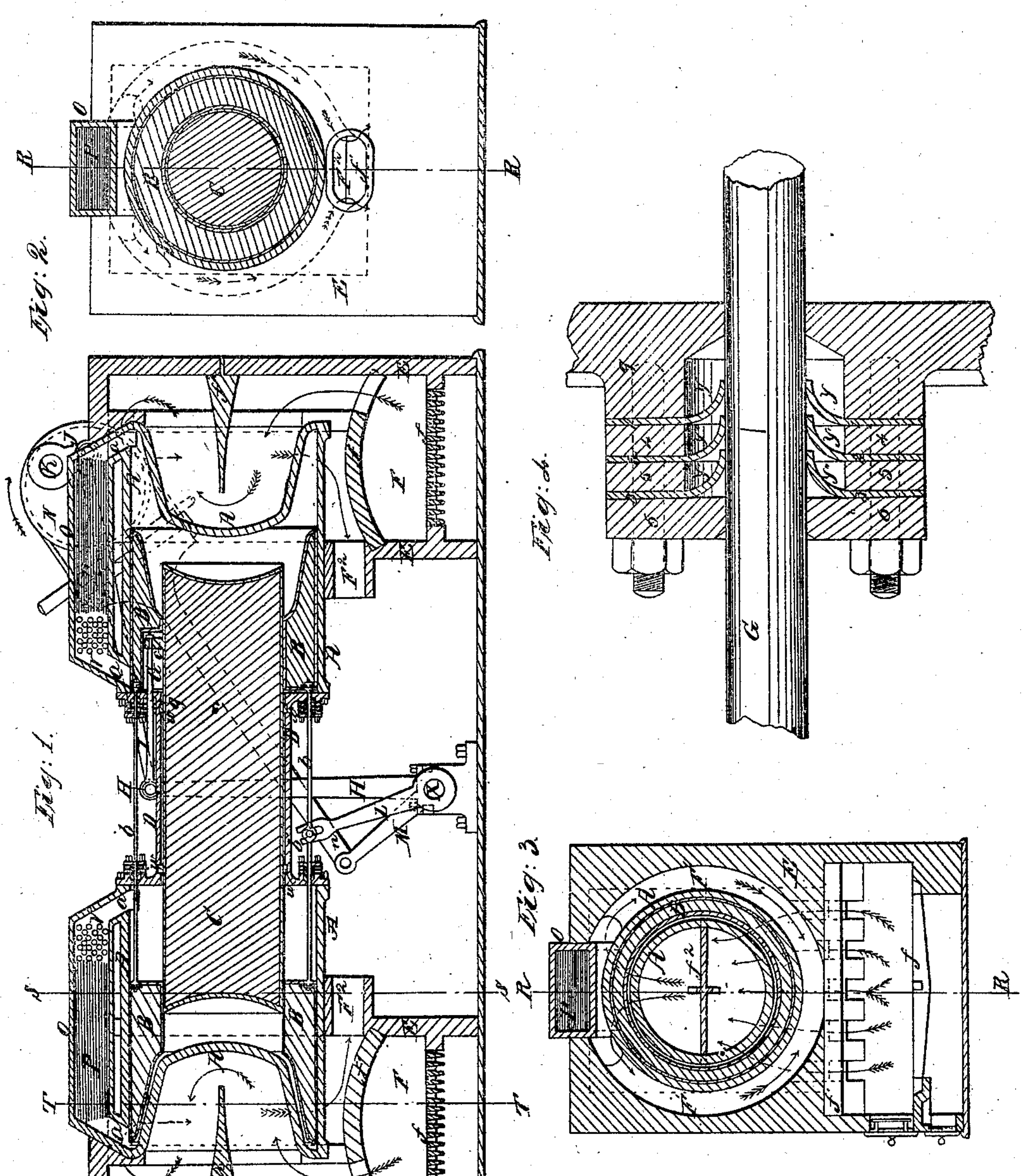
S. WILCOX, Jr.

AIR ENGINE.

No. 31,924. Patented Apr. 2, 1861.



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

HOT-AIR ENGINE.

Specification of Letters Patent No. 31,924, dated April 2, 1861.

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 Hot-Air Engines; and I do hereby declare that the following is a full and exact description of the construction and operation of the same.

My improvements are based on the air engine shown in the English patent of Robert Stirling dated Oct. 1st 1840 and numbered 8652, in which the same air was alternately made to increase and diminish its pressure by changes of temperature and thus to impart motion to a working piston, while the changes in pressure were induced or controlled by the motion of another piston termed a changing piston.

The nature of my invention consists, first, in arranging the working and changing pistons so that the former works within the latter and both within a single cylinder or in other words so that the changing piston shall be annular and shall inclose the working piston within it in the manner and so as to produce the effect explained below. By this arrangement I obtain all the advantages of the use of two pistons in one cylinder, such as compactness, cheapness, little lost space, etc., together with the advantages of separate working and changing cylinders and pistons, such as independent action of the two pistons, increased heating surface, etc., thus combining in my improved arrangement the peculiar advantages of the two previously known forms.

The nature of my invention also consists in the employment of a tight case around the central portion of a plunger, one end of which plunger serves as the working piston of one single acting hot air engine, and the other end of which serves as the working piston of another and similar engine, in combination with the employment of a peculiar means of connecting such double working piston with the exterior parts of the engine. By this combination, I reduce the extent of packed surface dividing the working air from the external air, and thereby reduce the leakage from the working chamber or space which leakage would occasion a serious loss when a very high pressure was employed.

I employ a peculiar arrangement of parts for packing certain details of my engine. By this arrangement for packing these parts, which parts are the slender rods serving to communicate motion to and from the several parts within the working chamber I am able to retain the air at a very high pressure without much leakage or friction at these packings, and also with a greatly reduced liability to sudden loss of pressure by leakage caused by the wearing or breaking away of such packing.

The drawings represent my engine as working in a horizontal position with a separate fire under each end; and a horizontal shaft—the main shaft of the engine—extending across directly above one of the ends.

To enable others skilled in the art to make and use my invention I will proceed to describe its construction and operation by the aid of the drawings in which—

Figure 1 is a longitudinal vertical section (on the line R, R, in Figs. 2 and 3) and shows every part more or less plainly. Fig. 2 is a vertical section on the line S, S, in Fig. 1. It shows the general rectangular framing or case of the structure, the regenerator plates at the top, one of the large fixed cylinders which stand at each end, the annular changing piston which works loosely within the same, one end of the working piston which works within the changing piston, and the flue below through which the products of combustion are discharged. Fig. 3 is a vertical section on the line T, T, in Fig. 1. It shows the same rectangular frame, the same regenerator and the same large cylinder as Fig. 2. It also shows the smoke flue around the latter, through which the gaseous products of combustion circulate, and the concave portion of the end of the fixed cylinder with the horizontal bridge or deflector. It also shows the furnace and the heat shield by which the cylinder is protected from the direct radiant heat of the fire. Fig. 4 is an enlarged view of one of the small stuffing boxes showing the peculiar mode of packing.

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

A, A, are the large stationary cylinders which inclose the annular changing pistons B, B, and the plunger C, which serves as the working pistons, in the manner represented. The annular changing pistons, B, B, run loosely in the cylinders, A, A, and inclose the working piston loosely within themselves, there being little occasion for tight fitting or packing because the pressure is always very nearly equal on both sides of B, B, and the only function of the latter is to drive the air alternately in opposite directions through certain passages.

D is a smaller cylinder which connects the two large cylinders A, A′. These three cylinders A, D and A′ compose the main stationary portion of the engine and are supported on masonry, E, which latter forms the furnaces, F, for heating the outer ends of both the cylinders A.

The fires are made upon the grates *f f*. Arches of fire brick *f′ f′* are constructed over each fire and horizontal deflectors or bridge walls f^2 f^2 are properly located as represented, to compel the hot products of combustion to circulate into the cavity represented at the outer ends of A, A. After these currents of gases have risen to their highest points they descend through the flues F′, F′, around A, A, and escape at the apertures F^2, F^2, flowing from thence to the chimney or other suitable discharge, through pipes not represented.

I will distinguish the two ends of the structure as right and left according to their position in Fig. 1. The right end of C has a stout projection or lug *c*, and the interior of the corresponding changing piston B is recessed to allow space for this lug to traverse back and forward with C without touching B. A rod G which serves as a piston rod is fixed to *c* and extends out through a stuffing-box *g* as represented into the external air where it is connected to a long lever H, which latter turns loosely on a shaft X and is connected by a rod I to the crank J on the main shaft K. Through this train of connections the reciprocating action of the part C is caused to impart a rotary motion to the shaft K, while the only communication between the exterior and interior of the cylinders required, therefor is the single slender rod G.

The annular changing pistons B, B, are constructed separately and independently, but are compelled to move together as one piece, being rigidly connected each with the other by the two rods *b*, *b*. These rods traverse the external atmosphere passing through stuffing boxes as represented, each of which is similar in construction to *g*. The lowermost rod *b* carries a transverse pin *b′*. A forked lever L keyed to the shaft X stands outside of this pin *b′* and thus compels *b′* with its connections—the annular pistons B, B,—to move with every oscillation of X. A second lever M is also keyed upon X and its extremity is connected by a rod *n* with the eccentric N which latter is fixed upon K at or near the angle of 90° in advance of the crank J. The throw of the eccentric N and the length of the levers L and M are such that the extent of the reciprocations of the annular changing pistons B, B, is about equal to that of the working pistons C.

On both the outer and the inner end of each large cylinder A is an opening or port *a* connecting the interior of A with a chamber O immediately above. These chambers contain both plates of metal P for receiving and again yielding up heat and tubes V containing water for receiving and conveying away heat. They are arranged as represented, the plates P being laid horizontally one above another at very small distances apart, in that end of each chamber nearest the outer end of the corresponding cylinder A, and the tubes, as represented, at the opposite end of each chamber. The pipes V are supplied with a continuous flow of cold water through a pipe and pump or other convenient means not represented.

Metallic or other suitable packing *w*, *w*, is introduced in the smaller fixed cylinder D in any ordinary manner to prevent leakage from the right to the left end of the engine and vice versa. The prevention of leakage between these parts is important, because the power of the engine depends on the excess of pressure alternately obtaining first in one and then in the other end, and acting on the part C in opposite directions, but a moderate leakage between these points is not as serious an evil as an equal leakage through the stuffing boxes into the external atmosphere, for the following reason:—The pressure within the engine is intended to be ordinarily much higher than that of the atmosphere, and is only obtained by pumping with a great outlay of power. If air escapes therefrom an equal volume must be pumped in against a great resistance to supply its place, but if air flows from one end to the other of the engine it only diminishes the force of that stroke, while the air is still within the engine ready to act on the return stroke. If the adjustment of the packing *w*, *w* should chance to favor a leakage through it in one direction more than in the other, the pressure might accumulate in one end of the engine so as to average higher than in the other, but this is an evil which would evidently tend to cure itself before it could reach any very serious proportions.

The construction of my stuffing boxes *g* is so well shown in Fig. 4 as to require little explanation. A series of cup leathers are employed with a washer of metal between each leather and the next so as to leave little chambers Y, Y′, Y″. These chambers become filled with air at various pressures. The chamber Y′ between the inner cup leather 1 and the next 2 is filled at a pressure below the minimum pressure within the cylinders. The next chamber Y″ is filled by leakage from Y′ with air at a still lower pressure and so on, if the series be prolonged to any extent required, the outermost being only a little above the external air. In this arrangement each cup leather is held properly to its contact with the rod sliding through it with but a very slight friction and the leakage being checked by each leather is so slight as to be almost inappreciable while the whole is self adjusting and maintains its proper condition without attention until the whole is worn out. Where but one cup leather is used, as in Stirling's engine, or a ring of hemp or cotton, as in ordinary steam engines, there is also great liability of sudden and unexpected leakages occurring from wear or rupture of the packing, and such leakage in an air engine, using air at high pressure, would cause so serious a loss of power as to require the immediate stoppage of the machine for repair. By my arrangement, such liability is greatly diminished, from the improbability of all the cup leathers giving out at once, and in case of one or even all but one of them giving out the engine could run until convenient time for repairs.

The operation of my engine is as follows. The air is compressed into the cylinders A, A′, and chambers *o*, *o*, by a pump not represented to a pressure of say 100 pounds per square inch, and the fires are lighted in the furnaces F, and the metal at the outer ends of A, A′, is heated to a temperature of say 500° F. A current of cold water is now made to flow through V and the engine is started by turning the shaft K by hand or by any suitable means it being provided with a fly wheel not represented. The arrangement of the eccentric N, about 90 degrees forward of the crank J, causes the changing pistons to traverse the major part of their stroke while the piston C is at or near the end of its stroke, and the movement of B, B, drives air through both chambers *o*, *o*, among the plates P and tubes V therein. A movement of B, B, in either direction sends the air through O, O, in such a manner as to lower the temperature of the air in one cylinder A, while it raises the temperature of the air in the other, and these changes of temperature induce corresponding changes of pressure whereby C is actuated and the shaft K is thereby turned by the crank J without further aid from the hand. In the position represented the changing pistons have each completed a stroke to the left, driving air from the left to the right of each of these pistons through both chambers O and O. In the right chamber this movement carries the cool air from the inner end of the cylinder and chamber between the partially heated plates P into the hot end of the chamber and cylinder. This heats the air and raises the pressure at that end of the machine. In the left chamber this same movement carries the hot air from the outer end of the cylinder and chamber between the only partially heated plates P and cool pipes V. This cools the air and lowers the pressure at that end of the machine. The changes at each end conspire to force C to the left and when it has completed its stroke the movement of B, B, in the opposite direction will have induced such a change of pressure at both ends as to commence to urge it back again. These changes follow each other by the operation of the mechanism described and the crank J revolves with a force proportionate to the favorable differences of pressure obtaining on the ends of C. A portion of its power is consumed in overcoming the inertia and slight friction of B, B, *b*, *b* and of the other working parts, another portion may be consumed in pumping air into A, A, to compensate for leakages through the stuffing boxes *g*, and the remainder may be employed for any useful purpose desired.

It will be observed that the parts at the right of the cylinder D would form when isolated from those on the left a complete single acting engine and might under certain conditions, moderate pressure, &c. be used independently as such while the parts on the left of D are capable of forming also a separate engine.

When used together in the manner I prefer and have represented above the entire engine is double acting, it is composed of the principal parts of two single acting engines and I shall speak of it as such in the second clause of the claim. I do not intend in the use of my annular changing piston to confine myself to such double acting engine, but can when required use it with all its good effects on single acting engines.

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

1. The employment in a hot air or gas engine of a plunger C, in combination with an annular piston B, arranged and operating within the single cylinder A, substantially as and for the purposes herein set forth.

2. The employment of the tight case D

around a plunger C serving as the working piston of two single acting hot air engines, in combination with the employment of one or more lugs *c* and piston rods G arranged substantially as represented for the purpose of diminishing the liability of leakage of air from the interior of the engine.

In testimony whereof I have hereunto set my name in the presence of two subscribing witnesses.

STEPHEN WILCOX, Jr.

Witnesses:

Thomas D. Stetson,

G. H. Babcock.