

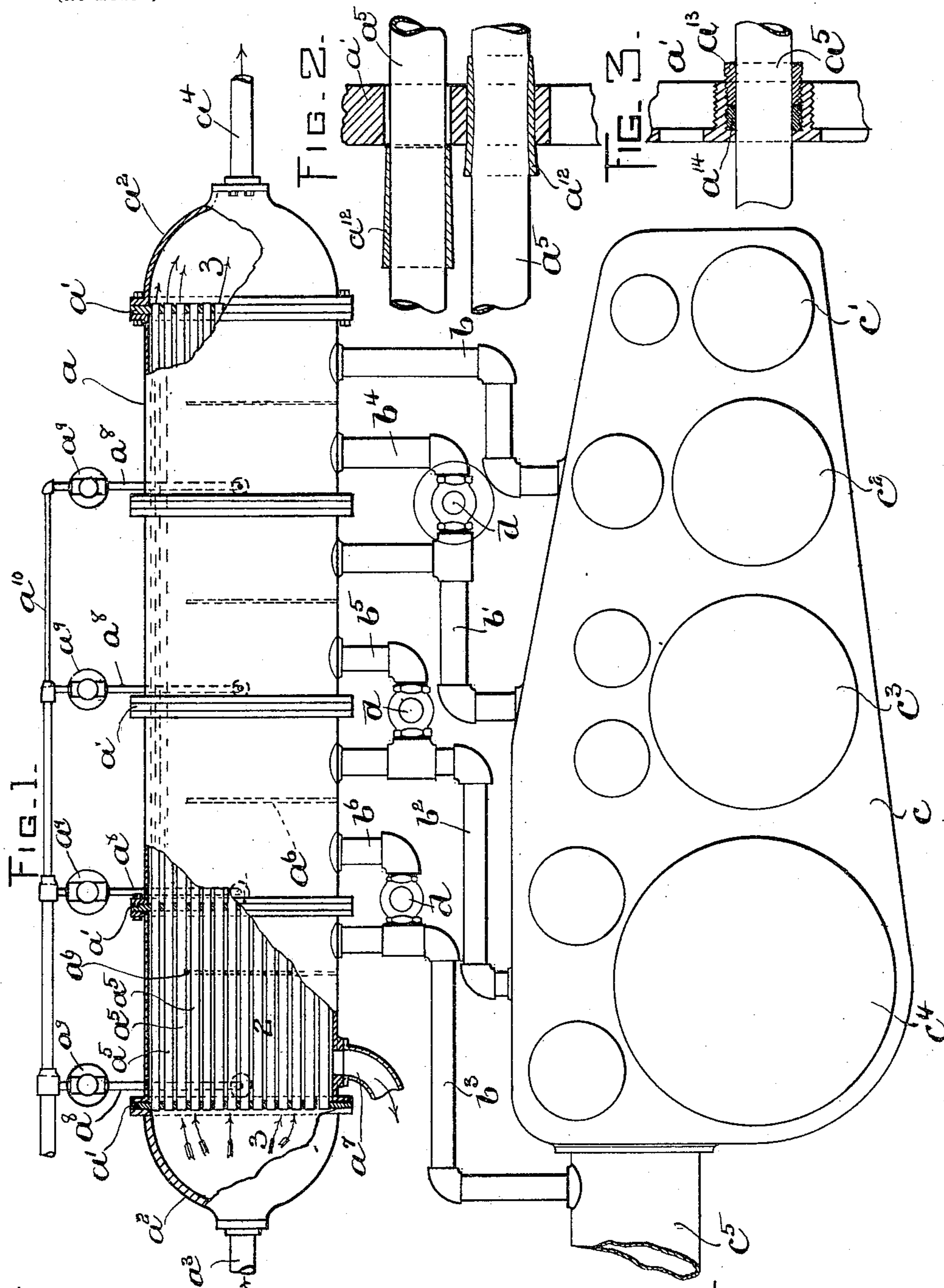
No. 641,318.

Patented Jan. 16, 1900.

C. D. MOSHER.  
FEED WATER HEATER.

(Application filed Feb. 21, 1899.)

(No Model.)



WITNESSES:

A. D. Harrison  
C. C. Stecher.

INVENTOR:

Charles D. Mosher  
by Knight Brown & Quincy  
Atty.

# UNITED STATES PATENT OFFICE.

CHARLES D. MOSHER, OF NEW YORK, N. Y.

## FEED-WATER HEATER.

SPECIFICATION forming part of Letters Patent No. 641,318, dated January 16, 1900.

Application filed February 21, 1899. Serial No. 706,343. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES D. MOSHER, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Feed-Water Heaters, of which the following is a specification.

This invention relates to feed-water heaters; and it has for its object to provide a construction in which the feed-water may be subjected to successively-increasing degrees of temperature.

It also has for its object to provide a heater in which a portion of the exhaust from each of the cylinders of a multiple-expansion steam-engine may be utilized to heat the feed-water.

The invention further has for its object to provide a sectional feed-water heater in which provisions are made for maintaining a steam-supply at different pressures and temperatures in the different compartments or sections of the heater.

Other incidental objects of the invention will appear when the same is more fully explained hereinafter.

Of the accompanying drawings, forming a part of this specification, Figure 1 represents a top plan view showing a feed-water heater constructed in accordance with my invention, part being in section, and a quadruple-expansion steam-engine connected with the heater. Fig. 2 represents a detail sectional view, on an enlarged scale, showing the construction at the point of passage of a tube through one of the tube-sheets. Fig. 3 represents a modification of the above.

The same reference characters indicate the same parts in all the figures.

Referring to the drawings,  $a$  designates an elongated cylindrical shell or casing having semispherical ends  $a^2$   $a^2$  and a series of transverse partitions  $a'$   $a'$ , dividing the heater into a number of intermediate sections or compartments 2 2 and two end compartments 3 3. The end compartment 3 at the left of the heater is provided with an inlet-pipe  $a^3$  for the reception of feed-water, and the compartment 3 at the right is provided with an outlet-pipe  $a^4$  for the delivery of the water. A series of tubes  $a^5$   $a^5$  pass through the several partitions or tube-sheets  $a'$  and connect the

two end compartments 3 to each other, thereby forming a continuous conduit for the feed-water which traverses the several intermediate compartments 2. The spaces surrounding the tubes or pipes in the latter constitute independent chambers separated by the partitions  $a'$  and adapted to receive different bodies of steam from suitable sources. For the purpose of deflecting the steam in its passage through said chambers or compartments baffles  $a^6$   $a^6$  may be provided therein, each baffle extending transversely from the side wall and part way across its compartment.

$a^8$   $a^8$  represent branch pipes connected with the bottoms of the several compartments 2 and leading into a common longitudinal pipe  $a^{10}$ . The several branch pipes are provided with traps  $a^9$   $a^9$ , and the whole arrangement serves to drain off the water of condensation from the heater. Adjoining compartments 2 are connected by means of pipes  $b^4$   $b^5$   $b^6$ , in each of which is placed a reducing-valve  $d$ . The last compartment 2 at the left is provided with an outlet-pipe  $a^7$ , which may lead to a condenser.

$c$  represents a quadruple-expansion steam-engine having high, first and second intermediate, and low pressure cylinders  $c'$   $c^2$   $c^3$   $c^4$  and a main exhaust-pipe  $c^5$  for the low-pressure cylinder. The exhausts from the several cylinders of the engine are connected to the several steam-compartments of the feed-water heater by means of branch pipes  $b$   $b'$   $b^2$   $b^3$ , the first pipe  $b$  taking steam from the exhaust of the high-pressure cylinder  $c'$  and conducting it to the first heating-compartment 2 at the right, the pipe  $b'$  connecting the exhaust of the first intermediate  $c^2$  with the second compartment 2, the pipe  $b^2$  connecting the exhaust of the second intermediate  $c^3$  with the third compartment 2, and the pipe  $b^3$  connecting the main exhaust-pipe  $c^5$ , which takes steam from the low-pressure cylinder  $c^4$ , with the last compartment 2 at the left. To save piping, the branch pipes  $b'$   $b^2$   $b^3$  are connected with the left-hand legs of the several looped pipes  $b^4$   $b^5$   $b^6$ .

Figs. 2 and 3 represent two different methods of making the joint between the diaphragms or tube-sheets  $a'$  and the tubes  $a^5$ . In Fig. 2 an externally-tapered bushing  $a^{12}$  is driven into the aperture in the tube-sheet

through which the tube passes and in so doing slightly necks or contracts the tube, the bushing being longer than the thickness of the tube-sheet and being slightly tapered on the outside finds the least resistance when it is driven through the aperture in the direction of the tube  $a^5$ , so that bushing and tube become slightly contracted as the bushing is driven in, and as the bushing reaches the opposite side of the tube-sheet its diameter slightly increases because of the resistance offered by the tube and the removal of the resistance offered by the walls of the aperture in the tube-sheet, thus making a tight permanent joint. In Fig. 3 an expansible bushing  $a^{14}$  surrounds the pipe at the end of a tapped counterbore in the tube-sheet, and a gland  $a^{13}$  screws into said bore and against the bushing  $a^{14}$ , expanding the latter against the tube  $a^5$  and forming a tight joint.

Each of the heating-compartments 2 of the feed-water heater receives through its branch pipe  $b$   $b'$ , &c., a small portion of the exhaust-steam from one of the cylinders of the engine  $c$ . These bodies of steam naturally vary in pressure and temperature, and hence the feed-water which passes through the heater in the direction of the arrow shown in Fig. 1 from the inlet  $a^3$  to the outlet  $a^4$ , filling the chambers 3 and the tubes  $a^5$ , is subjected successively to increasing degrees of temperature in its passage from one end of the heater to the other. In passing through the first chamber, which receives its steam from the low-pressure exhaust  $c^5$ , the feed-water is heated to, say, 130° Fahrenheit. In the second chamber, which receives its steam from the second intermediate cylinder, the water is heated to a somewhat higher temperature, and so on in each successive chamber or compartment until the water finally emerges from the heater at a sufficiently high temperature to pass with advantage directly into the boiler. The pressure-reducing valves  $d$  are set so as to maintain the proper pressure in each of the sections of the heater corresponding to but slightly lower than the pressure in the cylinder with which said chamber is connected, and said valves are also preferably regulated so as to produce a flow of the steam in the direction of the condenser-pipe  $a^7$ . This flow from the first branch pipe  $b$  into the heating-compartment 2 at the right and through the successive compartments past the several reducing-valves is regulated by the said valves, so that in its passage through said valves the pressure and consequently the temperature of the steam are successively reduced. The inflowing steam from the several branch pipes  $b$   $b'$ , &c., is deflected by the baffle-plates  $a^6$ , so as to come thoroughly into contact with the tubes  $a^5$  in the compartments 2.

It will be seen that the above-described construction and arrangement of apparatus provides for a very economical use of steam and permits the feed-water to be heated to a very high temperature before leaving the heater

by steam that has already been used in one or more engines.

It will be understood that the several compartments of the heater, or any of them, might be connected with the exhaust of auxiliary engines, pumps, or other apparatus using steam, and it will be further understood that the invention is not confined to the exact design here shown, as any number of separate and distinct heaters might be connected in series by pipes, so that the water to be heated may pass from one heater to the next and be successively heated by steam of increasing degrees of pressure and temperature.

I claim—

1. A feed-water-heating apparatus having provisions for subjecting the feed-water successively to different degrees of temperature, in combination with a plurality of different heaters connected with said apparatus and adapted to furnish heat thereto at said different temperatures, said heaters being respectively connected with the exhausts of a plurality of different-pressure steam-engine cylinders.

2. A feed-water-heating apparatus comprising a series of separate heaters, a feed-water conduit common to the several heaters, and a series of independent inlets to the several heaters, connected respectively with the exhausts of a plurality of different-pressure steam-engine cylinders.

3. A feed-water heater comprising a series of separate heating sections or compartments, provisions for admitting steam thereto from the exhausts of a plurality of different-pressure steam-engine cylinders, a feed-water conduit common to the several compartments, connections from one compartment to another, and pressure-reducing valves in said connections, whereby different steam pressures and temperatures are maintained in the several compartments and the feed-water is subjected successively to different degrees of temperature.

4. A feed-water heater comprising a series of separate heating sections or compartments, a feed-water conduit common to the several compartments, a series of independent steam-inlets to the several compartments, adapted to be connected to a number of different sources of steam, connections from one compartment to another, and pressure-reducing valves in said connections, whereby different steam-pressures and temperatures are maintained in the several compartments and the feed-water is subjected successively to different degrees of temperature.

5. The combination with a multiple-expansion steam-engine, of a feed-water heater having a series of separate heating sections or compartments, a feed-water conduit common to the several compartments, and connections between the several compartments and the exhausts from the several cylinders of the engine, whereby steam at different degrees of pressure and temperature is admitted to the

respective compartments, and the feed-water is thereby subjected successively to different degrees of temperature.

6. The combination with a multiple-expansion steam-engine, of a feed-water heater having a series of separate heating sections or compartments, a feed-water conduit common to the several compartments, connections between the several compartments and the exhausts from the several cylinders of the engine, whereby steam at different degrees of pressure and temperature is admitted to the respective compartments, connections from one compartment to another, and pressure-reducing valves in said connections, whereby successively-decreasing pressures and temperatures are maintained in the several compartments and the feed-water is subjected to successively-increasing temperatures.

7. A feed-water heater comprising a casing, a series of three or more transverse partitions dividing said casing into a number of separate heating-compartments, and two water-compartments at the ends, said end compartments having respectively an inlet and an outlet for feed-water, a series of tubes connecting said end compartments and traversing the heating-compartments, and inlets to the several compartments for the admission of steam from the exhausts of a plurality of different-pressure steam-engine cylinders.

8. A feed-water heater, comprising a casing,

one or more transverse partitions dividing said casing into a number of separate heating-compartments, a series of feed-water tubes traversing said compartments, an inlet to each compartment for the admission of steam from a number of independent sources, a pipe connection between each compartment and its neighbor, and a pressure-reducing valve in each of said connections, whereby different pressures and temperatures are maintained in the several compartments and the feed-water in the tubes is thereby subjected successively to different degrees of temperature.

9. In apparatus of the character specified, the combination of a series of separate heating sections or compartments, a feed-water conduit common to the several compartments, a series of independent steam-inlets to the several compartments and connected with the exhausts of a plurality of different-pressure steam-engine cylinders, branch pipes connected with the bottoms of the several compartments and communicating with a drain-pipe common to all, and drain-traps in said branch pipes.

In testimony whereof I have affixed my signature in presence of two witnesses.

CHARLES D. MOSHER.

Witnesses:

ROLLIN ABELL,  
C. F. BROWN.