S. WILCOX, Jr.

AIR ENGINE.

No. 30,700. Patented Nov. 20, 1860.

Fig: 1.

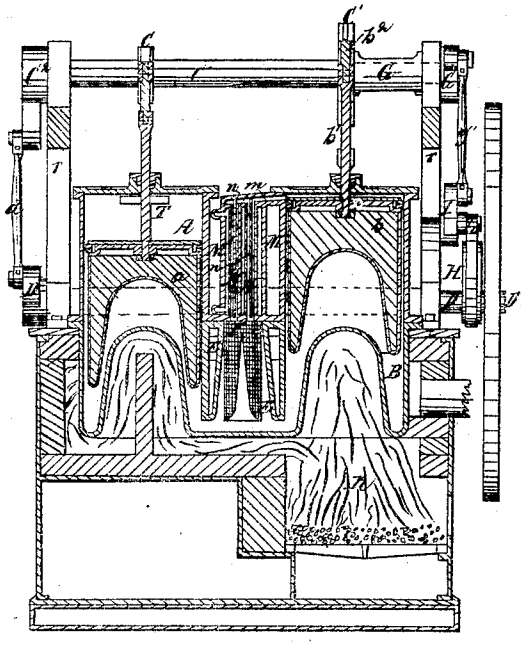


Fig: 2.

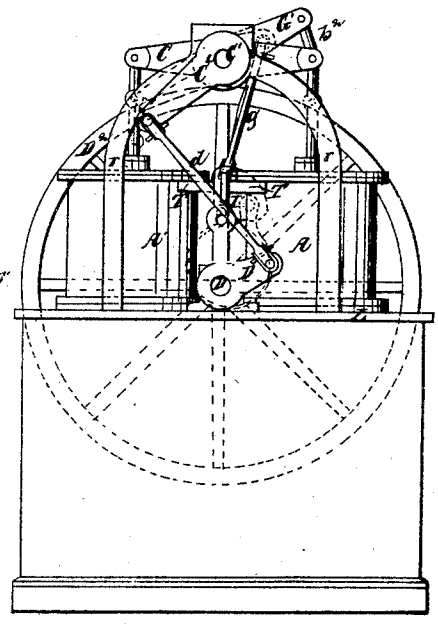


Fig: 3.

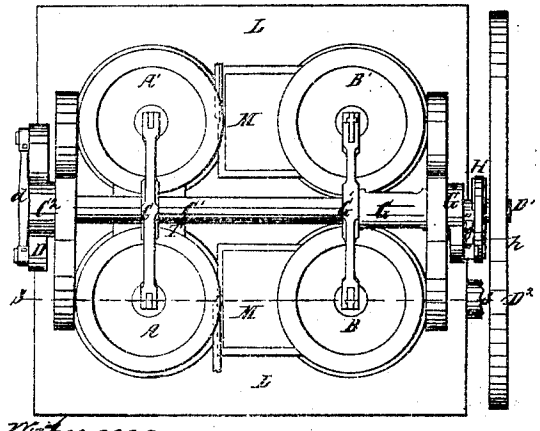
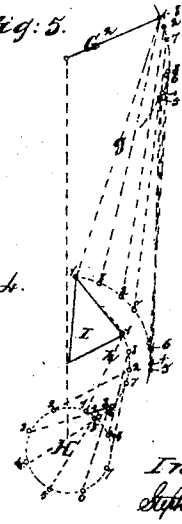


Fig: 4.

Fig: 5.



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UNITED STATES PATENT OFFICE.

STEPHEN WILCOX, JR., OF WESTERLY, RHODE ISLAND.

AIR-ENGINE.

Specification of Letters Patent No. 30,700, dated November 20, 1860.

To all whom it may concern:

Be it known that I, STEPHEN WILCOX, Jr., of Westerly, in the county of Washington and State of Rhode Island, have invented certain new and useful Improvements in Air and Gas 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 drawings and to the letters of reference marked thereon.

My improvements relate mainly to those engines in which the same air is used at each stroke being heated on the forward or outward stroke and cooled on the return stroke of the piston; but a part may be equally well applied to hot air engines of a different character.

The nature of my invention consists, first, in a certain combination and arrangement of two changing cylinders and two working cylinders peculiarly coupled together to form a compact double acting engine; second, also, in a certain combination and arrangement of an eccentric or crank with an idle lever the changing piston or pistons and connections whereby the proper periods of motion and rest are given to the changing pistons in the manner set forth below.

To enable others skilled in the art to which this is most nearly allied to make and use my invention, I will proceed to describe the construction and operation of the same by the aid of the drawings in which—

Figure 1 is a vertical longitudinal section on the line *s*, *s* in Fig. 3. Fig. 2 is an end elevation. Fig. 3 is a plan. Fig. 4 is a cross section of one tube of the refrigerator on a larger scale, and Fig. 5 is a diagram illustrating the motion of a portion.

Similar letters of reference indicate like parts in all the figures.

A A′ are the working cylinders, B B′ the changing cylinders, *a* one of the working pistons and *b* one of the changing pistons the others not being shown in the drawings, E the regenerator chamber, F the regenerator, and K the furnace. These parts bear the same relations to each other and are constructed and operate together as shown in the United States patent granted to me May 3d 1859. The working pistons are connected together by a beam C on a rock-shaft C′ in such a manner that when one goes up the other comes down and vice versa. An arm C^2 on the end of the rock shaft connects by a connecting rod *d* with a crank D on the main shaft D′.

G is a sleeve mounted loosely on the rock-shaft C′ to which sleeve is attached another beam G′. To this beam G′ both changing pistons *b*, are connected as represented by links b^2, b^2, and piston rods *b*′. At the other end of G is a short arm G^2 connected to an idle lever I by a link *g*. I is operated by an eccentric H on the shaft D′ by means of a short eccentric rod *h*. The shaft D′ has suitable bearings attached to the bed plate L and carries a flywheel D^2. Suitable frames *r*, *r*, support the rock-shaft C′. The furnace flues, heating surfaces &c. are arranged in the manner shown in the patent above referred to.

Over the regenerator chamber E I place a refrigerator constructed in the following manner: Tubes N, N, extend through a case M, their lower ends communicating with the regenerator chamber E and their upper ends with a passage *m*, which connects with the upper end of the cylinder B. Rods *n*, *n*, of metal or other suitable material are placed within the tubes N, as shown in Fig. 4, leaving a narrow annular opening between for the passage of the air. The number and size of tubes is such that the aggregate area of these annular passages is barely sufficient for the free passage of the air between E and B. The case M being filled with a current of air or water running therethrough, the metal of the tubes is kept at a low temperature, and the hot air in passing along this surface in a thin sheet rapidly imparts its caloric through the metal to the water. Were it not for the rods *n* within the tubes a quantity of air might escape through the center of the tubes without being cooled which would materially reduce the power of the engine, and were the tubes N made sufficiently small to avoid this difficulty the complication of parts, multiplication of joints and leakage and other obvious evils resulting therefrom would more than counterbalance the advantage. By my arrangement the proper amount of cooling surface is attained with little complication, no lost

space more than is absolutely required, and an efficient and durable apparatus is obtained.

The effect of my arrangement for operating the changing pistons *b*, *b*, is shown by the diagram Fig. 5. The eccentric H by reason of its short connection *h*, gives the idle lever I an irregular rocking motion, moving it but slowly and for a short distance when the eccentric is passing through a much longer distance at that portion of its path farthest from I, but moving it more rapidly when passing the other center or that portion of its path nearest to I. This property of a short connected crank or eccentric is well known and needs no farther description. The idle lever I bears such a relation to the arm G^2 that when the eccentric is passing the "center" nearest to I the latter and the connection *g* come into line as shown in the drawings. This arrangement is such that the arm G^2 and consequently the pistons *b* are caused to move very slowly at each end of their stroke, one by reason of the eccentric H passing its "long center" and the other by reason of the lever I and link *g* coming into line while the eccentric is passing its "short center." This motion is the one desired for the pistons *b* moving them rapidly when changing the air from one side to the other, and holding them nearly stationary while the pistons *a* are making their stroke.

The operation of my improved engine is as follows: The cylinder B and the lower portion of A being, by a pump or otherwise filled with air at any convenient pressure heat is applied which expands the air beneath the pistons forcing up *a*. When *a* arrives at or near the termination of its stroke, *b* is rapidly depressed and the air beneath it is forced up through the regenerator F and refrigerator M, M, *n*, into the top of the cylinder B. The passage of the air through the regenerator and refrigerator lowers its temperature thereby reducing its pressure and the momentum of the flywheel or the action of the other piston *a* through the beam C forces *a* down, passing the remainder of the air into the top of B. The piston *b* being now raised by the action of the eccentric and its connections drives the air back again through the refrigerator and regenerator against the hot surface of the lower ends of A and B, whereby it is increased in volume and *a* is forced upward again. The other pair of cylinders A′, B′, work in the same manner at alternate periods so as to form a double acting engine.

Were the working pistons exposed to atmospheric pressure only upon their upper sides while a pressure of several atmospheres was maintained beneath, there would be necessarily a heavy upward pressure upon the beam C and the rock-shaft C′, and each piston would require to be depressed against a high back-pressure causing a severe strain upon the parts. There would also be great liability to leakage owing to the extent of surface requiring to be tightly packed. To obviate this I inclose both the working cylinders above the pistons and connect them together by a pipe T. This space being filled with air at a pressure equal to about the average of that beneath the pistons prevents much tendency to leakage around the packing of the piston, and the stuffing box around the piston rod is easily kept tight. This confined air pressing equally on both pistons *a* neutralizes the upward pressure upon the beam C, and the sole strain thereon is that due to the difference of pressure beneath the two pistons, and the resistance or power exerted by the machine. At each stroke this confined air is transferred from one cylinder to the other, and exerts no effect upon the power of the engine. It will also be found beneficial to carry the waste water from the refrigerator around the cylinders A and B for the purpose of keeping them cool.

The advantages due to my several improvements are, first, by the combination and arrangement of the several cylinders A, A′, B, B′, and their respective pistons, operating as described. I am enabled to make a powerful double acting engine in a smaller compass and with less expense than with any ordinary arrangement. Second, by the arrangement of the several parts H, *h*, I, *g*, *b*, and their necessary connections I am enabled to give the proper periods of rest and motion to the changing pistons, without any jar or sudden change of motion.

I am aware that in the English patent granted to Robert Stirling in 1827, a series of idle levers and connections were used in combination with an eccentric for giving motion to the changing plungers, and I do not therefore claim such a device. But the arrangement shown in that patent is materially different from mine inasmuch as it is composed of many more parts and is consequently more expensive to construct and maintain, is subject to more lost motion and jarring when in use, and is liable to be sooner deranged.

Having now fully described my improved engine what I claim as my invention and desire to secure by Letters Patent is—

1. The combination and arrangement of the two single acting working cylinders and pistons, with the two changing cylinders and pistons so as to operate together substantially as herein described for the purposes set forth.

2. The combination and arrangement of the eccentric H, short connection *h*, idle lever I, link *g*, and the changing piston or pistons, *b*, together with suitable means for communicating the motion to the latter, for the purpose of giving the proper periods of rest and motion to the changing pistons, *b*, substantially as above specified.

In witness whereof I have hereunto set my hand in the presence of two subscribing witnesses.

STEPHEN WILCOX, JR.

Witnesses:
WILLIAM P. COY,
CHARLES H. DENISON.