No. 786,341. PATENTED APR. 4, 1905.

J. H. BAUDE & E. H. HOPPE.

HEAT EXCHANGE.

APPLICATION FILED JAN. 5, 1903.

Fig. 1.

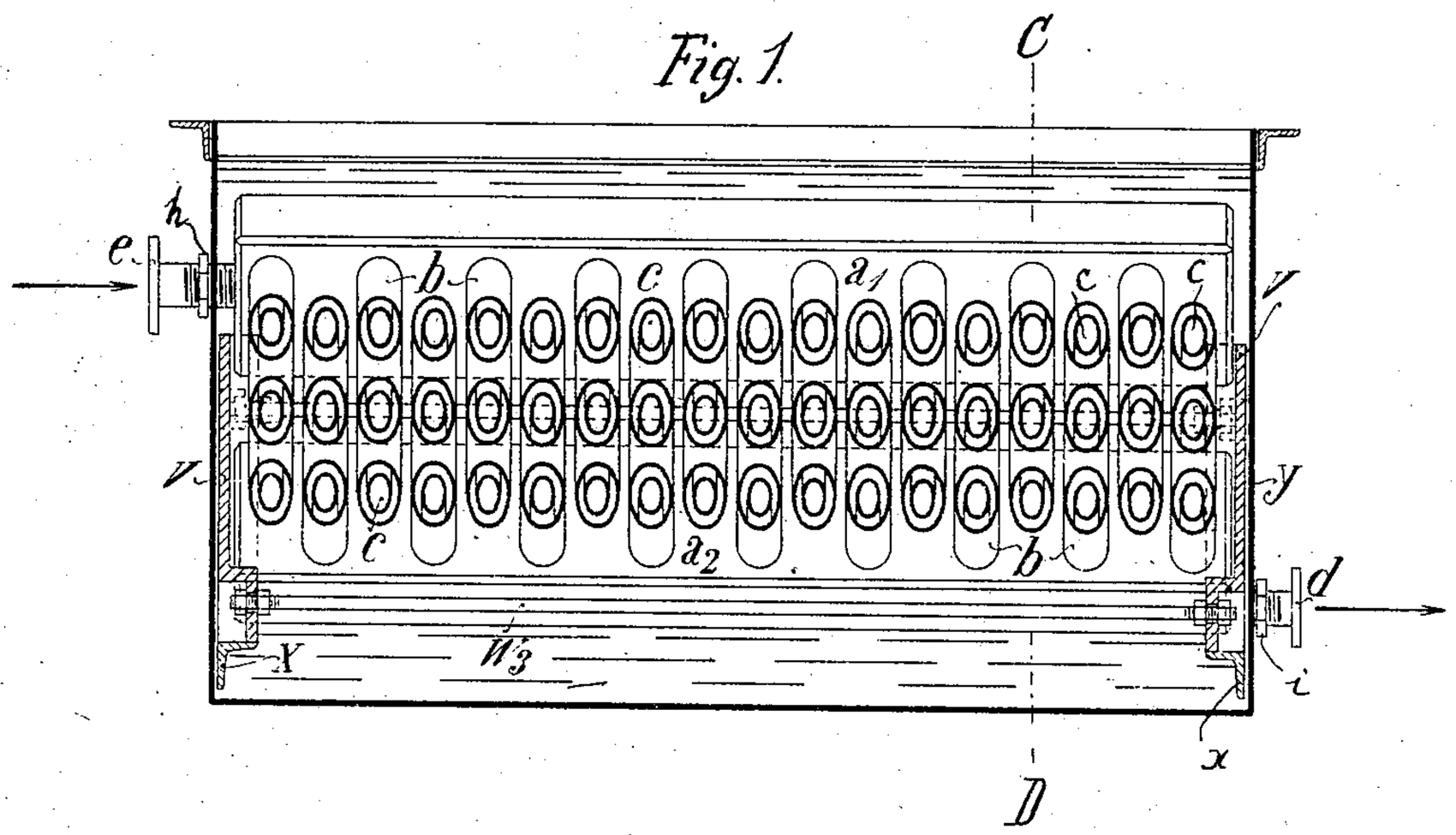


Fig. 2

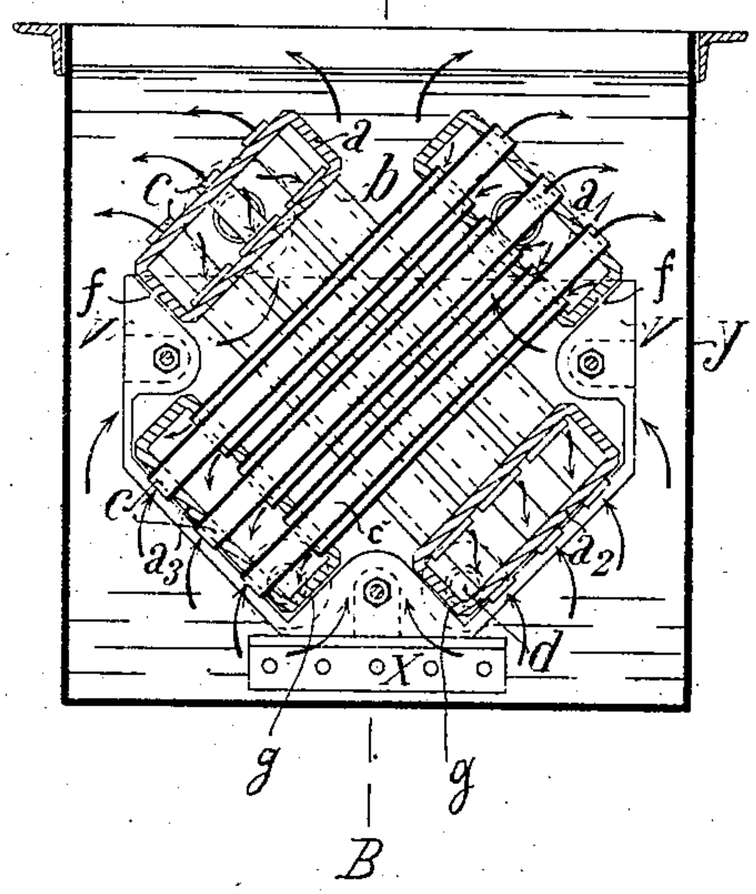
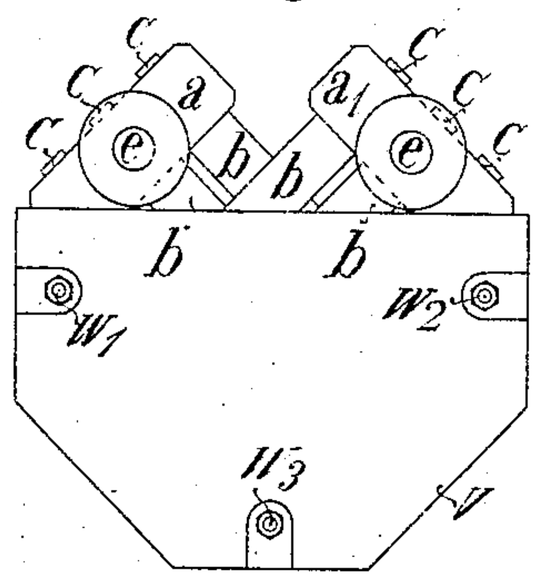


Fig. 3.



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No. 786,341. Patented April 4, 1905.

UNITED STATES PATENT OFFICE.

JOHANN HERMANN BAUDE AND EMIL HORST HOPPE, OF MONTWY, GERMANY.

HEAT-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 786,341, dated April 4, 1905.

Application filed January 5, 1903. Serial No. 137,946.

To all whom it may concern:

Be it known that we, JOHANN HERMANN BAUDE, director of a manufactory, and EMIL HORST HOPPE, engineer, subjects of the King of Prussia, German Emperor, residing at Montwy, in the Province of Posen, in the Kingdom of Prussia, German Empire, have invented new and useful Improvements in Heat-Exchanges, of which the following is a specification.

Our invention relates to a heat-exchange which comprises a receptacle and a plurality of obliquely-arranged tubes therein so related to the exterior and interior of the receptacle as to produce an interchange of temperature between a medium passing through the receptacle and a medium in the receptacle.

Figure 1 is a vertical longitudinal section through the apparatus on the line A B in Fig. 2. Fig. 2 is a vertical cross-section through the same on the line C D in Fig. 1. Fig. 3 is an end view of the tubed apparatus proper.

The heat-exchange proper essentially consists of four longitudinal chambers a a' a^2 a^3 of any length and cross-section and of a plurality of double tubes b and c, arranged in a special manner. Of the chambers two—viz., a and a^2 or a' and a^3—are opposed to each other and form a pair. Between them a plurality of tube groups placed in parallel planes are arranged, each group comprising several (in this case three) parallel double tubes—*i. e.*, external tubes b and internal tubes c—placed one within the other concentrically. The ends of the internal tubes c are left open and secured in any known manner in the external walls of the two chambers a and a^2 or a' and a^3, respectively. The ends of the external tubes b are equally left open, but secured in the chamber-walls, which are opposed to each other. The double tubes b c between the two chambers a a^2 are to be placed at an angle of about forty-five degrees to the horizontal or vertical walls of the vessel y in one direction, while the double tubes between the other two chambers a' a^3 are to be inclined in the opposite direction. Thus two sets of double tubes b c are formed, which cross each other alternately, as is shown in Fig. 1. Each set of double tubes forms, with its two chambers, a rigid self contained whole, and the two sets can be both shifted in the direction of their tube-axes and moved through a certain angle, which is limited by the longitudinal sides of the several chambers. For securing the two sets of double tubes in their relative positions at right angles or thereabout in a simple manner two end plates v v of the shape shown in Fig. 3 are employed, which are provided with inclined projections f f g g, on which the ends of the chambers a a' a^2 a^3 are made to rest. The two end plates v v are connected by longitudinal rods w' w^2 w^3 and nuts, of which latter the external ones are placed in suitable recesses of the end plates, (see Figs. 1 and 3,) so as to economize in the space required. The parts just recited form a casing to receive the assembled tubes and chambers, as shown. Then all the parts are united and form a self-contained whole—*i. e.*, the heat-exchange proper, as shown in Fig. 3. It can be introduced into any vessel y and placed on suitable angled supports x x or other supports. The two upper chambers a a' are on the one end of the vessel y each to be connected with a pipe e, and the two lower chambers a^2 a^3 are each on the other vessel end to be connected with a pipe d for the heating or cooling medium. The manner in which this is done is immaterial. In the present case it is assumed that each chamber has an opening with a female screw-thread into which the male-threaded end of the pipe e or d is screwed. The pipes e and d are each tightened in the wall of the vessel y by a nut h or i, as shown in Fig. 1, or in any other known manner.

The vessel y is filled with the medium to be heated or cooled, after which the heating or cooling medium is by any known means admitted to each upper chamber through the pipe e in the direction of the arrow in case the apparatus serves for heating purposes. The heating medium first passes through the upper chamber, then through the annular spaces between the external and the internal tubes downward, and is again collected in the respective lower chamber, from which it is

led off by the pipe *d*. Suppose the medium to be heated is a liquid, such as water or the like, and the heating medium is steam or the like. The upper layer or layers of the liquid are strongly heated by the upper ends of the tubes *b*, which are in contact with the hottest steam, and the heated liquid ascends comparatively quickly at the lower surfaces of the chambers *a a'* and rises to the surface through the space between these chambers. This ascending liquid is replaced by other portions of liquid streaming from both sides between the heating-tubes through the free spaces left between the chambers *a a*³ and *a' a*², and these portions of liquid are also heated and rise to the surface. Also the lower layer or layers of liquid present between the tubes is heated and not only rises by itself, but is also carried upward by the particularly strongly-heated liquid, which having been acted on by very hot upper chambers and the adjacent ends of the tubes *b* ascends quickly at and from both sides. The thus formed intimate mixture of the lateral streams of liquid of lower specific gravity and of the upward streams of liquid of higher specific gravity flows then upward through the space between the chambers *a* and *a'*, behaving somewhat like the liquid in an injector. Owing to this action, the lowermost layer of the liquid in the vessel is compelled to enter between the tubes through the space left between the chambers *a*² and *a*³, so that also that portion of liquid is heated and made to rise. While rising, this portion of liquid of higher specific gravity intermixes with the portions of liquid of lower specific gravity ascending from both sides in the manner already explained, so that also this mixture rises to the surface through the space left between the chambers *a* and *a'*. This rising and intermixing continues uninterruptedly, so that a very uniform and quick heating is obtained.

Obviously if the apparatus is intended for cooling purposes the cooling medium is preferably admitted by the pipes *d* and led off by the pipes *e*—*i*. *e*., in directions opposite to those of the arrows. In a similar manner the medium to be cooled will take directions in opposition to those of the arrows in Fig. 2.

A further important advantage of the heat-exchange is that it requires but a small space in comparison with its extremely-large heating or cooling surface, while it can be mounted very easily.

The heat-exchange can be varied or modified without deviating from the spirit of the invention. The chambers may be pressed or wrought of steel or iron, or made of sheet and angle iron or steel, or cast from steel, bronze, copper, &c. The tubes *e e* and *d d*, respectively, may be replaced by a common connection having but a single inlet or outlet, respectively. The above-mentioned angle of forty-five degrees between the double tubes and the horizontal or vertical walls of the vessel or reservoir may be more or less modified according to the kind and properties of the medium to be heated or cooled.

Having now described our invention, that which we wish to secure by Letters Patent of the United States is—

A receptacle for fluids, a casing mounted in said receptacle, said casing containing a plurality of angularly-arranged heat-exchanges, each exchange having at each of its ends a chamber communicating with the exterior of the receptacle, tubes passing through said chambers and communicating with the interior of the receptacle, and other tubes connecting the interiors of the chambers, substantially as described and shown.

In witness whereof we have hereunto set our hands in presence of two witnesses.

JOHANN HERMANN BAUDE.
EMIL HORST HOPPE.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.