(No Model.)

H. WARDEN.

SURFACE CONDENSER.

No. 352,378. Patented Nov. 9, 1886.

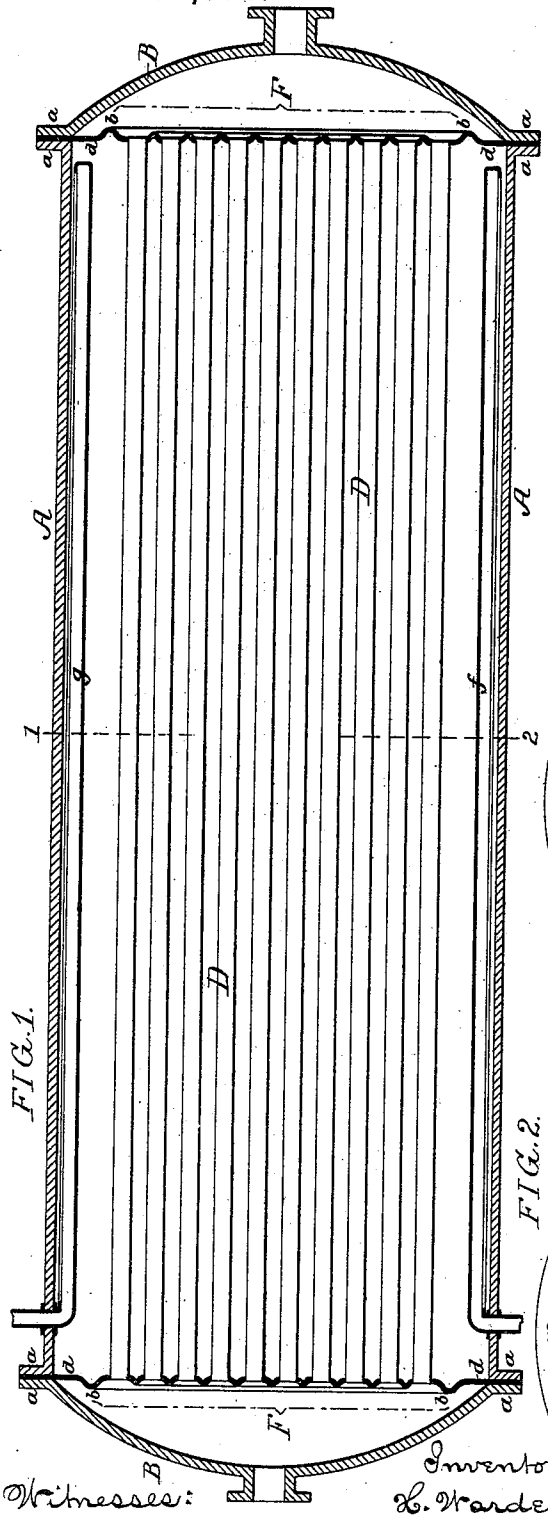


FIG. 1.

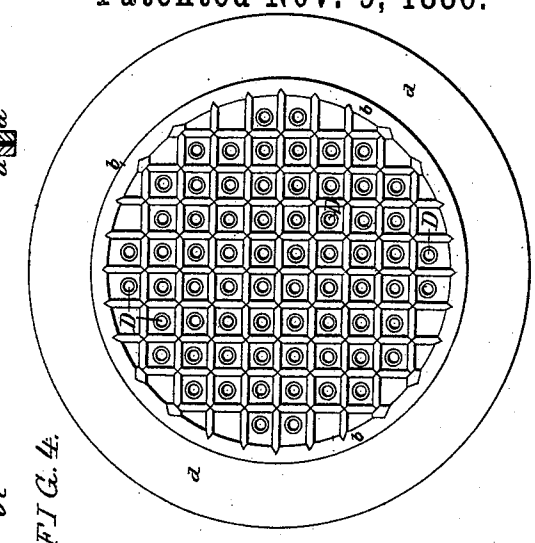


FIG. 4.

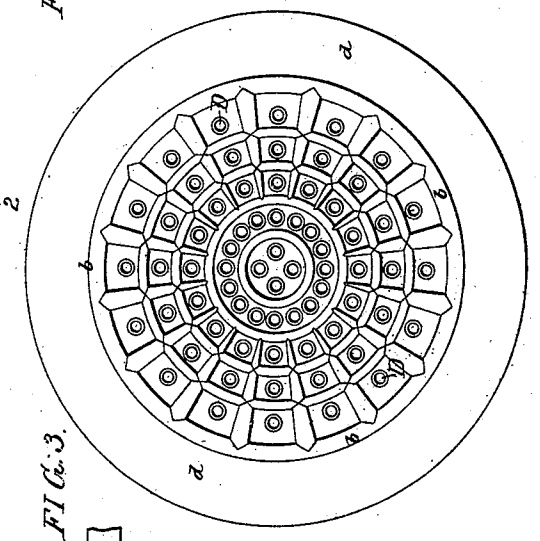


FIG. 3.

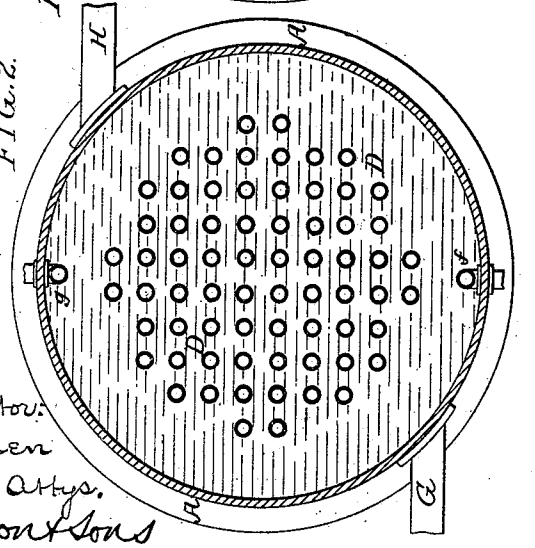


FIG. 2.

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Howson & Sons

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

HENRY WARDEN, OF PHILADELPHIA, PENNSYLVANIA.

SURFACE-CONDENSER.

SPECIFICATION forming part of Letters Patent No. 352,378, dated November 9, 1886.

Application filed June 19, 1885. Renewed August 23, 1886. Serial No. 211,648. (No model.)

To all whom it may concern:

Be it known that I, HENRY WARDEN, a citizen of the United States, residing in Philadelphia, Pennsylvania, have invented certain Improvements in Feed-Water Heaters or Surface-Condensers, of which the following is a specification.

One object of my invention is to so construct a tubed feed-water heater or surface-condenser that the desired expansion and contraction of the tubes will be permitted without the necessity of using stuffing-boxes or other expensive joints at the ends of the tubes, a further object being to provide simple and effective means for relieving the heating-chamber from sediment or scum.

In the accompanying drawings, Figure 1 is a longitudinal section of my improved feed-water heater; Fig. 2, a transverse section of the same on the line 1 2, Fig. 1; and Figs. 3 and 4, face views of tube-sheets constructed in accordance with my invention.

A represents the main casing or barrel of the heater, which is closed at the opposite ends by heads B B, and contains a number of tubes, D, the latter being carried by opposite tube-sheets F, which are confined between flanges *a* on the heads B B and similar flanges at the opposite ends of the barrel or casing A of the heater.

The opposite heads of the heater have branches, to which are connected steam inlet and discharge pipes, so that steam entering one end of the casing passes through the tubes D and is discharged from the opposite end, water being forced into the casing through a feed-pipe, G, and discharged through a delivery-pipe, H. In heaters of this class it is usual to adapt one end of each tube to a stuffing-box carried by the tube-sheet, or to otherwise provide each tube with a yielding connection, or to permit movement of the entire tube-sheet in the casing. These methods of construction are expensive, and also objectionable on account of their tendency to permit leakage; and one of the objects of my invention is to provide a simple and inexpensive substitute therefor.

In carrying out my invention the tube-sheet is corrugated throughout that portion which carries the tubes, these corrugations serving to stiffen the central portion of the sheet and render the same so rigid that any movement of one part of the corrugated portion independently of another is impossible. For instance, in the tube-sheets shown in the drawings, all that portion of each sheet which is within the outer corrugation, *b*, will move as a unit in yielding to strains such as would be caused by expansion or contraction of the tubes D. As the outer portion of the sheet is confined to the shell or casing, however, a sufficient portion of the sheet between the corrugation *b* and the outer edge is left plain to provide an elastic ring, *d*, which yields to permit the longitudinal movement of the center portion of the sheet, due to the expansion and contraction of the tubes. Close to the bottom of the casing A is a pipe, *f*, which has in the under side a slot extending almost throughout the length of the pipe. When the passage through the projecting portion of this pipe is open, the pressure of water in the casing A will cause a flow through the slot and into and through the pipe to the outlet, so that any sediment which may be deposited in the casing at any portion of the same will be carried up into the pipe and will be discharged from the same. A similar pipe, *g*, slotted on the upper side, is arranged close to the top of the casing A, the object of this pipe being to carry off the scum which rises when the water is heated to a high temperature.

In order that the incoming stream of water may not disturb the sediment deposited upon the bottom of the casing A, the inlet-pipe G is arranged at some little distance from the bottom of the casing; and to prevent any disturbance of the scum the outlet-pipe H is located at some distance from the top of the casing, as shown in Fig. 2. A series of perforations may be formed in the pipes in place of the slot; but the latter is preferred.

The construction and arrangement of the scum and sediment discharge pipes form no part of my present invention, but are shown and claimed in a separate application filed by me on the 2d day of November, 1885, Serial No. 181,620.

The corrugations in the tube-sheets F may be arranged in various ways without departing from the main feature of my invention, the character of the corrugations depending in a great measure upon the arrangement of the tubes in the heater. For instance, in Fig. 3

I have shown a tube-sheet in which the tubes are arranged radially, the tube-sheet being provided with circumferential and radial corrugations, while in Fig. 4 the tubes are arranged in vertical and horizontal rows, and the corrugations are correspondingly arranged and cross each other at right angles.

It will be evident that my invention is applicable to surface-condensers as well as feed-water heaters, and, if desired, the expansion tube-sheet may be arranged at one end of the tubes only, the opposite ends of the tubes being connected to a rigid tube-sheet.

I therefore claim as my invention—

1. The combination of the casing and tubes of a feed-water heater or surface-condenser with a tube-sheet confined to the casing at the rim, said sheet having the portion which carries the tubes stiffened by corrugations, and having between the stiffened portion and the rim an elastic expansion ring or band, as set forth.

2. The within-described tube-sheet for feed-water heaters or surface-condensers, said tube-sheet having a central portion stiffened by corrugations and an outer plain portion, as specified.

3. The combination of the casing and tubes of a feed-water heater or surface-condenser with a tube-sheet secured to the casing at the rim, and having a plain outer portion forming an expansion-ring, and a central portion stiffened by corrugations, this corrugated portion of the sheet being bounded by a corrugation, *b*, as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY WARDEN.

Witnesses:
WILLIAM F. DAVIS,
HARRY SMITH.