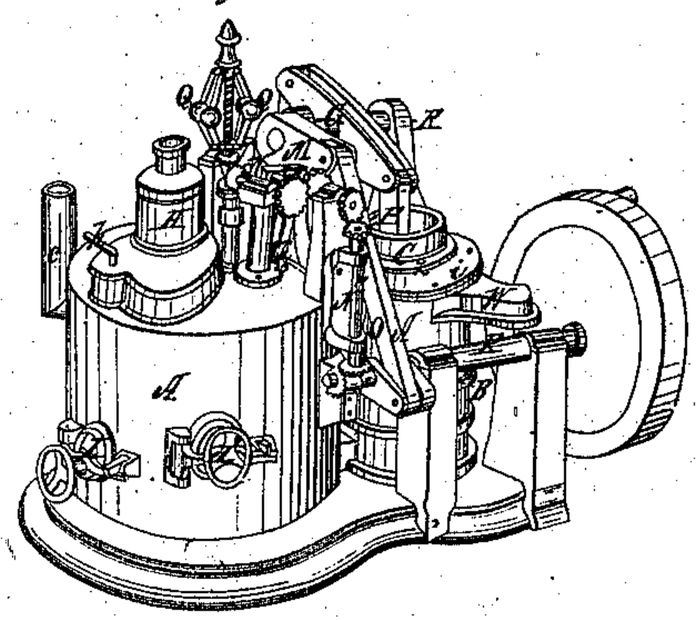
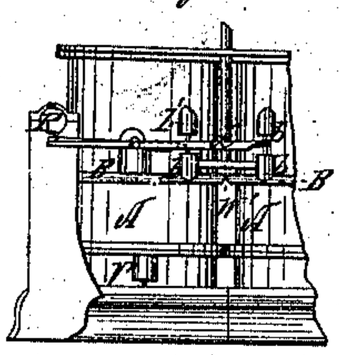


Fig. 6.



Witnesses:

Fitzgerald Parker

A. Hunt Berry

Inventor:

Philander Shaw

# United States Patent Office.

PHILANDER SHAW, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO SHAW'S UNION AIR-ENGINE COMPANY, OF SAME PLACE.

*Letters Patent No.* 90,128, *dated May* 18, 1869.

## IMPROVEMENT IN HOT-AIR ENGINES.

The Schedule referred to in these Letters Patent and making part of the same.

*To all whom it may concern:*

Be it known that I, PHILANDER SHAW, of Boston, in the county of Suffolk, and State of Massachusetts, have invented certain new and useful Improvements in Hot-Air Engines; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

To enable others skilled in the art to make and use my invention, I will proceed to describe its nature, construction, and use.

The nature of my invention consists—

First, in the construction and arrangement, as hereinafter described, and further illustrated in the drawings, of the inlet-valve. This valve being exposed to great heat, is made in the form of a cylindrical vessel, into which a pipe conducts, at each stroke of the engine, a current of cool air, which effecting its purpose, that is, lowering the temperature of the valve, is free to flow out upward around the outside of said pipe into the passage leading into the furnace.

Second, in combination of the inlet-vacuum valve with the working-cylinder of an air-engine.

*Drawings.*

Figure 1 is a perspective view of my engine.

Figure 2 is a plan.

Figure 3 is a horizontal section.

Figure 4 is a vertical section on the line *w x*, fig. 2.

Figure 5 is an elevation showing the valves.

Figure 6 is an elevation, showing the working-cylinders and the auxiliary valves.

S, figs. 3 and 4, represent the furnace, fig. 3 showing it in horizontal section, with a plan of the grate, and fig. 4 in elevation, J representing an inside lining of fire-brick.

These fire-bricks have projections *j j*, or knobs, made on their outer side, as shown, thus leaving an air-space between the inner and outer lining, extending entirely around the furnace, through which the air that enters the furnace above the grate flows.

A' A', in all the drawings, is an air-tight casing extending entirely around the furnace, and, with its top and bottom, forms an air-tight reservoir for compressed air, and includes within itself the furnace, the inlet and outlet-valves, and most of the tubes through which most of the air flows.

*c*, figs. 2, 3, and 5, represents the direct draught or orifice for the escape of the products of combustion when the fire is first built, but may be closed by means of a door or valve, similar in construction to that shown, when the fire is well started.

I, figs. 1, 2, and 3, represents the ash-opening, which leads directly into the furnace.

Both the ash and fuel-openings have doors that fit air-tight, constructed similar to those shown in the drawings.

H, figs. 1, 2, and 4, represents a fuel-receptacle, from which the fuel is fed to the fire, while the engine is in action, through the top of the furnace.

The bottom of this fuel-box H is provided with a sliding bottom or valve, U, which is operated by the swinging arm U', fig. 4.

This swinging arm has a gear cut upon its rear end, as shown in the drawings, into which a pinion, P', works. This pinion is operated by a lever, *h*.

By this arrangement, and by proper manipulation, which will be understood by inspection of the drawings, it is obvious that the fire may be replenished with fresh fuel, while there is the requisite pressure within the furnace to operate the engine without reducing this pressure.

The furnace is provided with an opening, *a*, figs. 3 and 4, above the grate, and with an opening, *a'*, fig. 4, below the grate, through which air under pressure is supplied to the furnace.

The working-cylinders, of which there are two, act upon one rocking-beam.

The cylinders are single-acting, that is, the piston of each is forced upward by admitting the compressed heated air and gases from within the furnace beneath the piston, both pistons being connected with the rocking-beam G, by means of the pitman P, figs. 1, 2, and 4, so that the downward movement of each piston is produced by the upward movement of the other acting through the pitman P and the rocking-beam G.

The cylinders A A are divided into two sections by the annular recess B B, figs. 1, 4, and 6.

That part of the cylinder which is above this space is turned true and polished, so that the piston-head D works within it, similar to the piston of a steam-engine. The lower part of the cylinder is left rough.

That part of the piston which is marked D, fig. 4, is constructed nearly like a steam-engine piston, so far as packing is concerned, and does not need further explanation than is afforded by the drawings.

Immediately above the part D, and connected to it, is the trunk-piston C.

In this trunk, the connecting-rod or pitman P, figs. 1, 2, and 4, plays, and is connected to the piston head D by a joint, as shown in fig. 4, which is kept cool by a free exposure to the atmosphere, and by lubrication, for which good facilities are afforded.

The trunk passes through the upper head *i*, figs. 1, 2, and 4 of the cylinder, where it is packed and guided by the gland Z.

The upper cylinder-head is furnished with valve, which, when forced open by the compression of the air in the annular space between the trunk and the upper section of the cylinder, permits the said compressed air to pass through the valve-box K, figs. 3 and 4, and pipe L', into the reservoir around the valves.

The upper cylinder-head is furnished with a puppet-valve working in the valve-box W, the purpose of

which is to open and admit air into the annular pump when the piston descends, and to close and remain closed at other times.

Extending from and connected to the piston-head D, is the cylindrical drum or extension of the piston F, which is somewhat smaller in diameter than the inside of the cylinder A, and so long that when the piston is at the lowest point of its downward stroke, the bottom of this drum comes very near to the bottom of the cylinder, there being always an annular and end clearance.

The groove or chamber B B, around the cylinder, communicates with the compressed air in the outlet (pump)-valve chamber. where it is comparatively pure and cool.

This communication is made by means of the pipe W', figs. 3 and 6, which terminates in the auxiliary valve-box *b*.

The auxiliary valve-box *b*, figs. 3 and 6, contains puppet-valves, operated by any suitable mechanism, that shown being a cam on the main shaft, figs. 2 and 3, acting on the levers *d' d'*, figs. 2, 3, and 6, and through them upon the valve-stems *b' b'*, to open the valve against the pressure of a spring, the reaction of which assists to close it.

It will be seen that when one of these valves is open, air will flow into the pipe W', figs. 3 and 6, and thence into the annular space B.

If this valve is open, as it should be, after the exhaust-valve closes, and before the main inlet-valve opens, all the clearance or unoccupied space in the cylinders and valve-passages will be filled with pure air but little heated, and of density equal to that within the casing and furnace.

The object of thus introducing air through the pipe W' at this place and time is threefold: first, by rendering the pressure alike on both sides of the inlet-valve, it is balanced and operated *in equilibrio*, by which the power necessary to work it is reduced to the minimum; second, by having the space in the cylinder filled with pure air, that which rushes in afterward from the furnace will not be likely to carry the solid products of combustion into the joint or annular space between the finished portions of the cylinders; third, by the introduction of cool compressed air, as described, the temperature of the finished parts of the cylinder, and piston which work in contact with each other, are kept sufficiently cool to admit of efficient lubrication.

V, figs. 4 and 5, is the inlet-valve, and corresponds to the sliding valve on a steam-engine.

This valve is open at the commencement of the upstroke of the piston, but closes at about three-fourths stroke of the same, or at such a point as will give the best result.

As shown in the drawings, this valve V has, besides the disk common to all puppet-valves, a hollow cylinder, extending upward, so that the valve, as a whole, forms a cylindrical vessel open at the top.

The pipe T", figs. 4 and 5, extends downward in the valve, as shown in the drawings, so that when the engine is working, a current of cool air is sent down from the air-pump, through L' and T", into said valve at each stroke of the piston, thus preventing it from being overheated.

At about the time the upward movement of the piston ceases, and after the inlet-valve V has been closed, the exhaust-valve V' opens and permits the contents of the cylinder to escape and to be forced out by the descent of the piston into the exhaust-pipe N', figs. 2, 3, 4, and 5.

The valves shown in the drawings are of the puppet variety, and are operated at all times by cams attached to the shaft N, figs. 1, 2, and 4, said shaft being operated by the shaft N", figs. 1 and 5, which connects by gears to the main shaft R.

The throttle-valve *p*, figs. 4 and 5, situated in the hot-air passage L, serves to regulate the speed of the engine, being connected by its valve-stem to the regulator Q, figs. 1, 2, 4, and 5, so that as the speed of the engine increases, the orifice connecting L is more or less closed, thus checking the flow of air through the engine until the speed is reduced to its normal rate. If the engine is going too slow, the reverse of this action takes place.

V" represents a vacuum-valve, one of which is attached to each cylinder, near the bottom, and serves to admit air when the engine is started, or whenever, from any reason, a vacuum occurs in the cylinders under the pistons.

In starting a fire on the grate, the main inlet and exhaust-valves should be opened, as well as the ash-pit door, to establish a draught through the engine by way of the cylinder.

When the fuel is well ignited, all the doors and valves through which air can pass to or from the furnace should be closed and made air-tight.

The main shaft of the engine itself may be rotated by suitable means, when the pumps forming part of the engine will supply the air needed in the furnace.

When sufficient pressure has been generated to rotate the engine, the extraneous force may be discontinued, as the expansion of the air supplied by the pumps of the engine will continue to increase the pressure within the furnace until the engine has some work applied to it to absorb the power generated

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

1. The inlet-valve V, when made hollow and combined with the cold-air pipe T", substantially as described.

2. The combination of the inlet-vacuum valve V" with the working-cylinder of the air-engine, substantially as described.

PHILANDER SHAW.

Witnesses:
WILLIAM EDSON,
JOS. R. EDSON.