

No. 608,775.

Patented Aug. 9, 1898.

A. G. HOFFMANN.
HEATING AND EVAPORATING LIQUIDS.

(Application filed Dec. 28, 1897.)

(No Model.)

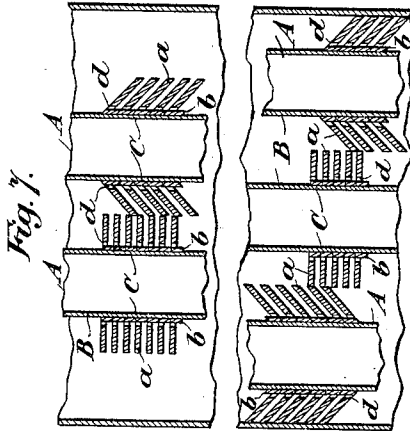


Fig. 7.

Fig. 4.

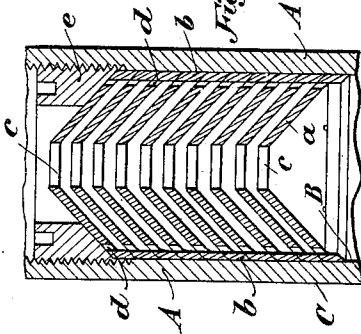


Fig. 1.

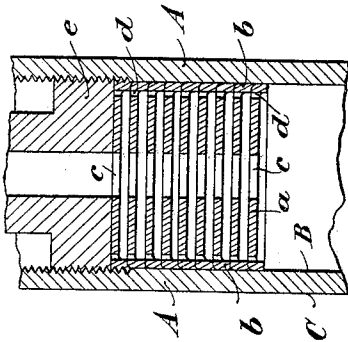


Fig. 9.

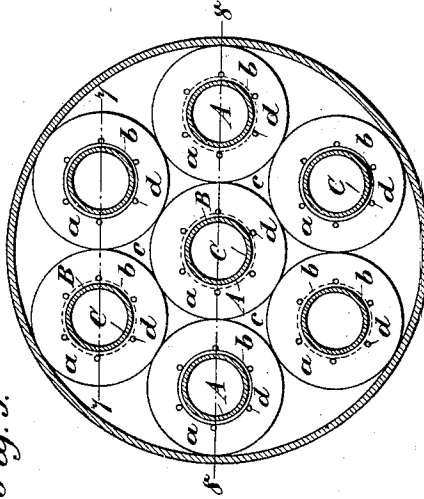


Fig. 5.

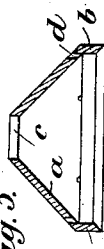


Fig. 6.

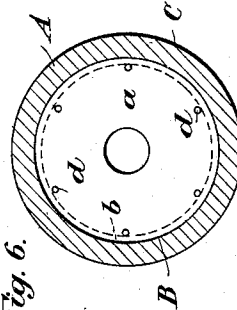


Fig. 2.

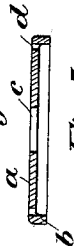
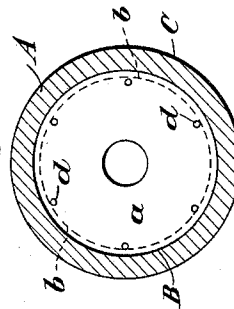


Fig. 3.



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UNITED STATES PATENT OFFICE.

ADOLPH GEORG HOFFMANN, OF BERLIN, GERMANY, ASSIGNOR OF ONE-HALF TO AUGUST SCHWARZ, OF SAME PLACE.

HEATING AND EVAPORATING LIQUIDS.

SPECIFICATION forming part of Letters Patent No. 608,775, dated August 9, 1898.

Application filed December 28, 1897. Serial No. 663,955. (No model.)

To all whom it may concern:

Be it known that I, ADOLPH GEORG HOFFMANN, a subject of the King of Prussia, residing at Berlin, in the Kingdom of Prussia, German Empire, have invented new and useful Improvements in the Means for and Process of Heating and Evaporating Liquids and Heating of Vapors and Gases, of which the following is a specification.

The means for and mode of heating and evaporating liquids and heating vapors and gases as hitherto used are still imperfect for the reason, as experiments have proved, that the areas heated by the fire-gases and the areas that are in contact with the liquids are not in such proportion to each other as to be able to obtain the highest useful effect of the fire-gases. No mode of heating heretofore carried out enables, as the present invention does, me to really utilize the heat introduced to the areas or surfaces heated by the fire or other heating-gases in the time in which the said heat is produced—that is to say, so that all the heat produced is almost in *statu nascendi* led over to the liquid or gases, whereby the heating-surfaces uninterruptedly receive new heating effects.

To carry out my invention, I arrange within a tubular vessel a system of narrow spaces or chambers, (cells,) independent one from the other, in such a manner that the walls of each space are directly and conductively combined with the source of heat and that a channel common to all said spaces communicates with them in such a manner as to lead off the vapors or heated gases at the time of their development or formation, while the remaining liquid is retained in the spaces or cells and is prevented from being swept away by the vapors or gases. Said narrow spaces or cells may be formed by inserting suitable plates, disks, spirally-wound strips of sheet metal, or the like in the tubular vessel, the outer surface of which is subjected to the heat, care being taken that these inserted bodies always maintain an intimate and extended contact with the heated surface, so as to constitute one single metallic piece with the surrounding vessel, whereby the heated surface of the same is considerably enlarged. Thus what I may call the “inner” heating-

surface, formed by the walls of the narrow spaces inclosing the liquid to be treated, is divided into a great number of little cells communicating with each other and each of which is conductively connected with the heat-receiving surface of the vessel.

The means and arrangements of parts by which the described result is obtained are illustrated in the accompanying drawings, by way of example, in which—

Figure 1 is a longitudinal section of a part of my heating device; Fig. 2, one of the bodies, in section, by which the cells are formed; Fig. 3, a cross-section of the device shown in Fig. 1. Figs. 4 to 6 are corresponding figures, referring to a modified form of the bodies forming the chambers or cells. Figs. 7 to 9 represent a heating apparatus consisting in a combination of several devices of the kind shown in the former figures, Fig. 7 illustrating a section following the line 7 7 in Fig. 9, Fig. 8 another section on the line 8 8 in Fig. 9, and Fig. 9 a cross-section of the apparatus.

Similar letters refer to similar parts through out the several views.

As illustrated in the drawings, the outer vessel preferably consists in a tube A, within which the narrow spaces or cells are formed by superposed plates *a*, with projecting or turned-up edges *b*. This border or edge *b* is slightly conically enlarged and of a diameter corresponding to that of the tube A, but so that on inserting these plates (one of which being represented in Fig. 2) in the tube a certain pressure is to be exerted, in consequence whereof a good contact between the corresponding surfaces of the plates and the tube is maintained. I have found that when the vessel is heated the plates *a* are of the same temperature as the tube A and thus enabled to transmit the heat immediately unto the fluid contained in the spaces or cells. The distances between the plates *a* inclosed in the vessel A are determined by the borders *b*, the height of the latter being so small as to form capillary cells in the whole length of tube A, whereby any spheroidal condition of the liquid when heated is prevented. Screw plates or collars *c*, Figs. 1 and 4, are provided for to press the edges *b* together in order to secure a good contact of the plates *a* among them-

selves and the plates and their inclosing tubular vessel A.

An aperture *c* or several apertures *c d* are provided in the plates *a* for the purpose of feeding liquid into the cells and leading off the vapor produced therein. The main communication is effected by the aperture *c*, preferably arranged in the center of the plates *a*, whereas the smaller apertures *d*, arranged at or near the peripheric of the plates, maintain a sufficient circulation within each space or cell and prevent bubbles of steam from remaining within the cells. A still better means for this purpose than the dish-like plates shown in Figs. 1 and 2 is illustrated by Figs. 3 and 4 to 6. The plates *a*, made in a conical shape, offer a natural way for the vapor upward to the main communication *c*.

Figs. 7 to 9 represent, by way of example, a mode of combining several tubular vessels A to form a boiler or superheating apparatus and show a modified form of arranging the plates *a* in regard to the tube A, inasmuch as the former are surrounding the tubes and the heating medium is conducted through the interior of said tubes instead of being led around the same, as this is presumed in the arrangements described above. As shown in Figs. 7 and 8, conically-shaped plates may be employed, in combination with some of the tubes and dish-like plates in combination with others, but it is left to the constructor to use plates of the form shown in Fig. 2 exclusively or only such as shown in Fig. 5. The remaining spaces *c* between the columns of plates form the channels for leading off the produced steam or gases.

It is a matter of course that boilers, superheaters, or the like arranged according to my invention are provided with the requisite accessories—such as feed and discharge pipes, safety-valves, pressure-gages, steam-collector, and so on, parts which being well known to all those skilled in the art need no peculiar description and drawing.

Now to describe more exactly the new mode of heating and evaporating liquids and heating of vapors and gases it may be supposed that the tubular vessel A, Figs. 1 to 6, or the vessel containing several tubes A, Figs. 7 to 9, be filled with liquid and a heating medium acting upon the one surface C of the tubular vessel or vessels. From said surface the heat taken up from the fire-gases or other heating agent is immediately conducted to the other surface B, the edges *b* of the plates being in contact with this surface, to the plates themselves, and to the liquid inclosed in or surrounded by the cells formed by said plates. In consequence thereof an extremely quick and vigorous circulation takes place within said narrow spaces or cells, and with a sufficient amount of heat an instantaneous evaporation of the liquid is produced. The steam enters the main channel formed by the apertures or holes *c* and is conducted to the steam-

collector, thus enabling fresh liquid to enter the cells of the apparatus. The heat required to evaporate instantaneously this new charge of liquid is again furnished by the tube or tubes A, and by this constant demand of new heat the heat supplied to the tubes is so fully utilized as to exclude the surfaces receiving the first heat to get superheated. Moreover, owing to the capillary arrangement of the cells no spheroidal condition of the liquid can take place even if a very great amount of heat is supplied to the tubes.

Any parts of the liquid that may be swept away by the vapors settle down on the following plates or fall back into the cells and are retained there by adhesion for so long until the heat exerted has brought them to evaporation.

In exactly the same manner wet vapors are treated with the view of drying them. This is effected quickly and completely within the cells of my apparatus, which is also applicable for superheating steam or gases. The quick transmission of the heat of every temperature prevents the walls of the superheater that are directly exposed to the heating agent from glowing or burning.

An essential merit of my invention consists in the possibility of constructing steam-boilers which, owing to the immediate utilization of all the heat taken up from the heating agent, are of extremely compendious form. The rapid circulation of the liquid within the cells and the quick evaporation of said liquid prevent any foreign material suspended in the liquid from depositing in the cells and from leading to incrustations. Such material is swept away by the steam leaving the cells and settles down in the steam-receiver, from where it can easily be removed. In consequence of the positive conduction of the heat taken up by the tube or tubes to the liquid contained in the cells and owing to the small amount of superheated liquid within the apparatus constructed according to my invention any danger of explosion is completely excluded.

As compared with the arrangements at present in use, an apparatus constructed according to my invention presents the advantage of being for equal capacity of much smaller size and less weight, of warranting a great economy in fuel, and of requiring much less time for getting steam.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In an apparatus for heating and evaporating liquids, heating vapors and gases, the combination of a tube or tubes acted upon by the heating agent, with a number of independent perforated plates forming small cells communicating with each other, and so combined relatively to the tubes, that one of the circumferences of each of the perforated plates is in direct contact with the tube, so that the heat taken up by the tube is posi-

tively conducted by the plates to the liquid or vapor contained in the cells formed by such plates, substantially as described.

2. In an apparatus for heating and evaporating liquids, heating vapors and gases, the combination of a tubular vessel A acted upon by the heating agent, with perforated plates *a* having turned-up edges or borders *b* and apertures *c*, *d*, and so combined relatively to the tubes A, that the edges of the plates are in direct contact with the tubes, the said edges serving to space the plates a proper distance apart essentially as set forth.

3. In an apparatus for heating and evaporating liquids, heating vapors and gases, the combination of a tubular vessel A acted upon by the heating agent, with perforated plates *a* of conical shape having edges or borders *b* and apertures *c*, *d*, and so combined relatively to the tubes A, that the edges of the plates are in direct contact with the tubes, essentially as set forth.

4. In combination, the vessel A and the series of separate plates inserted therein, each having a perforation and having also turned-

up edges to space the plates apart, substantially as described.

5. In combination, the vessel A and the series of plates extending across the same having the central perforations and the perforations near the borders of the plates, substantially as described.

6. In an apparatus for heating and evaporating liquids, heating vapors and gases, the combination of a tubular vessel A acted upon by the heating agent, with perforated plates *a* forming small cells communicating with each other and so combined relatively to the tubes, that one of the circumferences of each of the perforated plates is in direct contact with the tube, means being provided to press said plates together and against the surface of the tube, essentially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

A. GEORG HOFFMANN.

Witnesses:

CHAS. H. DAY,
HENRY HASPER.