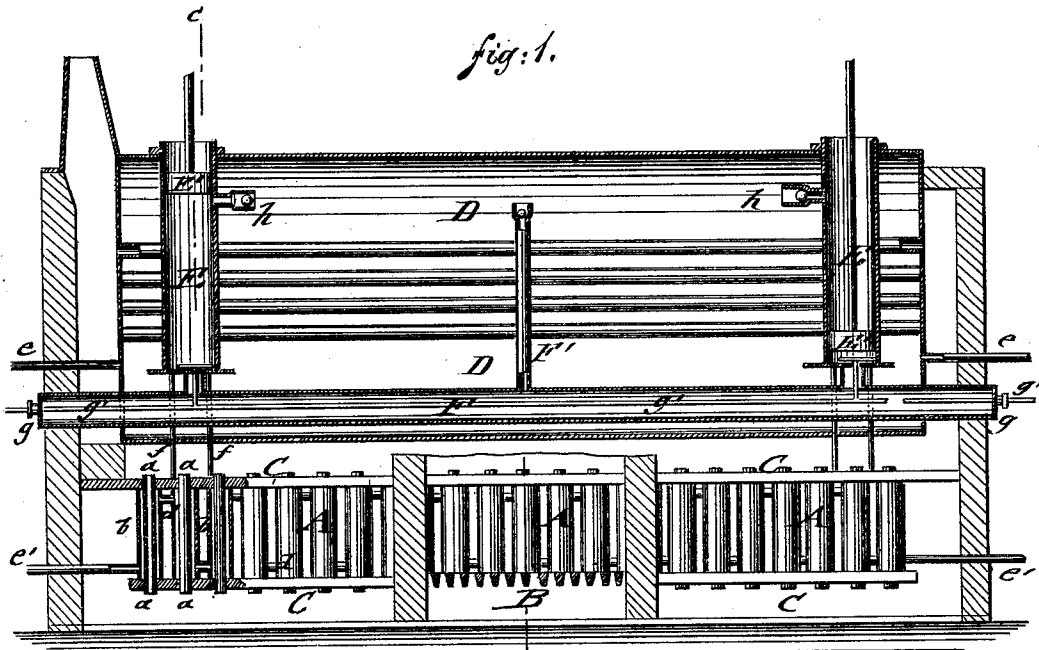


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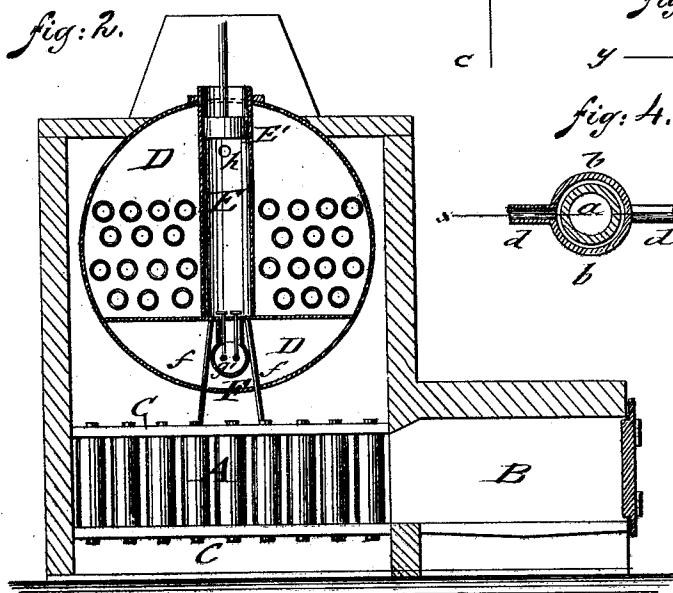
COMPOUND STEAM BOILER AND ENGINES.

No. 183,845.

Patented Oct. 31, 1876.



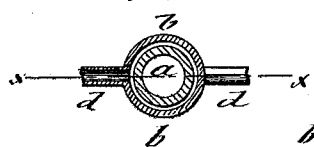
*fig: 2.*



*fig: 3.*



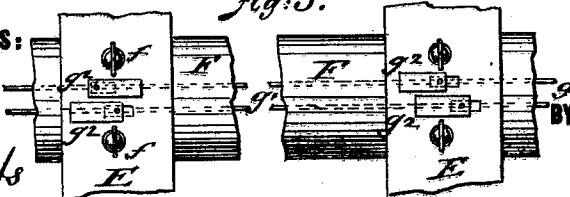
*fig: 4.*



*fig: 5.*

WITNESSES:

*Chas. Nida*  
*A. F. Roberts*



INVENTOR:

*Wm. Hanna*

*Munn*  
ATTORNEYS.

# UNITED STATES PATENT OFFICE.

WILLIAM HANNA, OF GILROY, CALIFORNIA.

## IMPROVEMENT IN COMPOUND STEAM BOILERS AND ENGINES.

Specification forming part of Letters Patent No. **183,845**, dated October 31, 1876; application filed December 18, 1875.

*To all whom it may concern:*

Be it known that I, WILLIAM HANNA, of Gilroy, in the county of Santa Clara and State of California, have invented a new and Improved Compound Steam Boiler and Engine; 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, in which—

Figure 1 represents a vertical longitudinal section of my improved compound steam boiler and engine; Fig. 2, a vertical transverse section of the same on the line *c c*, Fig. 1. Figs. 3 and 4 are, respectively, vertical central and horizontal sections on the lines *x x* and *y y*, Figs. 4 and 3, of a compound tube for generating steam of high pressure; and Fig. 5 is a top view of the cylinder-supplying valves.

My invention relates to an improved compound steam boiler and engine, by which steam of high pressure is generated and applied in twofold manner as a motive power for engines, and the exhaust steam further utilized to augment the generation of steam of less pressure for the additional application of the same.

The invention consists, mainly, in the arrangement of a series or battery of compound tubes, which are made of an interior tube or flue open at both ends, and of an exterior tube fitted around the same and forming a small intervening space therewith, which is supplied with water from a tubular boiler heated by the gases of combustion. These compound tubes are connected to form batteries, being mounted by solid top and bottom plates, through which the interior open tubes project. The fire from the furnace passes around the outer tubes, then downward below the bottom plates, and then through the interior tubes to a chamber, the boiler and top plates, and then through the flues of the boiler to the chimney. The steam of high pressure generated in the compound tubes enters vertical cylinders, with steam supply and exhaust valves to operate the pistons of the same, the surplus and exhaust steam being conducted into the boiler to increase the pressure of the steam already generated therein by direct heat.

In the drawing, A represents a series or battery of compound tubes for generating steam of high pressure by the direct action of the heat circulating between the same from the furnace B. The compound tubes A are mounted between solid top and bottom plates C, below a tubular boiler, D, extending longitudinally above the battery or batteries of compound generating-tubes below. Each compound tube A is made of an interior tube, *a*, that extends with its open ends through perforations of the top and bottom plates C, and serves thereby as an interior heating-surface or flue for the fire-gases passing up from the chamber below the bottom plate C to that above the top plate C. Each interior tube is encircled between the top and bottom plates C by an exterior tube, *b*, which is closed at the ends, arranged at a small distance from the inner tube, so as to form a narrow intermediate space, into which water is admitted by top or bottom tubes *d*, that connect alternately the outer tubes of the battery or collection, as shown in Figs. 3 and 4. The small sheet of water between the outer and inner tube is exposed suddenly to a high degree of heat, acting thereon from both sides, so that steam of a high degree of pressure is instantly generated therein. The fire-gases pass from the furnace to the compound flues, circulate around the same, and are then drawn down into the chamber below the bottom plate, then through the inner tubes to the chamber formed between top plate and boiler, then upward at the end of the boiler into the flues of the same, and finally through the flues to the chimney at the opposite end of the boiler.

By the arrangement of suitable dampers the heat of the furnace may be thrown directly on the boiler, when it is desirable to use the boiler separately from the system of compound tubes, which are, by cutting out the heat, thrown out of function. The water in the boiler is heated by the fire-gases passing through the flues, so that steam of less pressure is generated therein. Suitable tubes *e* conduct, in connection with pumps, hot water from the boiler to the supply-tubes *e'* at different points of the system or batteries of tubes, to furnish the amount of water required for the almost instant generation of steam in

the same. The strong construction of the compound tubes and the small space formed in the same for the generation of steam admit the production of steam of high pressure in a perfectly safe and economical manner.

Vertical steam-cylinders E are arranged near both ends of the boiler D, being open at the top, and connected at the bottom by steam-tubes *f*, with the generating-battery of compound tubes. Below the cylinders E is arranged in the lower part of the boiler a larger tube, F, that passes longitudinally through the boiler-heads and end walls to the outside, where both ends are closed by suitable caps with central stuffing-boxes *g* for guiding the reciprocating rods *g*<sup>1</sup> of the regulating-valves *g*<sup>2</sup> of the cylinders. The steam-tubes and ball-valves *f* supply the high-pressure steam to the cylinders, while the alternately reciprocating valves *g*<sup>1</sup> admit the escape of the back-acting steam, and of the surplus steam supplied thereto to the tube F. The high-pressure steam from tube F ascends through a vertical tube, F', within the boiler, ending above the level of the water, and issues through a check-valve into the boiler. The high-pressure steam admitted to the cylinders operates the pistons E' of the same, the steam being exhausted on the completion of the upward stroke through check-valves *h*, that open into the boiler, and are arranged just below the highest point reached by the pistons at their upward stroke. As the steam in the cylinder is of higher pressure than in the boiler, the pressure in the latter is readily overcome by the exhaust steam, until an equilibrium of pressure is produced in the boiler and compound generating-tubes. The exhaust-valves *h* are instantly closed by the internal steam pressure, as soon as the pistons pass on their downward stroke past the same, so that no escape of steam to the outside is possible. The steam, generated in the compound tubes during the downstroke of the pistons, which also closes the check-valves of the steam-tubes *f*, is applied to produce the upstroke, establishing at the extreme end of the stroke the equilibrium of pressure by exhaust, so that by the alternating generation of high-pressure steam, and the establishment of equilibrium of pressure, the pistons are alternately worked, and made, by connection with a walking-beam, &c., available as a motor. Simultaneously therewith a second

engine may be operated by the steam of the boiler in the usual manner, so that a compound action of the boiler on an engine within the same, and on an engine outside of the same, which is operated by the steam of less pressure, generated therein and augmented by the exhaust steam of higher pressure from the compound-tubes. Thus the heat, which has hitherto been utilized for the direct generation of steam in a tubular boiler, is in addition utilized for the generation and application of high-pressure steam in a perfectly safe manner, which increases the effective force of a certain quantity of fuel, and furnishes greater motive power in a more economical and advantageous manner.

Having thus described my invention, what I claim as new is—

1. A compound steam-boiler, consisting of one or more series or batteries of compound tubes, generating steam of high pressure, in combination with a tubular or other boiler generating steam of less pressure, substantially in the manner specified.

2. The combination of the top and bottom plates C C, exterior water-tubes *b*, and interior open-ended heating-flues *a*, extending through said plates, as and for the purpose set forth.

3. The combination of the system of compound generating-tubes, by suitable supply and exhaust valves, with one or more vertical steam-cylinders within a steam-boiler, to operate pistons of the same, and establish equilibrium of pressure in compound tubes and boiler at the completion of each upstroke of pistons, substantially as specified.

4. A common tubular boiler, combined with vertical interior cylinders, operated by the steam of high pressure from a system of compound generating-tubes, substantially as set forth.

5. The combination of the boiler with the interior cylinders, and a longitudinal regulating-tube below the same, both cylinders and tube having exhaust check-valves above the level of the water, to augment the pressure in boiler by the high pressure from the cylinders, substantially as set forth.

WILLIAM HANNA.

Witnesses:

W. H. BURROWS,  
O. F. HANSON,  
D. W. KLINE.