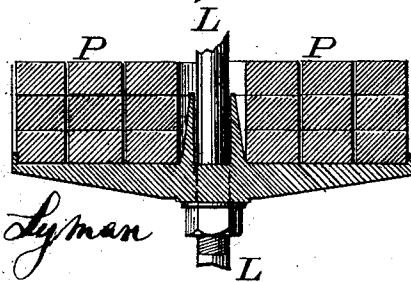
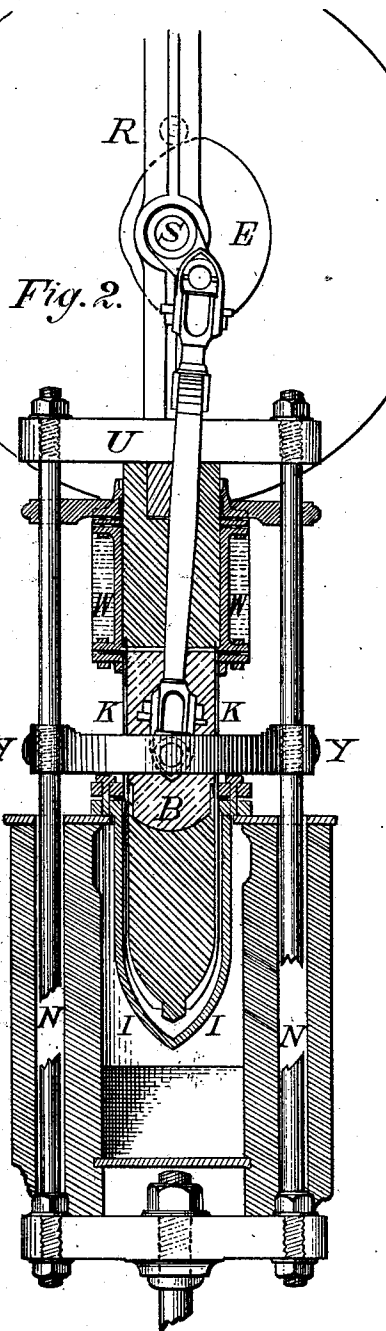
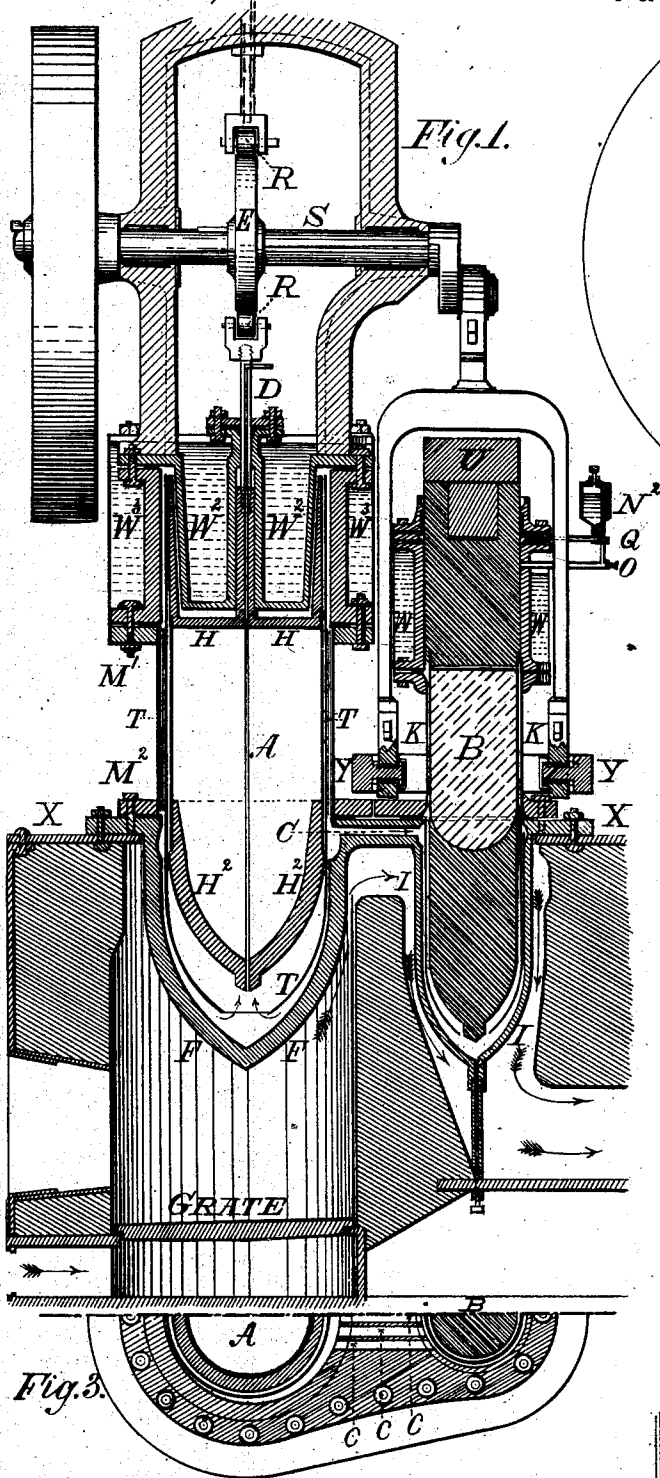


A. S. LYMAN.
Air Engine.

No. 236,954.

Patented Jan. 25, 1881.



Witnesses:
A. B. Denning
O. H. Riblet

Inventor:
Asel Storm Lyman

(No Model.)

2 Sheets—Sheet 2.

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Fig. 4.

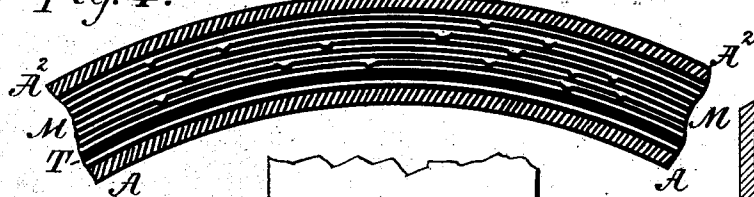


Fig. 5.

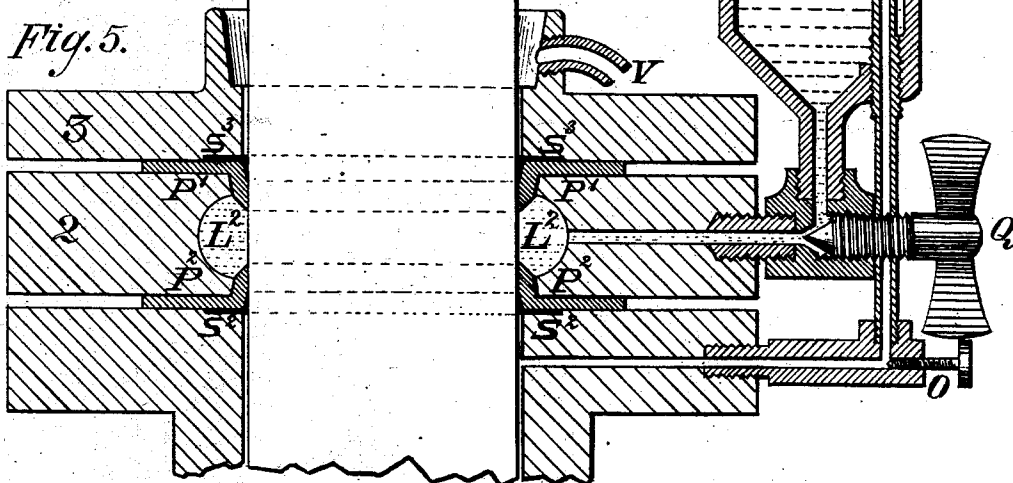
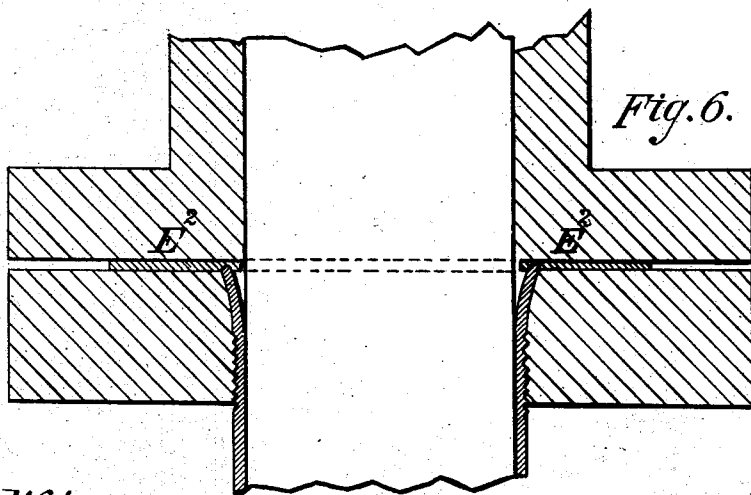


Fig. 6.



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A. B. Deming
W. H. Riblet

Inventor:

Azel Storrs Lyman

UNITED STATES PATENT OFFICE.

AZEL STORRS LYMAN, OF NEW YORK, N. Y.

AIR-ENGINE.

SPECIFICATION forming part of Letters Patent No. 236,954, dated January 25, 1881.

Application filed June 22, 1880. (No model.)

To all whom it may concern:

Be it known that I, AZEL STORRS LYMAN, of the city, county, and State of New York, have invented new and useful Improvements in Air-Engines, of which the following is a specification.

This invention relates to that class of hot-air engines which are charged with a high pressure and use the same air or gas over continuously by merely moving it back and forth between the working-cylinder and the cooler and heater of the generator. Its object is to avoid the practical defects which have prevented the successful introduction of this class of engines.

Figure 1 represents a vertical central section of the generator A and the working-cylinder B. Fig. 2 is a vertical central cross-section through the working-cylinder B when this engine is used for constantly pumping water and also for doing other work. Fig. 3 is a partial section through *x x* of Fig. 1, showing the air-passages *c c c* in the base-plate between the generator and working-cylinder. Fig. 4 on Sheet 2 is a cross-section, on an enlarged scale, of a short segment of a circle through T T of Fig. 1, showing the economizer or regenerator M between the outer cylinder, A², of the generator and the cylinder T, in which the displacer A moves up and down. Fig. 5 is an enlarged vertical section, showing the leather packing P' P² of the working-cylinder, also the pressure oil-cup N and its connections with the chamber L², extending around the working-cylinder, over the packing, and filled with a mixture of plumbago and oil. Fig. 6 is a section showing the mode of packing the joints with copper washers E² between the ends of the tubes and the castings, which are drawn together with such a pressure as to force the end of the tube into the copper.

The outer portion of the generator consists of three main parts—viz., the upper part or cooler, which is of cast metal, filled, covered, and surrounded with water, W² W³, the lower part or heater, F, which is made of heavy cast iron or steel, which will endure a high heat, and connected at its top flange with the heater of the working-cylinder B, as shown in Fig. 3, and the central part, which is made of light, strong, lap-welded sheet iron or steel tube, which will not conduct much heat upward.

This thin tube is screwed into the flanges M' M², and has a bore considerably larger than the outside of the displacer H H², for the purpose of containing the economizer or regenerator M, Fig. 4, between them. The joints between these three parts are rendered air-tight by copper packing-rings, as shown in Fig. 6.

Inside the outer case of the generator is the displacer H H², which is moved up and down by the rod D as we wish to heat and cool the air. The upper and lower portions of this displacer are made of cast metal, and the central portions of thin sheet-metal tube, which will not conduct much heat upward, and it is solidly packed full of dry fire-clay or other bad conductor of heat. Surrounding this displacer H H² is the thin sheet-metal tube T. The bore of this tube is but slightly larger in diameter than the outside of the displacer, so as to allow it to move up and down without contact of the surfaces. Wrapped around this tube T, for the purpose of forming an economizer or regenerator, is a sheet of thin metal or series of narrow sheets, one above the other, extending from the bottom of the flange M², Fig. 1, to the top of the flange M'. A short segment of one side of the cylinder, showing how the sheets may be wrapped round and round, leaving very narrow passages for the air between, is shown in larger size at M, Fig. 4, on Sheet II. These sheets are, say, one thirty-second of an inch thick and one sixty-fourth of an inch apart, easily kept at about this distance by indentations, forming small projections, as shown, not over one-sixteenth of an inch in diameter at their tops and one sixty-fourth of an inch high on every half-inch square of their surfaces. These projections may be made by passing the thin sheets through rollers properly constructed. This displacer is raised and lowered by the cam E, (shown above it in Figs. 1 and 2,) with the small friction-rollers R in the cam-yokes. When used for pumping only, the displacer may be moved by much more simple arrangements.

The working-cylinder consists, also, of three main parts—viz., the lower casting or heater, I, the central part, K, of lap-welded sheet iron or steel, which will not conduct much heat upward, and the upper or cast-metal cooler, which is surrounded by water, W. This upper

casting is bored out and polished, so that the piston or plunger fits it quite accurately while moving up and down in it. The top flange of this upper portion is shown full size for a small engine in the lower part of Fig. 5, and the working-plunger is packed with leather on this flange. To put this part together we first slide the protecting-washer S^2 of brass down over the plunger; then the leather packing P^2 ; then the cast-iron plate No. 2 till it bears firmly upon the leather packing below it. Then we turn into the chamber L^2 a thick mixture of plumbago and oil, filling it full; then slide down the leather packing-ring P' and the brass protecting-washer S^3 , and the upper casting No. 3, as shown, upon the top of all; introduce the bolts (not shown) and draw these three plates tightly together, holding the packing-rings firmly in their positions. The pressure oil-cup N^2 is connected as shown. Now, when the engine is charged with ten or twenty atmospheres, the plumbago soon fills the pores of the leather packing, so that there can be no leak through it, except, perhaps, of oil and a little plumbago, which may be forced up between the leather and plunger into the groove around the plunger and run off by the tube V into the cup, (not shown,) to be returned into the pressure oil-cup.

The working piston or plunger is also in three parts. The upper, which is carefully turned off and polished to work in the leather packing with plumbago and oil, and the lower, which acts as a heater, are preferably of cast-steel, and the central part, B , of sheet-metal lap-welded tube, which will not conduct much heat upward, and the space in the plunger between the heater and the cooler is firmly packed with slow-conducting material.

To prevent the oxidation of the metal, the air may be deprived of its free oxygen before being admitted into the engine.

To prevent the accumulation of plumbago and dust—the result of the wear of the engine—that would in time be packed in the lowest part of the generator and working-cylinder, a small tube with a bore only three-sixteenths of an inch or less in diameter may be passed from the lowest point of the displacer $H H^2$ up through its center, as shown, and nearly through the rod D , then out at right angles just above D , and stopped with a screw-plug or small valve at its end; then, when the cylinder is highly charged and the displacer near its bottom, the valve may be opened and all the dirt near the bottom blown out.

The working-cylinder may, where the fire-grate is only under the generator, be blown out from a tube, arranged as shown in Fig. 1, directly downward.

For the purpose of bringing the air as much as possible in contact with the heating-surfaces with each revolution, the heater of the working-cylinder is also provided with the thin tube like the lower part of T in the generator, nearly fitting the lower part of the plunger, and having a narrow space for the

air to flow between it and the heater, so that as the piston of the engine rises the hot air flows freely from under the plunger of the generator back down through the opening in the bottom of T , in a direction the reverse of the arrows in Fig. 1, again in contact with the heater on all sides from its bottom to its top; thence through the hot-air passages *ccc*, (shown more fully in Fig. 3;) thence down in contact with the heater I of the working-cylinder on all its sides, and up through the opening at its bottom against the piston, thus very thoroughly heating it. When the displacer is pushed to the bottom the air below it is forced back in contact with the heater F , up through the regenerator, where it leaves most of its heat, and into the cooler above.

In an engine the working-piston of which is eight inches diameter and twelve inches stroke, the plunger of the generator may be about sixteen inches diameter, and with a stroke of three or four inches. The economizer or regenerator is about twenty inches long and sixteen and one-half inches in diameter, or fifty-two inches circumference, made up of sheets of thin metal, the lower or hottest part being preferably of steel and the upper or coolest part copper. If the sheet metal is wound seven times around the tube T , as shown in Fig. 4, it requires fifty square feet of this metal and presents a heating and cooling surface of one hundred square feet. Besides these, there are four other surfaces—that is, both sides of the tube T and one of the outer cylinder and one of the displacer—making in all one hundred and twenty-five feet area, which, if the engine is not driven too fast, will do a very large proportion of the work of heating and cooling the air at each revolution, and proportionally less fuel and water and fire-heating and water-cooling surfaces will be required.

The object of arranging the engine in this form with the working-cylinder fully open at one end, while the generating-cylinder is closed, is so that we can load the working-plunger, and thus be enabled to charge with a heavy pressure and make it double-acting.

If we wish to carry ten atmospheres pressure in a working-cylinder eight inches diameter, or fifty inches area, we load it with weights, as shown at $P P$ in Fig. 2, which, together with that of the plunger, pump-rods, &c., shall equal 50 inches $\times$ 150 pounds = 7,500 pounds. Then, as soon as there is a pressure of air slightly over one hundred and fifty pounds per inch in the working-cylinder, it will lift the plunger a short distance above the bottom. This extra weight makes the engine double-acting, besides immensely increasing its power. It may be made of iron, as shown, or stone and sand in a suitable reservoir below; or, where weights would be impracticable, the cranks of two engines may be set one hundred and eighty degrees apart; or the engines may be connected with the opposite ends of a rock-shaft; or, better than any other mode, the supply-reservoir of condensed

air may extend over the working-plunger B, and the plunger of same size may extend up into it packed with leather and lubricated with oil and plumbago, the pressure of cold air on the top of this plunger being constantly about the same as that of the air below when it is not heated. This balancing the pressure with compressed air possesses a great advantage over all other modes, as it enables us to very greatly increase or lessen the power at a moment's notice by having a reservoir of air at a much higher pressure, from which the additional pressure may be drawn, if needed.

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

1. An air-engine having its working-piston in the form of a plunger one end of which projects from its inclosing-cylinder where it is packed, combined with a generator, the plunger of which, acting merely as a displacer, is entirely inclosed in its cylinder, with its heater

below and cooler above, and with a small rod extending up through the cover for raising and lowering it, substantially as and for the specified purposes.

2. An air-engine having its working-piston in the form of a plunger one end of which projects from its inclosing-cylinder where it is packed, combined with a generator, the plunger of which, acting merely as a displacer, is entirely inclosed in its cylinder, with its heater below and its cooler above, and with a small rod extending up through the cover for raising and lowering it, the working-piston being either loaded with weights or held down by the pressure of the air in a chamber opposite, so as to balance the high pressure and make it double-acting, substantially as specified.

AZEL STORRS LYMAN.

Witnesses:

ARTHUR B. DEMING,
WM. H. RIBLET.