5 Sheets—Sheet 1.

S. HUGHES.

Feed-Water Heater and Purifier.

No. 201,181. **Patented March 12, 1878.**

Fig. 1.

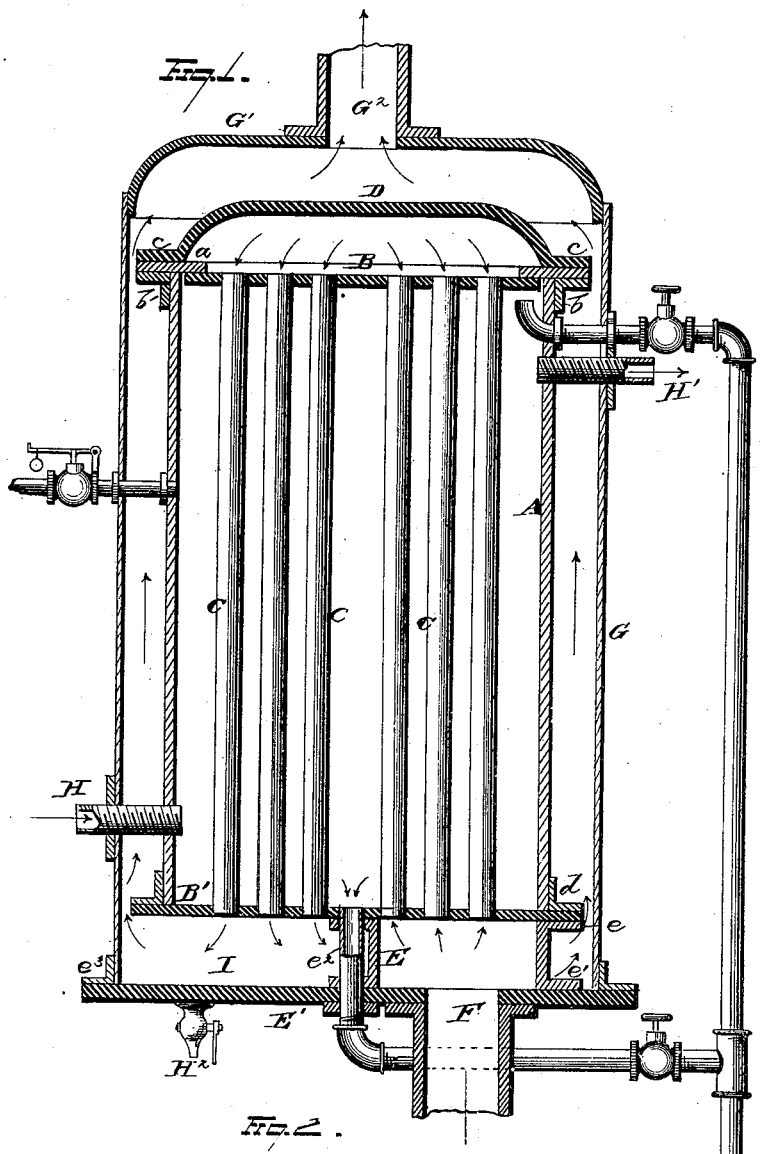
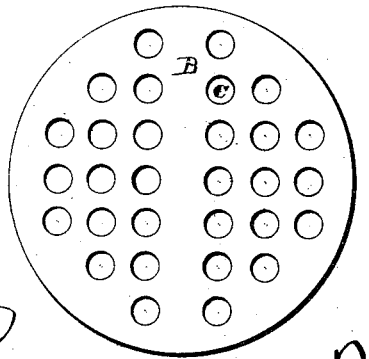


Fig. 2.



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5 Sheets—Sheet 2.

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Fig. 3.

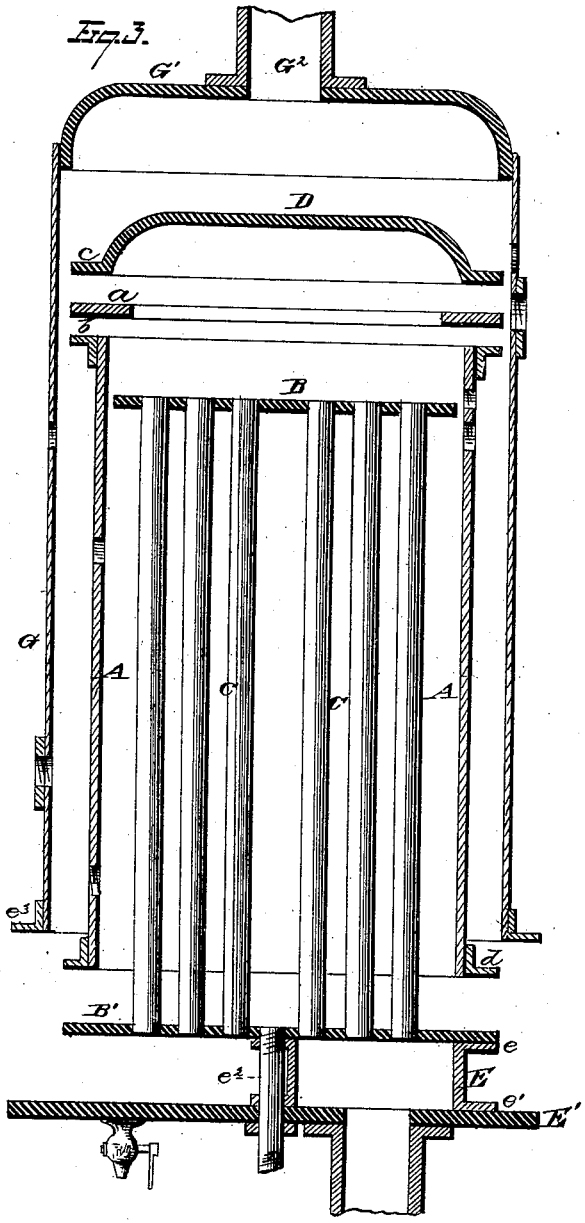

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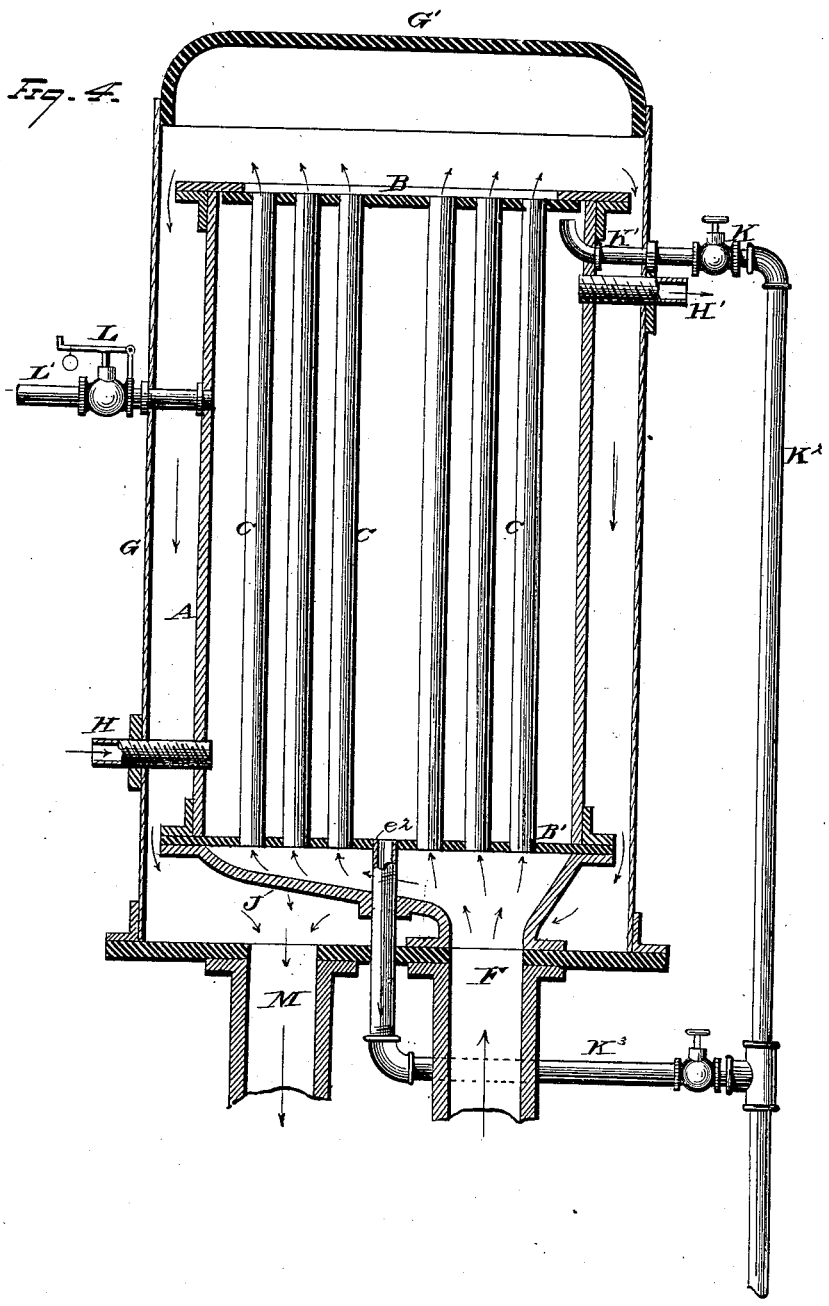
Fig. 4.



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5 Sheets—Sheet 4.

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Feed-Water Heater and Purifier.

No. 201,181. **Patented March 12, 1878.**

Fig. 5.

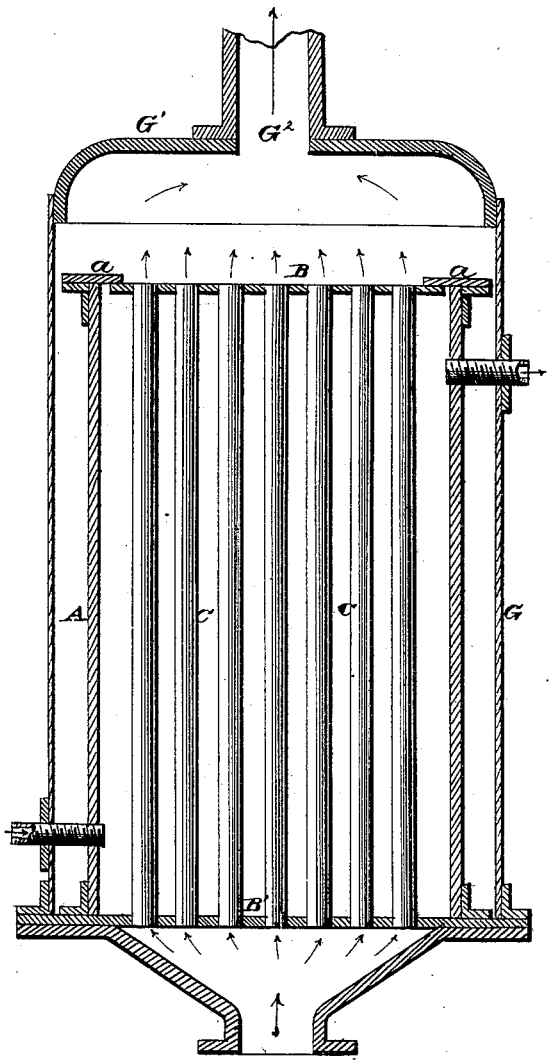

Fig. 6.

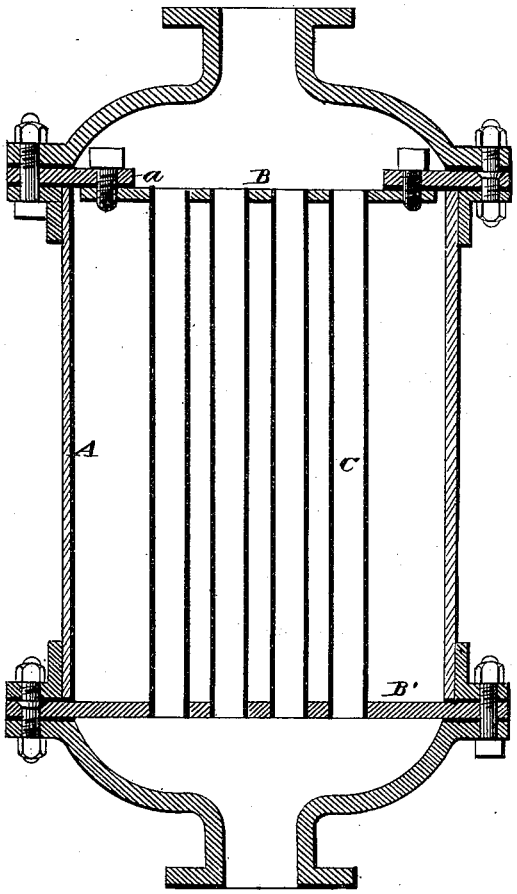

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Fig. 7.

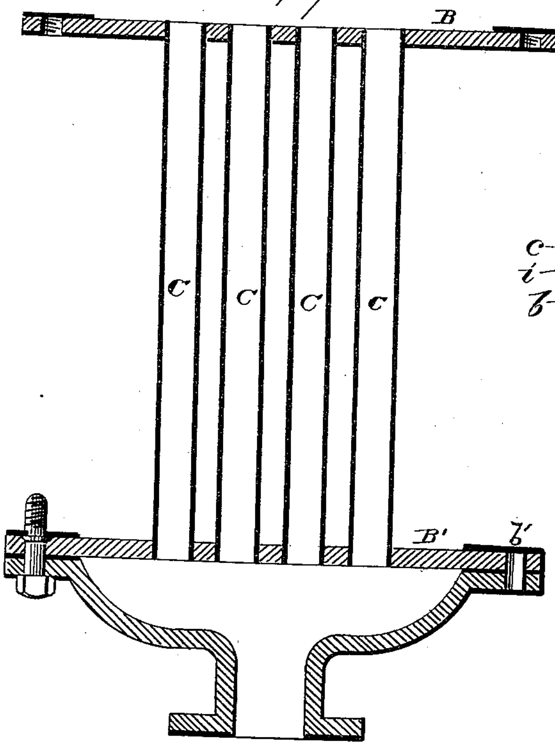


Fig. 8.

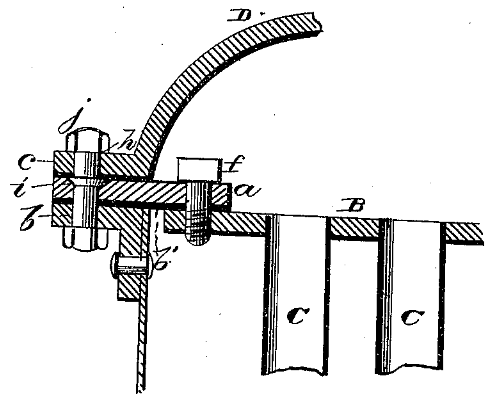


Fig. 9.

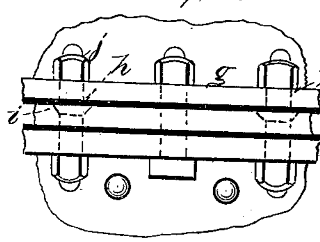


Fig. 10.

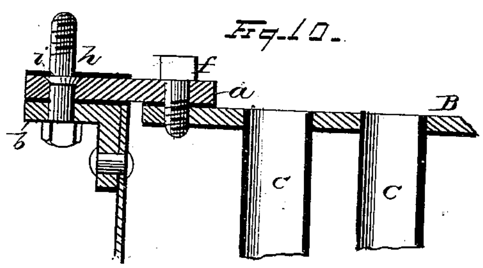


Fig. 11.

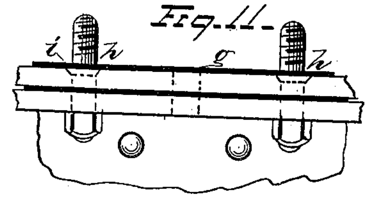
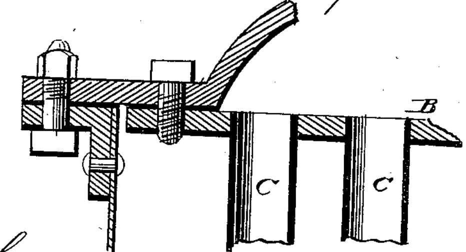


Fig. 12.



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UNITED STATES PATENT OFFICE.

SAMUEL HUGHES, OF CHARLESTON, SOUTH CAROLINA.

IMPROVEMENT IN FEED-WATER HEATERS AND PURIFIERS.

Specification forming part of Letters Patent No. **201,181**, dated March 12, 1878; application filed January 30, 1878.

To all whom it may concern:

Be it known that I, SAMUEL HUGHES, of Charleston, in the county of Charleston and State of South Carolina, have invented certain new and useful Improvements in Feed-Water Heaters and Purifiers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

My invention relates to an improvement in feed-water heaters and purifiers; the object being to provide a combined heater and purifier for the feed-water of steam-boilers of such a construction that the feed-water shall be subjected to the maximum amount of heating-surface, the several parts of the apparatus to be secured to each other in such a manner that entrance to the interior of the same, for the purpose of cleaning the same, may be readily effected without disturbing the tubes or tube-sheets; and to that end my invention consists, first, in a feed-water heater and purifier consisting, essentially, of a water-heating cylinder provided with a series of steam-tubes and a steam-jacket surrounding said water-cylinder, the several parts being so arranged that the steam is first conveyed through the tubes in the water-cylinder, and then conducted through the intervening annular space between the water-cylinder and steam-jacket, whereby the feed-water is subjected to the heat radiated from the steam-tubes and also the water-cylinder.

My invention further consists in a feed-water heater and purifier wherein the water-cylinder is surrounded by a steam-jacket, and the steam-tubes in said water-cylinder separated from each other, in such a manner that steam will pass through a portion of said tubes, and then return through the remaining tubes of the series, and from the chamber formed in the end of the apparatus the steam is then conducted into the annular space between the steam-jacket and water-cylinder to the steam-exit, located at the upper end of the heater.

My invention further consists in the novel construction and arrangement of parts, as hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a vertical section of my improved heater and purifier. Fig. 2 is a plan view of the tube-sheet. Fig. 3 is a vertical sectional elevation of the apparatus, constructed in the manner illustrated in Fig. 1, showing the different parts as disconnected. Fig. 4 shows a vertical sectional elevation of a heater and purifier embodying my invention in a modified form of construction and arrangement of parts. Fig. 5 is a vertical sectional elevation of a heater and purifier of modified form of construction, the same illustrating certain features of my invention. Fig. 6 is a vertical sectional elevation of a modified form of heater and purifier embodying my invention. Fig. 7 is a vertical sectional elevation of a heater and purifier constructed the same as the apparatus shown in Fig. 6, the casing and cover being removed, so as to expose the tubes and tube-sheets for cleaning and repairs. Fig. 8 shows a section of a portion of one end of the apparatus, and Fig. 9 a side elevation of a portion of the joint between the cover and casing. Figs. 10 and 11 represent views similar to those shown in Figs. 8 and 9, the only difference being that in Figs. 10 and 11 the covers are removed. Fig. 12 is a modification.

In Figs. 1, 2, and 3, A represents the inner or water cylinder. B B′ are the respective upper and lower tube-sheets, having a series of tubes, C, properly secured thereto. The upper tube-sheet B is secured in position by means of an annular ring or plate, *a*, the outer edge of said tube-sheet being bolted to the inner edge of the ring, while the outer portion or edge of ring *a* is bolted between the flange *b*, which is riveted to cylinder A, and the flange *c* of the cover D. The lower tube-sheet B′ is bolted to the flange *d*, which latter is riveted to cylinder A, and is supported by means of the ring E, which is constructed with flanges *e* *e*¹. Ring E rests upon the lower head E¹ of the apparatus, and, as will be observed, serves to conduct the incoming steam, which enters the heater and purifier through opening F, into such tubes only of the series as are located within the ring E. The lower

tube-sheet B′ is provided with a sediment-discharge pipe, e^2, which extends through the lower head E^1, and is provided with a suitable cock or valve. (Not shown.) G is a steam-jacket, surrounding the water-cylinder A, the lower end of said jacket being attached to the head E^1 by means of the flange e^3, and the upper end supporting the outer cover or top portion G^1, which has a central steam-discharge opening, G^2. The feed-water is introduced into the water-cylinder A through the pipe H, located at the lower end of said cylinder, while the pipe H^1, located on the opposite side of cylinder A, and near the upper end thereof, constitutes the feed-outlet. H^2 is a drip-cock, attached to the lower head of the heater, and the same serves to empty the heater of water of condensation.

The particular method of securing the several parts of the apparatus together is clearly illustrated in Figs. 8, 9, 10, and 11. The upper tube-sheet B is attached to the annular plate or ring *a* by means of top bolts *f*, a suitable gasket, *b′*, of yielding material, being preferably placed between the opposing faces of the tube-sheet and ring, in order to secure a perfectly tight joint. The ring *a* is secured between the flanges *b* and *c* by means of the two kinds of bolts *g h*, bolts *g* being of the ordinary construction, while the bolts *h* are each provided with a collar, *i*, which is formed on said bolts equidistant from its ends. These bolts *g h* are placed in succession around the entire cover of the apparatus, and serve the following important function: When it is desired to take the apparatus apart for the purpose of cleaning or repairing any portion of the same, the outer cover and jacket being removed, the inner cover D may be removed by simply removing the nuts *j* without disturbing the tube-sheets and tubes secured therein, as the collar-bolts *h* will serve to retain the ring *a* securely in place. This construction will be found desirable in the manufacture of the heaters, as the tube-sheets and water shell or cylinder may be firmly bolted together, and the joints made tight before the tubes are secured in place. In this way the tubes can be accurately adjusted and secured, and be allowed to remain in their proper position when the shell is taken off.

The operation of my improved heater, constructed in the manner illustrated in Figs. 1, 2, and 3, is as follows: The feed-water enters the lower part of the inner cylinder A through inlet-pipe H, and freely circulates around the series of tubes C, and is discharged in a heated condition through the exit-pipe H^1. Steam enters the heater through the inlet-passage F, in the lower head of the same, and, passing through the ring E, is conducted through the several tubes which open into said ring. From said tubes the steam escapes into the cover D, which extends over the entire series of tubes, and from thence it descends through the remaining tubes of the series and flows into the chamber I, located between the lower head of the heater and the lower head of the inner cylinder. From chamber I the steam flows into the annular space formed between the shell of the inner cylinder and the outer shell or steam-jacket, and escapes through the exit-passage in the cover of the steam-jacket.

It will be thus observed that the feed-water is brought in direct contact with the heating-surfaces formed by the series of tubes, the tube-sheets, and the inner cylinder, as all such parts are subjected to the direct contact of steam. The sediment, which precipitates and is deposited on the bottom or lower head of the inner cylinder, may be drawn off through the sediment-discharge leading therefrom.

In Fig. 4 the inner cylinder A is provided with steam-tubes C, which are secured at their opposite ends to independent tube-sheets B B′, the same as illustrated in Figs. 1 and 2.

In the construction of heater and purifier represented in Fig. 4, the inner cover over cylinder A is dispensed with, and steam flows from the steam-tubes directly into the chamber formed by the imperforate cover G^1 of the outer or steam jacket G. The lower tube-sheet B′ rests upon the steam-conduit J, the lower end of which is contracted to fit over the steam-inlet passage F, while the upper portion is enlarged to fit against the outer edge of the tube-sheet. The lower tube-sheet is provided with a sediment-discharge pipe, E^2, the same extending through the lower head E^1. Feed-water inlet H is located near the lower end of cylinder A, while the feed-water outlet H^1 is located on the opposite side of the cylinder, near its top.

K is a surface blow-off cock, having a pipe, K^1, coupled thereto, which leads into the upper portion of the inner cylinder A, and by means of which light particles of matter which rise to the surface of the water may be discharged from the heater. K^2 is a sediment-discharge pipe, and it may be connected with the main discharge-pipe K^3, as illustrated in the drawing, if so desired.

L is a safety-valve, which may be attached to any portion of the water-cylinder A, said valve being provided with an overflow-pipe, L′, which leads to the well. This valve operates to prevent the bursting of the heater, should the pump continue to work after the feed-water cock attached to the boiler has been closed. The valve may be adjusted to withstand any desired pressure, and when the pressure in the heater, from any cause, exceeds the pressure at which the safety-valve is set, the latter will be automatically opened, and allow the water to escape from the heater into the well, and from thence be pumped back into the heater, without causing any damage to the latter.

The operation of the heater and purifier, constructed in the manner last described and illustrated in Fig. 4, is as follows: Steam flows into the heater through the steam-inlet F, and, passing through conduit J, enters the several

tubes C, from whence the steam escapes into the chamber in the upper end of the heater. The confined steam flows from said upper chamber downwardly through the annular space between the water-cylinder and the steam-jacket, and escapes through the steam-outlet M, located at the bottom of the apparatus.

It will be thus observed that the feed-water in the cylinder A is subjected to the action of steam through the medium of the several tubes, the tube-sheets, and the shell or casing. The lighter particles arising from the water are blown out through the surface discharge-cock, while the heavier portions are discharged through the pipe located in the bottom of the cylinder.

The safety-valve, provided with an overflow leading to the well, serves the important function of regulating the pressure in the heater, and admits of the continuous operations of the pumps without danger of injuring the apparatus.

Fig. 5 represents a form of heater and purifier wherein the steam passes directly through the heater, and is discharged at its upper end.

The water-cylinder A is provided with a series of steam-tubes, C, which are secured to independent tube-sheets B B′ by means of the ring or plate *a*, in the manner hereinbefore described, and as illustrated in Figs. 8, 9, 10, and 11.

Figs. 6 and 7 illustrate a heater and purifier wherein the steam-jacket is dispensed with. In this form of construction the water-cylinder A is provided with any desired number of tubes C, which are attached to upper and lower tube-sheets B B′. This tube-sheet B is secured to the cylinder by means of the ring or plate *a*, which, in turn, is bolted between a flange secured to the cylinder and a flange formed on the lower edge of the cover, in the manner illustrated in Figs. 8, 9, 10, and 11.

Fig. 7 illustrates the heater shown in Fig. 6, when the cylinder, cover, and fastening-ring have been removed.

In Fig. 12 the flange on the cover is of sufficient width to allow of the tube-sheet being bolted thereto, and thus dispensing with the annular ring or plate *a*.

It is evident that slight changes in the construction and arrangement of parts may be resorted to without departing from the essential features of my invention—as, for instance, the heater may be placed in a horizontal instead of a vertical position, if desired; and also the exhaust-steam pipes may enter at the top, side, or bottom of the heater; and the steam-outlet may also be located at the top, side, or bottom thereof, and the apparatus still retain all the important functions of my invention.

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

1. In a feed-water heater and purifier, the combination, with an inner cylinder provided with a series of steam-tubes, of a steam-jacket surrounding said inner cylinder, and a closed steam-chamber attached to one end of the inner cylinder, the parts being arranged substantially as described, whereby steam is first conveyed through the tubes in the water-cylinder, and then conducted to the outlet-opening through the annular space between the steam-jacket and water-cylinder, substantially as set forth.

2. In a feed-water heater and purifier, the combination, with an inner cylinder provided with a series of tubes and a cover attached to one end of said cylinder, of a steam-jacket surrounding said inner cylinder, and a steam-conduit for conducting the steam to only a portion of the tubes of the inner cylinder, whereby the exhaust-steam is allowed to pass upwardly through a portion of said tubes into the chamber at the upper end of said cylinder, and from thence downwardly through the remaining portion of said tubes, and thence to the outlet through the annular space between the steam-jacket and water-cylinder, substantially as set forth.

3. In a feed-water heater and purifier, the combination, with an inner cylinder provided with a series of steam-tubes and an outer steam-jacket, of a safety-valve, attached to the inner cylinder by a pipe and connected with the well by an overflow-pipe, substantially as set forth.

4. In a feed-water heater and purifier, the combination, with the inner cylinder having a flange secured to its upper end, of a tube-sheet, secured to said flange by means of an annular ring or plate, substantially as set forth.

5. In a feed-water heater and purifier, the combination, with the inner cylinder having a flange secured to its upper end, of a tube-sheet having an annular plate or ring bolted to its outer edge, the outer edge of said annular plate being bolted between the flange on the cylinder and the cover over the end of the same, substantially as set forth.

6. In a feed-water heater and purifier, the combination, with the cylinder, of the tube-sheet, having an annular ring or plate attached thereto, said ring being secured to the cylinder by means of plain and collared bolts, substantially as set forth.

In testimony that I claim the foregoing I have hereunto set my hand this 5th day of January, 1878.

SAML. HUGHES.

Witnesses:

JAMES J. GRACE,

LAURENCE R. PINKMAN.