April 28, 1931. O. ENGLER 1,802,413

HEAT EXCHANGER

Filed Sept. 18, 1930 2 Sheets-Sheet 1

Fig. 1

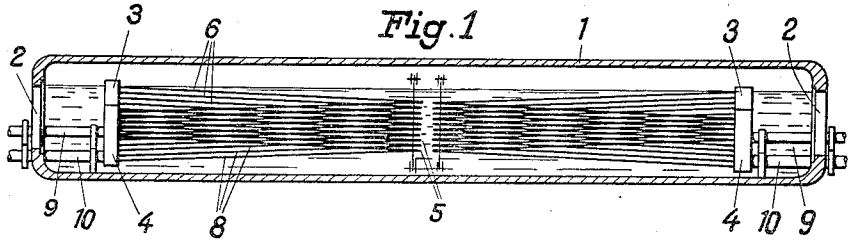


Fig. 2

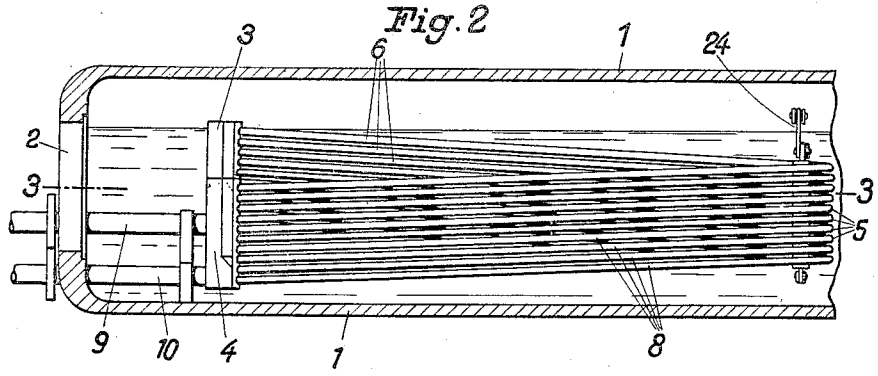


Fig. 3

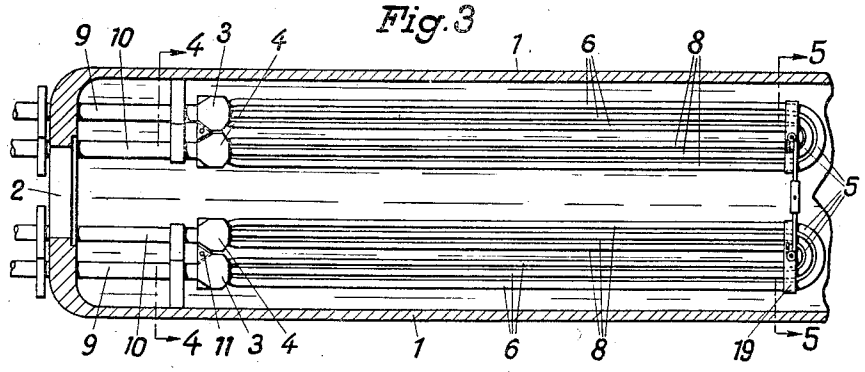


Fig. 4

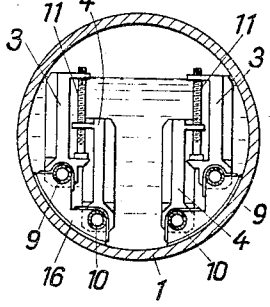


Fig. 5

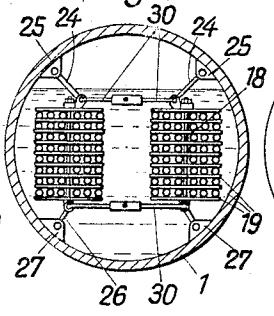
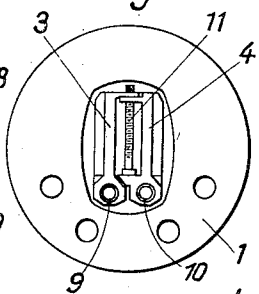


Fig. 6



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Fig. 7

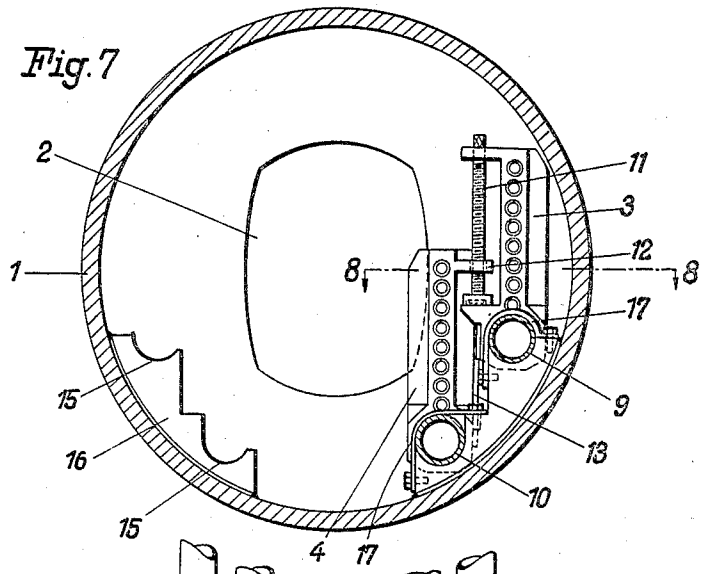


Fig. 8

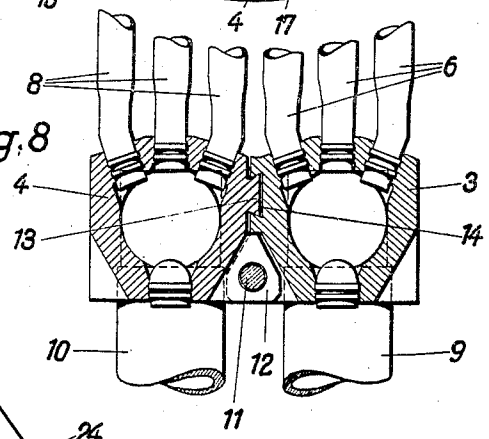


Fig. 9

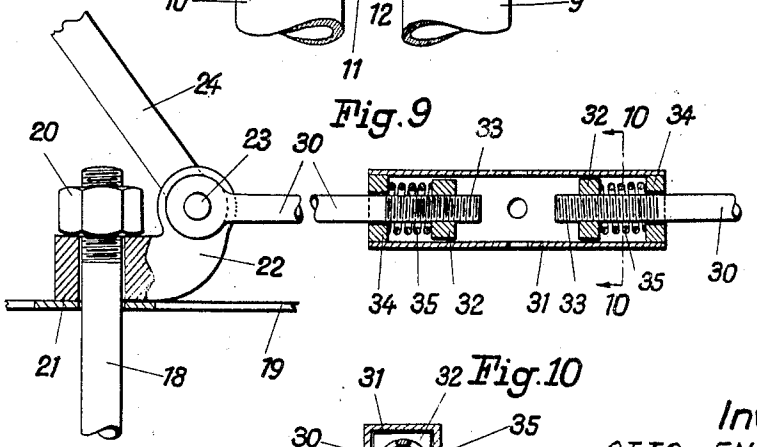


Fig. 10

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UNITED STATES PATENT OFFICE

OTTO ENGLER, OF KASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG, OF KASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY

HEAT EXCHANGER

Application filed September 18, 1930, Serial No. 482,842, and in Germany October 9, 1929.

The present invention relates to heating elements used in connection with indirectly heated heat exchangers, and is more particularly concerned with those of the type in which a group of heating tubes is connected to an inlet header at one of their ends and to an outlet header at the other of their ends, the heating fluid being adapted to enter the inlet header and flow through the tubes to the outlet header from whence it is discharged. The heating fluids used in this type of heat exchanger are usually in the form of vapor or gas and provision must therefore ordinarily be made for the removal of condensate collecting within the tubes. For this purpose, the tubes are inclined downwardly so as to have successive decreases in elevation from their points of connection with the inlet header to their connections with the outlet header. As a consequence, the outlet header is necessarily at a lower elevation than the inlet header.

When the tubes have been bent into substantially the form of a U having elongated legs the inlet and outlet headers thus lie adjacent one another, the inlet header being vertically displaced with respect to the outlet header so that the inlet legs of the U incline downwardly toward their return bends and the outlet legs of the U incline downwardly from the return bends to the outlet header when the U is in generally horizontal position in which position it is ordinarily mounted in the drum of the heat exchanger.

Heating elements of this general character are usually built as separate units and inserted as such into drums through manholes provided in the drum walls. Due to the necessary vertical displacement of the inlet and outlet headers, as explained above, the over-all dimension from the top of the inlet header to the bottom of the outlet header of the heating element is appreciably greater than the height of each individual header, and the size of a heating element which has heretofore been capable of insertion into a drum having a manhole of given size has been limited to an over-all dimension from the top of the vertically displaced inlet header to the bottom of the outlet header which is slightly less than the diameter of the manhole. It is a general object of the invention to provide a heating element of this general character which may be inserted through any manhole having a diameter slightly in excess of the lengths of the individual headers.

According to the present invention the inlet and outlet legs of the individual heating tubes are held in substantially horizontal planes during the insertion or removal of the heating element from the drum and the inlet and outlet headers are therefore not vertically offset. It is only after the heating element is situated inside the drum that the legs of the tubes are spread or bent out of their horizontal planes and the headers are vertically offset to provide for the necessary fall for the removal of condensate. As a consequence, the over-all dimension from the top of the inlet header to the bottom of the outlet header is equal to the length of each individual header while the heating element of my construction is being moved through the manhole. In contradistinction to this, the legs of the tubes are bent out of their horizontal planes and the inlet and outlet headers are in vertically offset condition during passage of the heating element through the manhole where previously known constructions are dealt with.

The invention therefore makes it possible to insert heating elements into drums of given dimensions, whose individual headers are much larger than those of heating elements heretofore capable of insertion into drums of like dimensions. The larger and higher the header is, the more heating tubes can be connected thereto and the greater the heating surface becomes under otherwise similar circumstances. Another advantage accruing from the invention is thus the ability of utilizing an appreciably greater amount of heating surface in a drum of given dimensions than was heretofore possible.

Any convenient means may be employed for bending or spreading the legs of the tubes out of their original horizontal planes or for forcing them into their horizontal planes. If desired, the tubes may be so formed that the legs of each normally tend to assume a

position in the same plane. Also, the tubes may be so formed that their legs tend to assume a position providing for the necessary incline to carry off the condensate in which case those of each would be pressed in so as to lie in a single plane during insertion and removal of the heating element.

In a preferred form of construction embodying the invention, an apparatus is preferably built in between the inlet and outlet headers by means of which the headers and each of the tubes may be brought into alignment when it is desired to insert the heating element into a drum and by means of which the headers and ends of the tubes may be vertically displaced to provide the inclination for flow of condensate when the heating element is inside the drum.

The various objects of the invention will be more clearly apparent from a reading of the specification and claims together with the accompanying drawings.

In the drawings, which are illustrative of the invention, Fig. 1 shows a drum having heating elements inserted from both ends, in longitudinal section;

Fig. 2 shows one half of the drum shown in Fig. 1 in larger scale;

Fig. 3 is a partial section along the line 3—3 of Fig. 2, the heating elements being shown in plan;

Fig. 4 is a cross section along the line 4—4 of Fig. 3;

Fig. 5 is a cross section along the line 5—5 of Fig. 3;

Fig. 6 is an end view showing a heating element being inserted into the drum;

Fig. 7 is a section in enlarged scale showing a front view of one of the heating elements arranged in the drum;

Fig. 8 is a cross section along the line 8—8 of Fig. 7 in an even more enlarged scale;

Fig. 9 partially shows in longitudinal section some of the individual parts of the means for supporting and holding the heating tubes at their return bends; and

Fig. 10 is a cross section along the line 10—10 of Fig. 9.

The drum 1 is provided with a manhole 2 at each end through which the heating elements are inserted. There are four heating elements within the drum, two being inserted in the manhole at each end of the drum and lying end to end in pairs, one pair having its inlet and outlet connections at one end of the drum and the other pair having such connections at the other end of the drum. Each individual heating element comprises adjacent inlet and outlet headers 3 and 4 which are connected to a number of superposed and concentrically arranged heating tubes bent into the form of a U having elongated legs. The headers 3 and 4 are offset vertically and the legs of the U-shaped heating tubes are so bent or spread that the inlet legs 6 of each incline downwardly toward their return bends 5 and the outlet legs 8 incline downwardly from their return bends to the outlet header 4. Any condensate thus forming at any point in the heating tubes will flow into the outlet header 4. The heating steam inlet conduit 9 and the condensate outlet conduit 10 are connected to the headers 3 and 4 respectively, and make gas tight fits with the walls of the drum at their passage therethrough.

As clearly shown in the drawings, the overall dimension between the top of header 3 and the bottom of header 4 is appreciably greater than the height of manholes 2 when the headers are vertically offset to provide for the necessary inclination of the heating tubes as explained above. As a result, the heating element cannot be moved in and out of the drum when the headers and tubes are in such position, but in order to make such insertion and removal possible, means are provided for pressing the inlet and outlet legs of the heating tubes in such manner that the inlet and outlet headers will be brought into alignment, i. e. the tops of the inlet and outlet headers will be at substantially the same height. In this position, the insertion and removal of the heating elements through the manholes can take place as will be apparent from Fig. 6.

In order to provide for the relative displacement of the inlet and outlet headers, I preferably provide a threaded spindle 11 rotatably mounted on header 3 in any convenient manner but held against longitudinal movement with respect thereto. This spindle 11 is engaged by the internal threads of a lobular projection 12 which is fixed to the header 4 so that a relative displacement of the two headers will occur upon rotation of the spindle. For the purpose of guiding the two headers during their movement with respect to each other, a dovetail shaped tongue 13 is formed on the header 4 and engages a similarly shaped groove in the header 3. When the headers are displaced with respect to each other there will therefore also be a corresponding displacement of the ends of the U-shaped heating tubes, but these will be held firmly in position whereby the conduits 9 and 10 may readily be fitted to the headers. Supports for these conduits within the drum comprise the curved cut out portions 15 of the supporting plates 16 which are secured to the drum walls. The conduits are held fast to the supporting plates by means of bands 17 secured to the supporting plates in any convenient manner.

The heating tubes are so mounted with respect to the drum walls at their return bends that an expansion of the former due to the temperature rise occurring upon the admission of heating steam may take place readily, without resulting in any undue

stresses. The tubes of each individual heating element are held together by means of an anchor bolt 18 and cross pieces or splints 19 which extend transversely of the tubes. The anchor bolts are provided with fastening nuts 20 and mounted on the anchor bolts adjacent these nuts 20 are discs 21 carrying eyelets 22. Links 24 are connected to eyelets 22 by means of bolts 23 and are loosely pivoted at their opposite ends to eyelets 25 secured to the drum walls. The lower ends of the anchor bolts 18 are connected to links 26 which in turn are loosely pivoted to eyelets 27 secured to the drum walls in similar manner.

Each pair of adjacent heating elements is connected at the top and at the bottom by means of tensioning devices. The tensioning devices are built identically and a description of one will therefore suffice. The two draw spindles 30 of one of the tensioning devices are connected to bolts 23 at their outer ends (Fig. 9). The means for connecting the draw spindles 30 comprises a casing 31 of rectangular cross section having disposed therein a pair of four sided nuts 32 which engage the threads 33 on the ends of spindles 30, the threaded ends of the draw spindles passing into the casing though openings provided at either end 34. A compression spring 35 surrounds each draw spindle between its nut and its adjacent end 34 of the casing. Since the ends of the draw spindles are oppositely threaded, the draw spindles will either be spread apart or drawn together upon rotation of casing 31 and ensuing rotation of nuts 32. The spindles are free to slide within the openings provided in ends 34 of the cylinder against the compression of spring 35.

Each pair of adjacent heating elements is thus connected together by an upper and a lower tensioning device and is hung from the drum walls by means of upper links 24 and lower links 26. The heating elements may thus not be swung to any great extent, i. e. to the extent of endangering the connections between conduits 9 and 10 and headers 3 and 4, but expansion of the heating tubes will not result in any undue stresses. Upon expansion of the heating tubes, the anchor bolts 18 tend to move longitudinally of the drum. The links 24, 26 pivot about their connections with eyelets 25, 27 thus tending to increase the distance between the two heating elements at their return bends. As a consequence, the tensioning devices connecting the heating elements expand and this expansion is made possible because of the fact that nuts 32 may move toward the ends 34 of casing 31 under the compression of springs 35. When the tubes again contract, the links 24, 26 will move back to their original positions and the spindles of the tensioning devices will again be drawn together by springs 35. The device could obviously also be so arranged that the return bends of the heating tubes of adjacent heating elements would tend to move together upon expansion. In this case it would not be necessary to employ springs equivalent to springs 35 in the cylinder 31 if the draw spindles were made of resilient material so as to be capable of bending sufficiently to resiliently oppose the inward movement of the ends of the heating elements.

Having described my invention, what I now claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In a device of the class described, a drum having a manhole in its walls, and a heating element lying within said drum, said heating element comprising a plurality of U-shaped heating tubes, an inlet header connected to the inlet legs of said tubes, an outlet header connected to the outlet legs of said tubes, and means for displacing said headers relatively to each other thereby to effect relative displacement of the ends of the heating tubes and to move the inlet and outlet legs of each of said heating tubes into and out of a common plane.

2. In a device of the class described, a drum having a manhole in its walls, a plurality of substantially U-shaped heating tubes within said drum, an inlet header connected to the inlet ends of said tubes and an outlet header connected to the outlet ends of said tubes, said tubes being positioned with their return bends in substantially horizontal position, and means for displacing the said headers relatively to each other, whereby said headers may be brought into alignment for passage of the headers and heating tubes through the manhole of the drum as a unit and whereby said headers may be offset thereby to effect an inclination of the legs of said tubes to provide for flow of condensate within the same.

3. The combination with a drum, of a heating element disposed inside said drum, said heating element comprising a plurality of U-shaped heating tubes having adjacent inlet and outlet ends, an inlet header connected to the inlet ends of said tubes, an outlet header connected to the outlet ends of said tubes, said headers lying adjacent one another, and means between said headers for displacing the same relatively to each other, whereby the headers may be moved into and out of alignment and the inlet and outlet legs of each of said heating tubes may be moved into and out of a common plane.

4. The combination with a drum, of a heating element disposed inside said drum, said heating element comprising a plurality of U-shaped heating tubes having adjacent inlet and outlet ends, an inlet header connected to the inlet ends of said tubes, an outlet header connected to the outlet ends

of said tubes, said headers lying adjacent one another, a threaded spindle rotatably secured to one of said headers and held against movement longitudinally thereof, the other of said headers having an interiorly threaded opening engaged by the threaded part of said spindle, whereby the headers may be moved into and out of alignment upon rotation of the spindle.

5. A heating element comprising a plurality of heating tubes formed with inlet legs, return bends, and outlet legs, an inlet header connecting the ends of the tubes adjacent their inlet legs, an outlet header connecting the ends of the tubes adjacent their outlet legs, and means connecting said headers for moving the same relatively to each other in a path perpendicular to the planes of the return bends of the heating tubes, whereby said headers may be moved into alignment for transportation of the heating element through relatively small openings and whereby said headers may be offset to incline the legs of the heating tubes with respect to each other.

6. A heating element as claimed in claim 5 wherein one of the headers is provided with a dovetail groove and the other of the headers is provided with a coacting dovetail tongue, whereby said headers are held together and guided upon their relative displacement.

7. In a device of the class described, the combination with a drum, of a heating element comprising U-shaped tubes having their inlet ends connected to an inlet header and their outlet ends connected to an outlet header within said drum, said heating element being resiliently connected to the walls of the drum at the return bends of the U-shaped heating tubes.

8. In a device of the class described, the combination with a drum, of a plurality of heating elements mounted side by side within said drum, said heating elements each comprising an inlet header, an outlet header, and a plurality of U-shaped tubes having their inlet and outlet ends connected to the inlet and outlet headers, means for supporting the heating element adjacent said headers, a plurality of links pivoted to the drum walls at one of their ends and to the bottom and top of each said heating elements adjacent their return bends at the other of their ends, and a pair of tensioning members connecting the heating elements adjacent their return bends.

9. In a device of the class described, a drum having a manhole in its walls, and a heating element lying within said drum, said heating element comprising a plurality of U-shaped heating tubes, an inlet header connected to the inlet legs of said tubes, an outlet header connected to the outlet legs of said tubes, the said tubes being so formed that their legs tend to assume an inclined position relatively to each other, the said inlet and outlet headers being offset, and means for bringing the said headers into alignment during their passage through the manhole of the drum.

In testimony whereof, I have hereunto set my signature.

OTTO ENGLER.