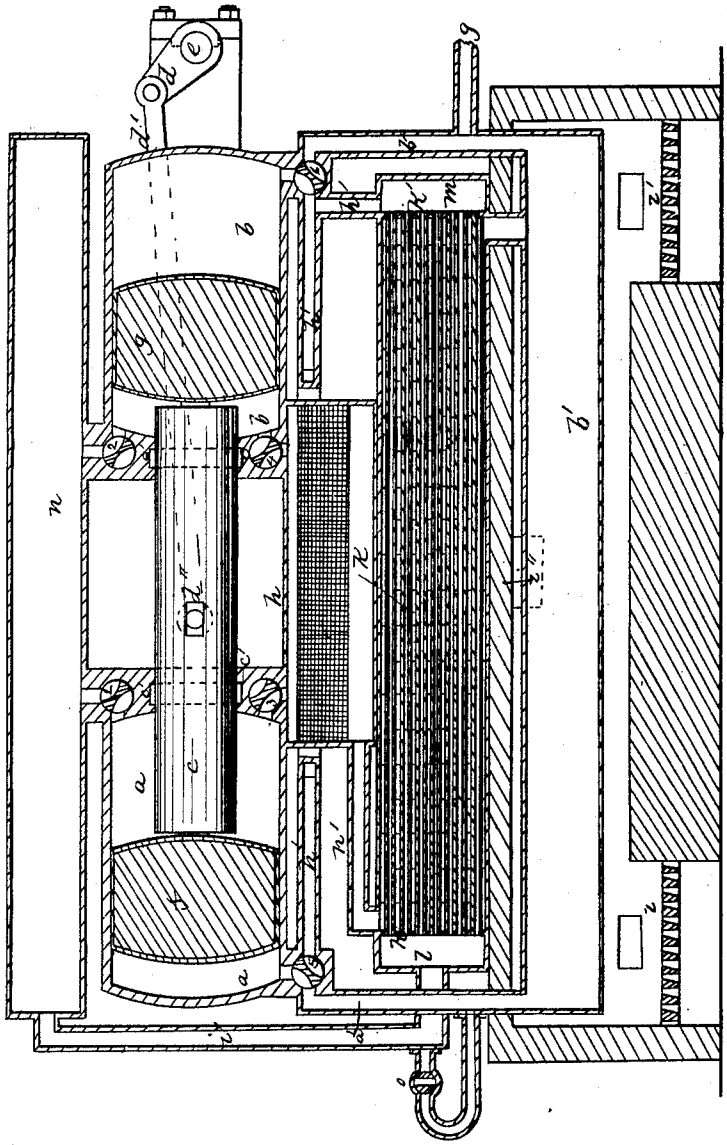
J. ERICSSONS.

AIR ENGINE.

No. 30,306. Patented Oct. 9, 1860.



Witnesses.

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JOHN ERICSSON, OF NEW YORK, N. Y.

## AIR-ENGINE.

Specification of Letters Patent No. 30,306, dated October 9, 1860.

*To all whom it may concern:*

Be it known that I, JOHN ERICSSON, of the city, county, and State of New York, have invented certain new and useful Improvements in Air-Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, forming part of this specification, said drawing representing a central longitudinal vertical section of an air-engine constructed according to my invention.

In all air engines operated under condensed pressure as hitherto constructed the motive force of the working piston has been found inadequate, owing principally to the rapid diminution of the acting pressure by expansion, during the movement of the piston from end to end of the cylinder.

One great object of my invention is not only to obviate such diminution of the acting pressure toward the end of the stroke but to augment the same as well as the effective force of the piston, as it approaches the termination of the stroke. This I accomplish by placing two cylinders which I call equilibrium cylinders in a direct line at a certain distance from each other. Close to these cylinders I place a strong air tight vessel or series of vessels to which heat is applied, and also another strong air tight vessel or series of vessels kept cool by the application of cold water of currents of atmospheric air. Within each of the equilibrium cylinders a hollow piston which I call the equilibrium piston is made to operate, and both pistons are connected by a long piston of relatively small diameter resembling the ram of a hydraulic press. This piston which I call the working piston passes through air tight stuffing boxes in the heads of the equilibrium cylinders. The working piston is connected with the driving crank of the engine by a cross head and side rods, or by beams and connecting rods as in steam engines. By means of an air pump operated by auxiliary power, atmospheric air is charged into the equilibrium cylinders, heater and cooler, but in such a manner that a greater pressure is charged into the heater than into the cooler. The pressure in the equilibrium cylinders will vary as will be explained hereafter.

By means of certain connecting pipes and valves I establish an alternating communication, between the heater, cooler and equilibrium cylinders, the arrangement being such, that both ends of one equilibrium cylinder are simultaneously in free communication with the heater while both ends of the other equilibrium cylinder are at the same time in free communication with the cooler. The pressure in the heater being greater than on the cooler the working piston will be forced from or out of the cylinder which is in communication with the heater into the cylinder communicating with the cooler. When the working piston has completed the stroke the communications between the equilibrium cylinders, heater and cooler are reversed by valves operated as in non expansive steam engines, and thus a continuous motion is produced. The greater volume of air withdrawn from the heater is compensated by the dilatation caused by heating the air during its passage through the heater or heaters, all of which will be hereafter more fully explained.

In the accompanying drawing *a*, and *b*, are cylinders placed in a direct line with each other provided with close heads at both ends. These cylinders I call equilibrium cylinders.

*c* is a piston resembling the ram of a hydraulic press to be made either hollow or solid. This piston I call a working piston which passes through the heads of the equilibrium cylinders with air tight packings at *c'*, *c'*, and is connected to a crank *d*, on the driving shaft *e*, by means of a connecting rod *d'*, and a cross head *d''*, fixed in the working piston.

*f*, and *g*, are hollow pistons fitted easily in the cylinders *a*, and *b*, filled with pounded charcoal and attached at opposite ends of the working piston *c*.

*h*, is a strong air tight vessel placed near the equilibrium cylinders partially filled with a number of disks of wire cloth. I call this vessel a heat deposit vessel. *i*, is another strong air tight vessel surrounded by brick work with fire places at *i'*, *i'*, and a flue *i''*, connected with a smoke pipe in a chimney.

*k*, is a strong air tight vessel provided with head plates *k'*, and head chambers *l*, and *m*, these latter being put in communication by a series of small tubes inserted in the head plates. *n*, is a strong air tight

vessel to act as a cooler either by being freely exposed to the atmosphere or by being immersed in a surrounding cistern of cold water or other means usually adopted for purposes of refrigeration.

$a'$, and $b'$, are pipes for forming a communication between the equilibrium cylinders and heater.

$l'$, is a pipe communicating between the head chamber $l$, and the cooler $n$.

$l''$, is a pipe communicating between the vessel $k$, and the heater $i$.

$h'$, $h'$, $h'$, is a bent pipe for forming a communication between the two extreme ends of the equilibrium cylinders and the head chamber $m$.

$o$, is a stop cock for opening or shutting off the communication between the pipes $a'$, and $l'$.

$p'$, is a pipe communicating between the heat deposit vessel $h$, and the vessel $k$.

$q$, is a pipe through which the heater and other parts may be charged with compressed atmospheric air.

1, 2, 3, 4, 5, and 6, are valves operated by ordinary valve gear attached to the crank shaft in such a manner that 1 and 2, open the communication alternately between the cooler and equilibrium cylinders, while the pistons $f$, and $g$, move respectively toward the extreme outer ends of the cylinders. The valves 3, and 4, communicate between the cylinders and heat deposit vessel while the said pistons move respectively toward the inner heads. The valve 5, operates so as to form communication between $a'$, and $a$, when the equilibrium piston $f$, moves to the right, and a communication between $a$, and $h'$, when the piston moves to the left. In like manner the valve 6, communicates between $b$, and $h'$, when the piston $g$, moves to the right and between $b'$, and $b$, when it moves to the left. Having now described the various parts of my improved air engine I will now explain the manner of putting the same into operation.

Compressed air is charged into the interior of the engine through the pipe $q$, by means of an air pump actuated by auxiliary power. It will be seen by inspecting the drawing that the compressed air will enter the heater $i$, first, and from thence to the vessels $k$, and $h$, and also the equilibrium cylinder $a$ through the valves 3, and 5. As the equilibrium cylinder $b$, is at the same time in communication with the cooler by means of the valve 2, and 6, and the various pipes before described it will be seen that the pressure in $a$, owing to its more immediate connection with the heater $i$, will force the working piston $c$, into the equilibrium cylinder $b$, until it reaches the termination of the stroke when the position of the valves is reversed as before stated. A left handed movement of the piston will then take place in like manner by the equilibrium cylinder $b$, being in communication with the heater while $a$, is in communication with the cooler, In this manner a continuous reciprocating motion will be kept up as in a steam engine. It is proper here to state that the heated air as it passes off from the equilibrium cylinders through the valves 5, and 6, the pipe $h'$, and head chamber $m$, gives out its heat to the numerous tubes in the vessel $k$. On the other hand the cold air from the opposite end of the equilibrium cylinders after having passed through $h$, and $p'$, comes in contact with the heated tubes and therefore when entering the heater at $l''$, a very considerable elevation of temperature has been effected which will materially assist the heater. In like manner the heat lost by the exhaust air in passing through the tubes of $k$, will materially assist the cooler in reducing the temperature of the air before it enters the equilibrium cylinders through the valves 1, and 2. I have further to state that if the cooler $n$, be removed and the air from $l'$, be permitted to escape into the atmosphere and if the valves 1, and 2, open directly into the atmosphere my improved air engine will operate well and prove of great practical utility. Its power will however be greatly increased by applying the cooler and charging the interior with air of greater density than the atmosphere.

It will be seen that the wire disks inserted into the vessel $h$, will effectually take up the heat which otherwise would enter the cold end of the equilibrium cylinders through the valves 3, and 4, on opening these for establishing equilibrium of pressure in the cylinder. The heat thus imparted to the wires will in turn be taken up by the cold air as it passes off from the cylinders to the heaters.

It is evident that the exhaust valves 3, and 4, need not be opened until the compression of the cold air has established an equilibrium of pressure at both ends of the cylinders, and it is also evident that the inlet ports of the valves 5, and 6, may be closed somewhat before the termination of the stroke of the piston. An increase of motive power would attend the mode of opening and closing the valves now stated, but as the strain on the working gear of the engine would be increased in a nearly quadruple ratio, I prefer to open and close the valve as described. It is also evident that the two equilibrium cylinders with their pistons may be placed side by side, and that the working piston may be divided transversely through its middle thereby forming two pistons, and that the two pistons thus formed may be connected by beam by which a reciprocating movement would be produced and motive power obtained precisely as described. It is

also evident that the heaters and coolers may be placed in various positions provided they are connected with the equilibrium cylinder as described. I do not therefore confine myself to the precise arrangement there shown.

What I claim as my invention and desire to secure by Letters Patent is—

1. The combination of the equilibrium cylinders *a*, *b*, the equilibrium pistons *f*, *g*, and the working piston *c*, when used substantially in the manner and for the purposes above set forth.

2. The combination of the equilibrium cylinders *a*, *b*, the equilibrium pistons *f*, *g*, the valves 5, and 6, the vessel *k*, and the tubes therein contained when used substantially in the manner and for the purposes above set forth.

3. The combination of the equilibrium cylinders *a*, *b*, the equilibrium pistons *f*, *g*, the valves 3, and 4, and the heat deposit vessel *h*, when used substantially in the manner and for the purposes above set forth.

4. The combination of the equilibrium cylinders *a*, *b*, the equilibrium pistons *f*, *g*, the valves 5, and 6, and the heater *i*, when used in the manner and for the purposes above set forth.

5. The combination of the equilibrium cylinders *a*, *b*, the equilibrium pistons *f*, *g*, the valves 1, and 2, and the cooler *n*, when used in the manner and for the purposes set forth.

6. The combination of the equilibrium cylinder *a*, the equilibrium piston *f*, the valve 5, and the bent pipe *h'*, *h'*, *h'*, when used for the purposes above set forth.

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Witnesses:
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