April 14, 1931. R. UHDE 1,800,329

SUPERHEATER

Filed Oct. 23, 1929

Fig. 1.

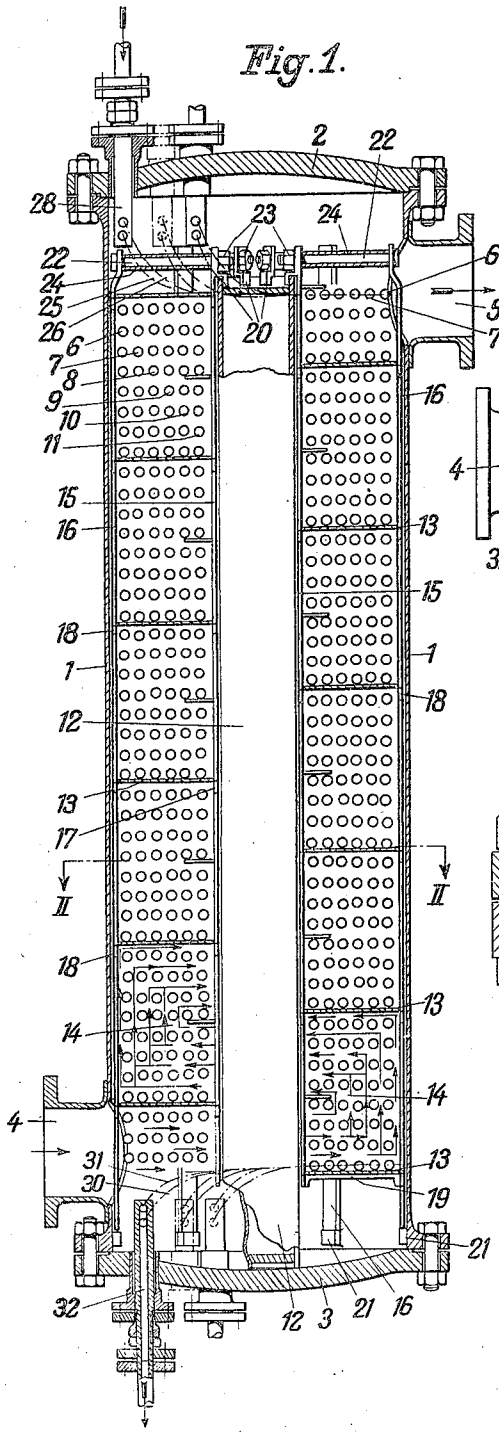


Fig. 2.

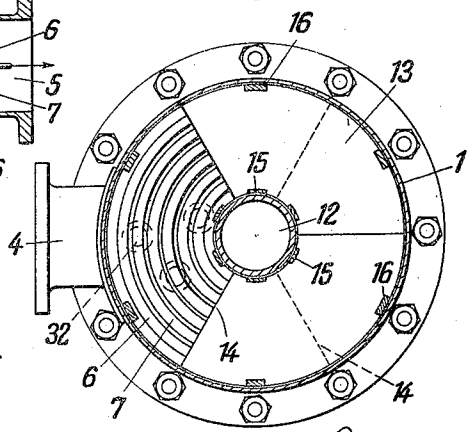
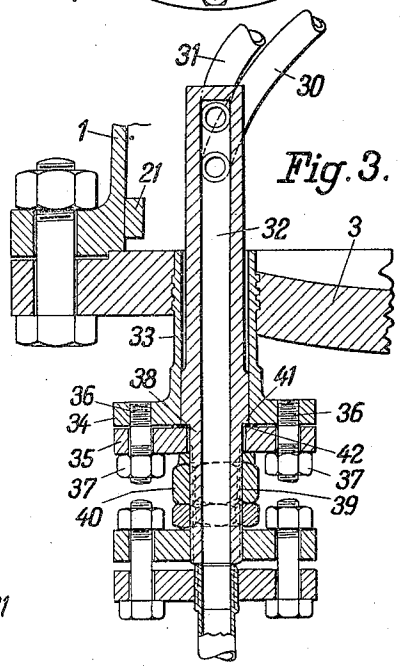


Fig. 3.



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Patented Apr. 14, 1931 1,800,329

UNITED STATES PATENT OFFICE

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SUPERHEATER

Application filed October 23, 1929, Serial No. 401,921, and in Germany January 9, 1929.

The invention relates to superheaters with tubular heating elements, through which the heating medium, for example superheated steam or a highly-heated liquid, flows from above downwards while the working steam to be superheated is admitted at the bottom of the superheater and withdrawn at the top.

The heating elements in such an arrangement may take the form of serpentine tubes with U-shaped return bends and lying side by side or of co-axial helical coils.

This known method of superheater construction has the advantage that a very large heating surface can be arranged in a given size of container.

If the working steam to be superheated flows, as is usual, in a substantially vertical direction through the superheater container, the velocity of flow is determined by the area of the interspaces between the individual elements lying side by side or within one another, or between individual elements and the container wall. As these interspaces, having regard to the manufacture and assembly of the elements, must be comparatively large, in the aggregate their cross-sectional area is so considerable that the velocity of flow of the working steam remains low under all circumstances.

Further, the working steam flowing in a vertical direction between the heating tubes is in contact with their outer surface along only two narrow strips.

For both these reasons, namely, the low velocity of flow of the working steam and its unfavourable contact with the heating surface, the co-efficient of heat transmission is low and the heating surface must be correspondingly large. The efficiency of the superheater as a whole is therefore poor and its cost of production high, quite apart from the fact that in many cases the necessary space for its installation is not available.

The above-mentioned disadvantages are avoided according to the present invention, which, while retaining the serpentine or helical coils, replaces the vertical direction of flow of the working steam by a substantially horizontal to-and-fro movement along the tubes of the heating elements.

With this object, the superheater is divided into sections by transverse partitions having openings for the working steam arranged in staggered relation.

The working steam flows through the opening of one transverse partition into a certain section of the container, distributes itself among the individual tubes and follows these along their length to the oppositely-disposed opening in the next higher partition. Through this opening, the steam passes into the following section and flows in the opposite direction along the tubes disposed therein, this to-and-fro direction of flow of the steam parallel to the heating tubes being continued to the outlet.

With the improved method of construction according to the present invention, it is no longer necessary to keep the interspaces small between adjacent serpentines or coils and between these and the container wall in order to obtain as high a velocity of flow as possible of the working steam and thereby a good heat transmission. The velocity of flow being no longer dependent on the area of these interspaces, it is possible, in accordance with the present invention, to choose as desired the velocity of flow of the working steam, in the vertical direction by appropriately proportioning the openings through the partitions and in the horizontal direction the distance apart of the heating tubes lying one above the other. The upper limit of the velocity is then determined solely by the permissible frictional losses of the steam passing over the smooth heating tubes.

With the to-and-fro movement of the steam as explained above, the further advantage is secured that steam sweeps over the heating tubes not only over narrow strips but on all sides along their entire length.

In addition, the difficulties connected with helical coils of unequal lengths are likewise overcome by the present invention.

By raising the velocity of flow on the one hand and by leading the steam to and fro along the length of the tubes in continuous contact with their entire surface on the other hand, a substantial increase in the heat transmitted and an efficient utilization of the heat-

ing surface are secured, these factors resulting in a corresponding reduction of the heating surface necessary in a given case and therefore in a reduction also of the space required for the superheater and of its cost of production.

The fitting of the heating elements in the superheater container and their connection with the heating-steam inlet and the condensate outlet are effected according to the present invention in such a way that a heating element can be replaced with very little labour and at a small cost.

Referring to the accompanying drawings, in which one constructional form of the invention is shown by way of example:—

Figure 1 is a vertical longitudinal section through the superheater, and

Figure 2 a cross-section on the line II—II of Figure 1, while

Figure 3 shows in section to a larger scale a method of passing a collector tube of the heating coils steam-tight through the bottom of the superheater container.

According to the form shown, the superheater container comprises a cylindrical shell, 1, having a detachable cover, 2, and bottom, 3, the shell, 1, being provided at its lower end with the inlet connection, 4, and at its upper end with the outlet connection, 5, for the working steam to be superheated. For the accommodation of the heating steam, six coils, 6 to 11, are provided, wound in the form of helices lying coaxially one within the other as shown. In the space within the innermost coil, 11, is arranged a sheet-metal cylinder, 12, closed at both ends, so that this space is shut off completely from the annular space within the container through which the working steam flows.

The division of this annular space into a number of annular sections by transverse partitions, 13, is an important feature of the present invention.

In the form of the invention shown, four convolutions of each coil are disposed one above the other in each annular section. The number of tubes lying in a given section can, however, be chosen as desired in order to obtain the vertical distance between the convolutions which gives the desired velocity of flow of the working steam through the interspaces.

Each transverse partition, 13, is provided with a sector-shaped opening, 14, and for the convenience of assembly and dismantling is preferably made in two pieces. The sectors, 14, are oppositely disposed in adjacent partitions so that the working steam is compelled on its path from the inlet, 4, to the outlet, 5, to flow to and fro in a serpentine path.

The transverse partitions, 13, are carried by vertical rails, 15 and 16, provided with ears or lugs, the rails, 15, with ears, 17, and the rails, 16, with ears, 18, on which the partitions, 13, rest. The inner rails, 15, are suspended from the upper edge of the cylinder, 12, by means of the hooks, 20, while the outer rails, 16, rest on projections, 21, which are fastened to the container shell. At their lower ends, the rails, 15 and 16, are connected in pairs by easily detachable cross pieces, 19, and at their upper ends by screw bolts, 22, with nuts, 23, and distance pieces, 24.

The heating coils are arranged in pairs, each with a common steam inlet and also a common condensate outlet; thus, in the example shown, the upper ends, 25, 26, of the two outer coils, 6 and 7, are connected to a distributor tube, 28, and the lower ends, 30 and 31, of these coils to a collector tube, 32.

As the method of leading these tubes steam-tight through the cover and bottom of the container is the same in each case, the common tube, 32, serving for the withdrawal of condensate and illustrated in Figure 3 will alone be described.

This collector tube, 32, is led through a sleeve, 33, either rolled into the bottom, 3, of the container or made in one piece therewith. Alternatively, the sleeves, 33, instead of being secured to the bottom and cover could be provided on the shell of the container. The sleeve, 33, carries at its outer end a flange, 34, which is fastened to a ring, 35, by screw bolts, 36, and nuts, 37. The ring, 35, passes loosely over a part, 38, of the collector tube, 32, of smaller diameter provided with screw threads, 39. By means of a nut, 40, engaging with the threads, 39, on the collector tube, 32, and butting against one face of the ring, 35, the collector tube 32, can be drawn up so that its shoulder, 41, butts against the other face of the ring, 35. To assist in securing steam-tightness, a packing ring, 42, is interposed between the ring, 35, on the one hand and the shoulder, 41, of the collector tube and the flange, 34, of the sleeve, 33, on the other hand.

This arrangement has the advantage that the joint lies outside the container. Due to this fact any leakage at once becomes visible and can be readily dealt with.

The common tubes for the steam inlet and the condensate outlet are offset with reference to the two corresponding heating coils in such a way that the one tube, for example, lies about on the horizontal projection of the outer coil and the other tube about on the horizontal projection of the inner coil.

In the form of the invention described, the common tube, 28, for the heating-steam inlet thus lies on the projection of the coil, 6, and the common tube, 32, for the condensate outlet lies on the projection of the coil, 7.

This offset arrangement of distributor and collector tubes has the advantage that if one coil is damaged, it can be replaced without

the necessity of breaking the joints of the other coil with the common tubes.

If a coil is damaged, the screw connections outside the bottom, 3, and cover, 2, are disconnected and the cover raised so that the heating-tube system can be withdrawn as a whole from the container. After removing the outer rails, 16, and the transverse partitions, 13, any individual pair of heating coils can be withdrawn with its corresponding distributor and collector tubes.

Supposing, for example, the coil, 7, is damaged, the pair of coils, 6, 7, is removed and the connection of the coil, 7, with the common tubes, 28 and 32, broken. The coil, 7, can then be at once withdrawn towards the end where the distributor tube, 28, is situated, since the latter is offset with reference to the coil, 7. The connection of the common tubes, 28 and 32, with the coil, 6, can therefore remain unbroken.

If the coil, 6, is damaged, it can be detached in the same way and withdrawn at the end where the collector tube, 32, is situated.

By thus arranging the coils in pairs and offsetting the common tubes as described, the work required in replacing a coil is reduced to a minimum.

When the convolutions have a comparatively large diameter, pairs of "double-threaded" coils may replace the single coils described and be secured to common tubes at the two ends; with such a construction, a double coil can be replaced in exactly the same simple manner as described with reference to a single coil.

The path of the working steam through the annular sections of the superheater formed by the intermediate walls, 13, is shown in Figure 1 by arrows. The steam entering through the inlet connection, 4, flows into the annular section lying immediately above the lowest partition, 13, and passes by way of the interspaces between the convolutions of the coils lying one above the other to the opposite side where it flows upwards through the opening, 14, of the second lowest partition, 13, into the next section, this upward flow being effected through the annular spaces present between the individual convolutions and between the inner and outer convolutions and the container shell. The steam flowing upwards through these annular spaces is deflected and passes along the convolutions of the coils in the interspaces between them to the opposite side, where it is transferred to the next higher annular section and so on.

In this way the convolutions of the heating coils are surrounded as completely as possible by working steam.

As the steam is in contact not only with the under side of the convolutions but also with their upper side, in the lower annular sections in which the convolutions contain more or less condensate and have steam only in the upper part, transference of heat from this remaining heating steam to the working steam to be superheated can be effected in favourable circumstances directly through the tube wall, a circumstance contributing substantially to a complete utilization of the heat available in the heating steam.

When the container with its heating tubes is of sufficient breadth, the flow of working steam essential for the present invention in a substantially horizontal direction along the heating tubes, can also be effected if the openings through the partitions take the form of annuli disposed alternately on the inner and outer edges of successive partitions.

If serpentine tubes are used instead of the helical coils described, the partitions must be so arranged that their openings lie on the same side of the container as the reverse bends of the serpentines. The working steam after passing through the opening in a partition into the next container section, then meets the heating tubes in this section in a substantially horizontal direction.

What I claim is:

1. In a superheater a container, coaxial heating coils lying one within the other, inlet connections for the heating medium at one end and outlet connections at the other end of the container, the heating coils being connected in pairs to a common inlet header and a common outlet header, these common headers being so offset that the one header lies about on the projection of the outer of the two coils and the other header about on the projection of the inner of the two coils.

2. In a superheater a container, heating elements located therein, header tubes to which said heating elements are connected, hollow sleeves provided in the container wall, each header tube being led through one of said sleeves, that portion of the header tube which projects from the sleeve being reduced in diameter to form a shoulder, a ring loosely fitting over the reduced part of the header tube means for forcing said ring against the shoulder of the header tube and means for clamping the ring against the sleeve.

3. A superheater in which a heating medium is conducted in one direction and in which working steam to be superheated is conducted in the opposite direction, comprising a container, a plurality of tubular heating elements connected in parallel disposed within the container, means for admitting the heating medium to said tubular elements adjacent one end of the container, means for admitting working steam to the container at its opposite end, and transverse partitions located in the container subdividing the container into transverse sections, adjacent partitions being provided with open-

ings in staggered relation to each other, the tubular heating elements passing through said staggered openings and being arranged to form in section a plurality of superposed substantially parallel layers of tube windings, said layers having spaces therebetween whereby the working steam passing through the superheater moves between said layers in its passage through the various sections of the container.

4. A structure as claimed in claim 3 wherein the distance between adjacent layers of tube windings is greater than that between adjacent sections of tubing in the layers.

In testimony whereof I have affixed my signature.

ROBERT UHDE.