J. B. ATWATER.

COMBINED STEAM AND AIR ENGINE.

No. 63,198. Patented Mar. 26, 1867.

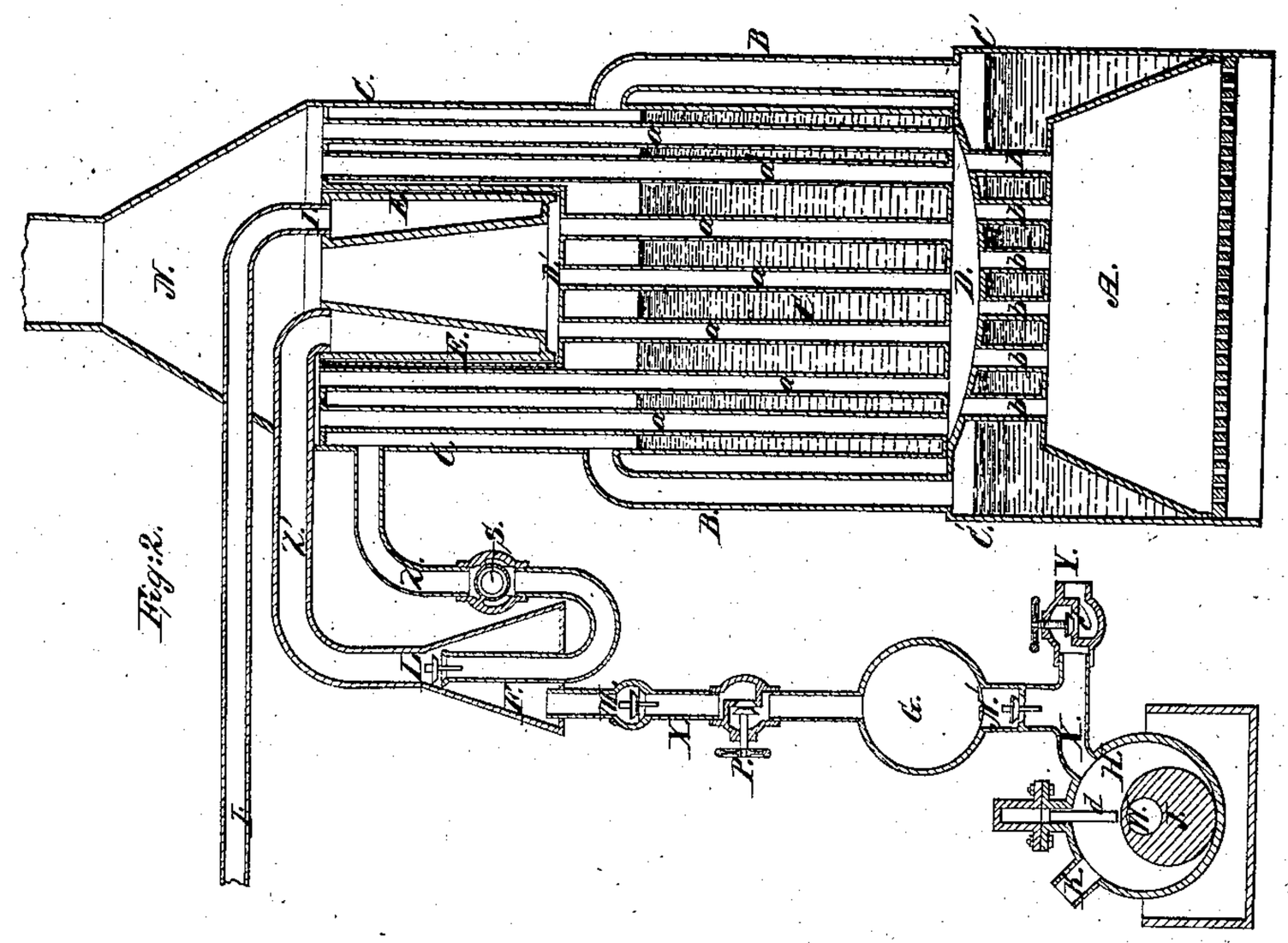

Fig: 2.

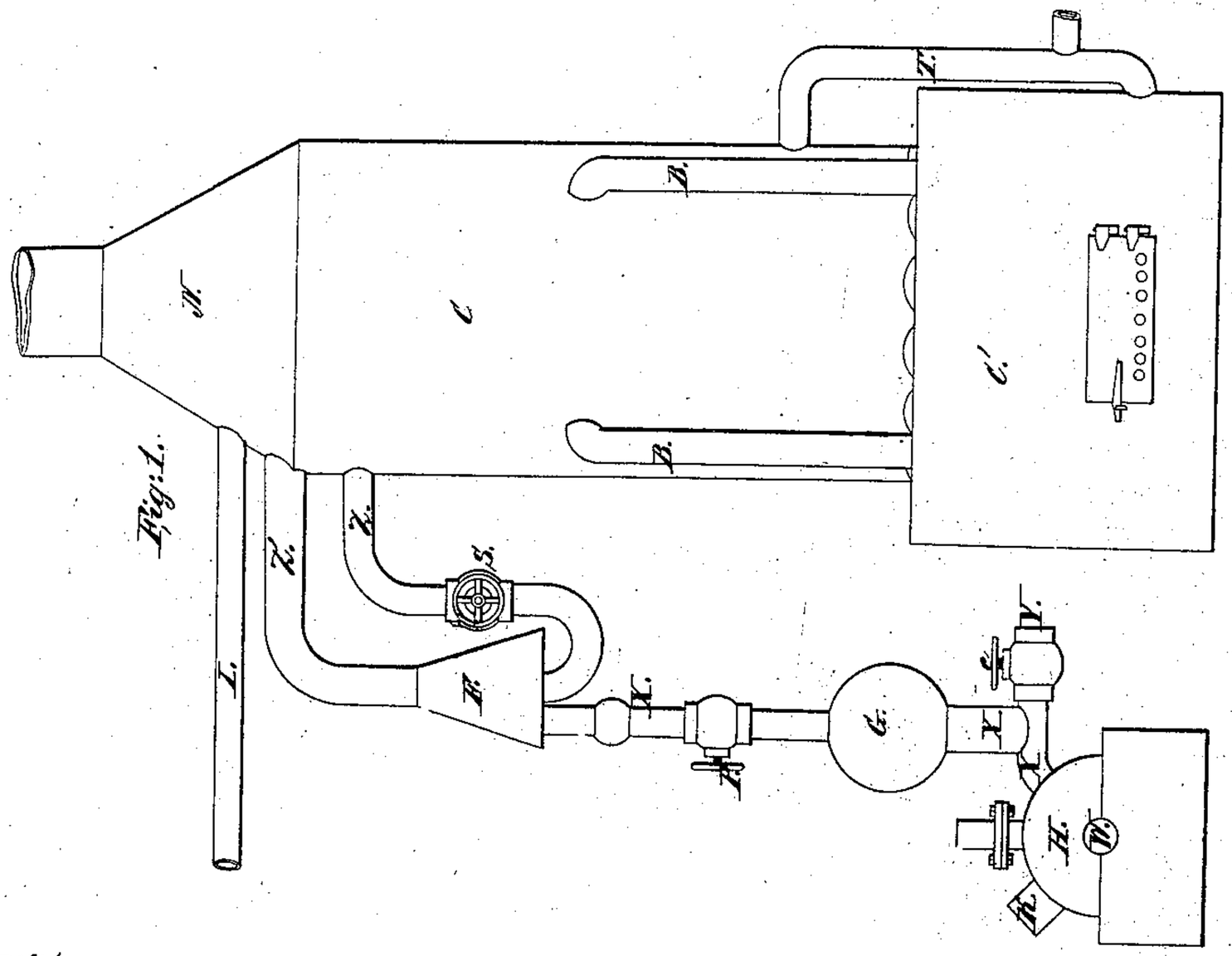

Fig: 1.

Witnesses:

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Letters Patent No. 63,198, *dated March* 26, 1867.

IMPROVEMENT IN COMBINED STEAM AND AIR ENGINES.

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

TO WHOM IT MAY CONCERN:

Be it known that I, JOHN B. ATWATER, of Chicago, in the county of Cook, and State of Illinois, have invented an Apparatus for Mixing and Superheating Air and Steam; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—

Figure 1 is a side elevation of the improved apparatus.

Figure 2 is a sectional view showing the interior construction of the apparatus.

Similar letters of reference indicate corresponding parts in the two figures.

The main object of this invention is to combine with a steam generator or boiler a desiccating-chamber and an air-injector in such manner as will more perfectly carry into effect the principle set forth in my Letters Patent for mixing and superheating air and steam, and employing the same as a mechanical agent for driving machinery, and for other purposes, as will be hereinafter explained.

To enable others skilled in the art to understand my invention, I will describe its construction and operation.

The apparatus consists essentially of a boiler, C, for generating steam, an air-pump or injector, for supplying air, and a desiccator, E, for receiving the air and steam, and superheating the same.

In carrying out my invention I prefer to adopt substantially the following arrangement: The boiler C is of a cylindrical form, with flues *a a* leading through it from one end to the other, through the water and steam spaces. This boiler C is mounted upon a secondary boiler or water-jacket, C′, which encloses the sides and top of the fire-chamber A, leaving a space, D, between them to serve as a combustion-chamber for consuming or partially consuming the products of combustion rising in the fire-box A, and passing through the flues *b b*. The primary boiler C, or steam boiler proper, is disconnected from the boiler C′, which is formed around the fire-chamber, except by the steam pipes B B, which lead from the crown sheet of this boiler C′ into the steam space above the water in the boiler C, as shown in the drawings. In the upper portion of the boiler C a desiccating-chamber, E, is arranged, so as to be exposed to the heat rising through some of the flues *a a*; and above this chamber a conical hood, N, covers the entire boiler, so as to concentrate and conduct off the smoke rising through the flues. The desiccating-chamber E is so arranged within a space provided for it in the boiler C as to leave beneath it a combustion-chamber, D′, which, in conjunction with the lower combustion-chamber D and a provision for supplying air, effects a complete consumption of the gases rising from the fire-chamber before they escape into the smoke flue above the boiler. The desiccating-chamber E is designed for superheating and drying the steam and air which are introduced into it to any desired degree of heat and pressure previously to conducting off the mixture for use. The steam from boiler C is conducted into the desiccator through pipes *s s′*, one of which pipes *s* is provided with a valve, S, and leads through the bottom of a conical chamber or injector, F, and terminates in the throat or lower flaring end of the pipe *s′*, as shown in fig. 2. Air is introduced into the conical chamber F, so as to mix with the steam issuing from pipe *s*, and be carried with this steam into the desiccator. The air is supplied under pressure by means of a rotary or other suitable pump, H, which communicates with the conical chamber or injector F by means of a pipe, X, having applied to it valves N′ and M, opening upward, a cock, P, and an air-chamber, G, as shown in fig. 2. K is the inlet pipe, leading into and supplying air to the air-pump. Y is an outlet pipe, which is provided with a cock, *c*, for a purpose which will be hereinafter explained. W is the shaft of the rotary piston J, and *d* is a sliding cut-off for preventing the air from returning after it once gets in front of the piston.

To understand the operation of this invention, let it be supposed that an upright engine is connected to the steam pipe I, leading from the desiccator, and that the pistons of such engine take hold of eccentrics, or of crank-wrists, upon wheels attached to the main shaft W. Steam being generated, the valve S, which is a throttle-valve, is opened, and the steam passes through the injector F, taking with it air into the desiccating-chamber E. This air enters the pump cylinder through pipe K, and thence passes through pipe X, through air-chamber G, and through the valve openings in this pipe X into the conical chamber of the injector F, as indicated by the arrows in fig. 2. In this apparatus it is designed to work equal proportions, or thereabout, of air and steam. The steam (or so much of it as is not condensed by contact with cool air) and air reach the desiccating-chamber through pipe *s′*, and are there mixed and dried or superheated and conducted off through pipe I to the engine.

Experiments have demonstrated that air and steam in the desiccator E assume a higher pressure than the steam in the boiler C. To prevent this excess of pressure from reacting upon the boiler a check-valve, L, is seated in the end of pipe z at the point of discharge; and just below the injector another check-valve, M, is applied in the pipe z. When the pressure is greatest in the desiccating-chamber both of these check-valves L and M close upon their seats, and the excess of pressure is allowed to work off through the exhaust of the engine. It is believed that these check-valves are superfluous, from the fact that the momentum of the steam from the boiler would resist a greater pressure, especially as the excess of pressure is not constant, the engine periodically exhausting a volume of steam and air from the desiccating-chamber E, thereby relieving the pressure. This excess of temperature in the desiccator is the result of two causes, namely: When steam at low pressure, say from five to ten pounds, is brought in contact with an equal volume of air, the steam is partially condensed, and the heat is liberated, thus becoming effective in instantly heating and expanding the air. It is not here claimed that a perfect condensation of steam takes place; but whatever condensation does occur liberates so much heat, which is communicated to the air. Another cause of such excess of temperature is the waste heat of the fire beneath the boiler acting upon the desiccating-chamber. The air-pump H will serve several important purposes. It is used as a means of forcing air into the desiccating-chamber. It serves as a fire engine for pumping and forcing water through a hose, for which purpose a hose is attached to pipe K at one end, and to a hydrant at the other end; or, this end can be dropped into a reservoir of water. A section of hose with a nozzle is then attached to the discharge pipe Y, and cock *c* opened, and cock P closed. The engine being put in motion by using steam alone, water will be drawn into the pump cylinder, and forcibly ejected through the pipe Y. The chamber G will, under these circumstances, act as an air-chamber for trapping air, which will react upon the water, and give a continuous stream.

When the improvement is employed for driving a locomotive engine the boiler will be arranged in a horizontal position instead of in the vertical position shown in the drawings, and the air-pump H, or its equivalent, attached to the shaft of the "drivers." The air-pump will in this manner operate as an auxiliary in starting and stopping the train or locomotive. It will operate under these circumstances as follows: The engineer, before reaching a station or "stopping place," will close the throttle-valve S, thus shutting off steam entirely. He will then close cock P, when the momentum of the train will continue to work the pump so as to compress air forcibly into chamber G. It will be seen that this compression of air will resist the momentum of the train, and thus operate upon the principle of a brake for stopping it. When the locomotive stops the valve N', below chamber G, closes, and prevents the escape of air. Suppose this air be compressed by the momentum of the train in stopping to three hundred pounds to the □ inch, this pressure will become effective on the pistons of the engine in starting the train by the opening of cocks S and P, and thus allowing the condensed air to work off through the desiccating-chamber E

Some of the advantages arising from this mode of constructing boilers and fire-boxes in compartments may be briefly stated as follows: It is well known that before steam can be generated ebullition must take place; or, in other words, the water must boil at the bottom of the vessel. The bubbles rise through the column of water, and when the whole body of water by this process of ebullition becomes equalized in temperature, and that temperature is at 212° Fah., these bubbles burst into vapor in the steam-chamber above the surface of the water. It is also well known that that portion of the boiler nearest the fire receives the greatest degree of heat. It therefore follows that the less the height of the column of water is in the boiler the sooner will steam be generated for practical purposes. It will be seen that the water-jacket or secondary boiler C', surrounding the fire-box A, communicates with the primary boiler C by means of pipes B, which will conduct the steam into the steam-chamber in boiler C as rapidly as it is formed in the steam-chamber nearest the fire. Hence sufficient may be generated to run an engine before the water in the boiler C is scarcely hot. In this case the ebullition of the water in the boiler C' is not taxed with the heating of the water above it. It will be seen by reference to fig. 2 that the crown plate of the secondary boiler C' is dished. This is done for the purpose of directing the bubbles of steam outwardly toward the steam pipes B, so as to facilitate the escape of the steam from this boiler into the steam space which is above the water in the boiler C. Water is supplied to the boilers C C' through the pipes T, shown in fig. 1, by connecting these pipes with the pump H, or with any other convenient pump.

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

1. A desiccating or superheating-chamber E, which is combined with a steam boiler, and adapted for receiving and desiccating steam mixed with air, substantially as described.

2. The combustion-chamber D, when arranged in a steam boiler and supplied with air, substantially as shown, so as to effect the combustion of the gases after they have escaped from the fire-box or chamber, substantially as described.

3. The air-injector, operating upon the principle specified, in combination with a desiccating-chamber E, substantially as described and for the purposes explained.

4. The arrangement of the steam generators C C', with steam communications B leading into generator C above the water level therein, with respect to the desiccator E, substantially as and for the purpose described.

5. The desiccator E, constructed as described, arranged within the circle of tubes, for the purpose set forth.

6. The valve L on the end of pipe *z*, in combination with an apparatus constructed and operating substantially as described

7. The combination of air-chamber G and cock P with an apparatus constructed and operating substantially as described.

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Witnesses:
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