Feb. 16, 1932. H. FELDMEIER ET AL 1,845,256

HEAT EXCHANGE DEVICE

Filed March 14, 1930 2 Sheets-Sheet 1

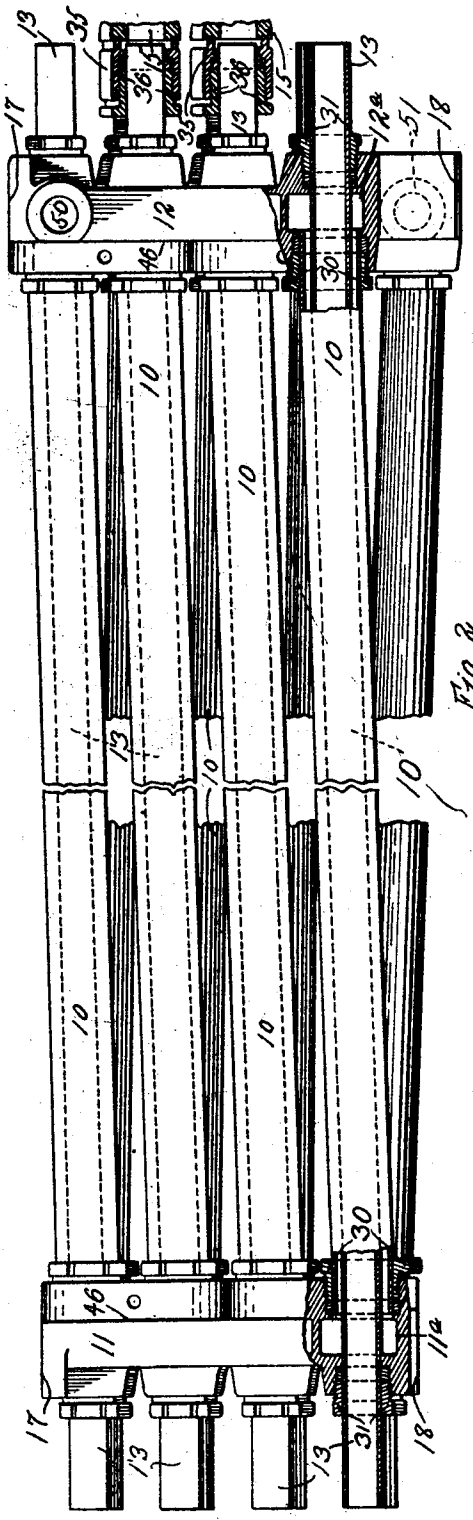


Fig. 2

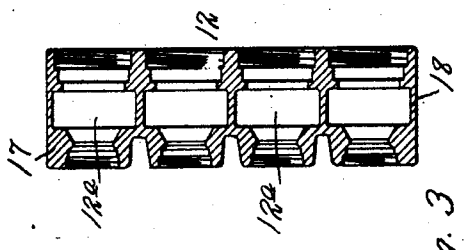


Fig. 3

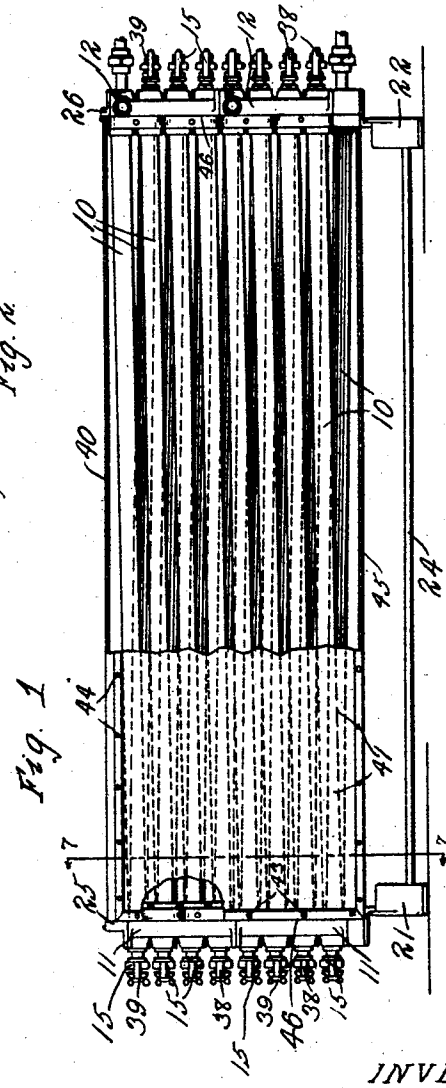


Fig. 1

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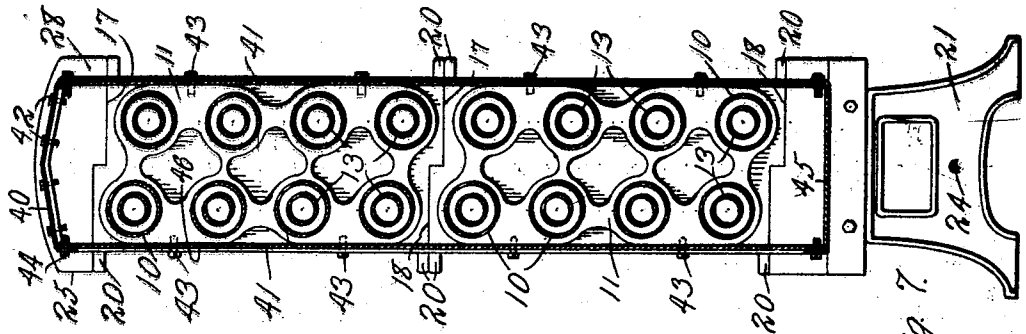


Fig. 7.

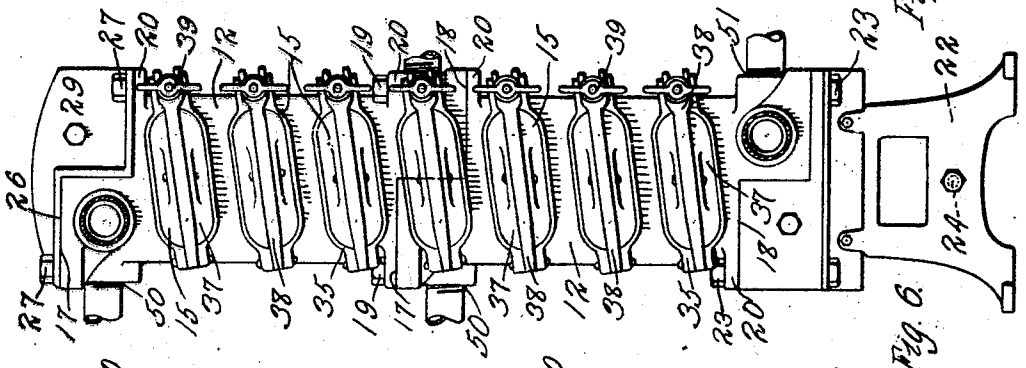


Fig. 6.

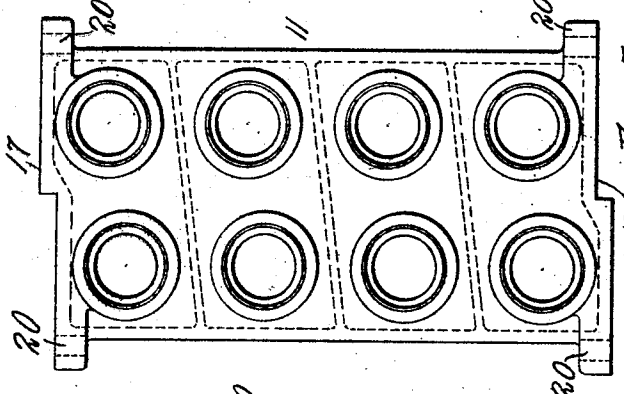


Fig. 5

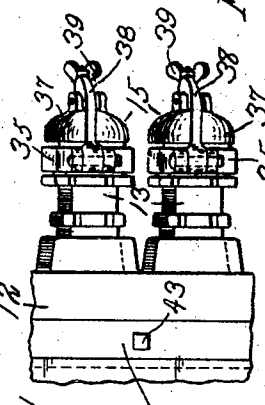


Fig. 8

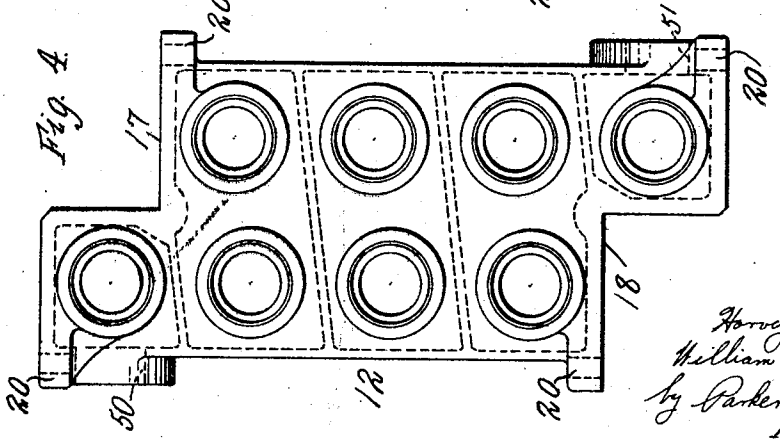


Fig. 4.

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UNITED STATES PATENT OFFICE

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HEAT EXCHANGE DEVICE

Application filed March 14, 1930. Serial No. 435,734.

This invention relates to tubular heat exchange devices and more particularly to improvements in internal tube heat exchange devices for cooling or heating liquids, such as milk, in which the tubes through which the liquid flows are arranged within outer tubes through which flows the medium for cooling or heating the milk or liquid. In these devices as ordinarily constructed, the outer tubes are connected at their opposite ends to headers which form return passages that join the outer tubes to form a continuous passage for the heating or cooling medium, and the ends of the inner tubes extending out through the headers are connected end to end by return caps or connections to form a continuous passage for the milk or liquid to be cooled or heated. The return connections or caps are usually constructed so that they can be removed or opened to permit the ready cleaning of the return caps and of the inner milk tubes. It is desirable in heat exchange devices of this nature to incline the tubes downwardly alternately in opposite directions so that the continuous passage formed by the tubes and their return connections shall have a continuous downward inclination to facilitate the complete and ready draining of the liquids from the devices.

One object of this invention is to provide an efficient and practical tubular heat exchange device of a desirable novel construction.

Other objects of this invention are to provide a heat exchange device having tubes connected to form a continuously inclined passage and which is made up of separate units or sections stacked one upon another, but in which nevertheless the tubes are uniformly spaced apart, and all of the return connections for the tubes are alike; also to provide a sectional heat exchange device which is composed of separate units stacked one upon another and in which both the tubes and return connections are uniformly arranged and spaced, notwithstanding that the alternate tubes incline in opposite directions; also to provide a heat exchange unit of novel construction such that a complete device can be composed of any desired number, one or more, of the units; also to provide base and top pieces for the units adapted to give a similar finished appearance to the device, whether composed of one or a plurality of stacked units; also to construct the device so that the tubes can be enclosed and protected by closure elements connecting the headers and top finishing pieces; and also to produce a heat exchange device having the advantages and features of improvements hereinafter described and set forth in the claims.

In the accompanying drawings:

Fig. 1 is a side elevation, partly broken away, and in section, on a reduced scale, of an internal tube heat exchange device exemplifying one embodiment of the invention.

Fig. 2 is a fragmentary side elevation, partly in section, showing one unit or section of the apparatus, the return connections for the inner tubes being omitted.

Fig. 3 is a vertical, central section of one of the headers detached.

Figs. 4 and 5 are outside end elevations, on a larger scale, respectively, of the headers used at opposite ends of the unit.

Fig. 6 is an end elevation of the device.

Fig. 7 is a vertical cross section thereof approximately on the line 7—7, Fig. 1, and

Fig. 8 is a fragmentary side elevation of one end of the device.

The device illustrated in the drawings is an internal tube milk cooler comprising two sections or units stacked one upon the other. These units are alike, and it will be understood that the device can be composed of any desired number of the units, depending upon the desired capacity.

Each unit, as shown, comprises a plurality of outer tubes 10 connected at their opposite ends to front and rear headers or tube supports 12 and 11, and a corresponding number of internal tubes 13 each extending through and spaced from one of the outer tubes 10. The headers 11 and 12 are suitably constructed to provide the usual passages 11*a* and 12*a* which join the outer tubes end to end in a continuous passage for the flow of a heating or cooling medium, and the ends of the inner tubes, which preferably extend out through the headers 11 and 12 are connected by return

caps or connections 15 which join the inner tubes in a continuous passage for the flow of the milk or other liquid to be cooled or heated. The medium flowing through the outer tubes surrounds the inner tubes so that an exchange of heat takes place between this medium and the fluid flowing through the inner tubes. The tubes are preferably arranged in two adjacent vertical rows or banks with the tubes in each bank paralled with each other and the tubes in one bank inclined oppositely to the tubes in the other bank. The return connections 15, each of which joins one internal tube in one bank to the next internal tube in the other bank, are also preferably inclined so that the tubes and the return connections form a continuous passage which has a downward inclination throughout its length.

The topmost internal tube 13 in one bank inclines downwardly from front to rear and its rear end is connected by a return connection 15 to the rear end of the topmost tube 13 in the other bank. The last mentioned tube inclines downwardly from its rear end, and its front end is connected by a front return connection 15 to the front end of the second tube in the first bank, which in turn is connected at its rear end by the second rear return connection 15 to the rear end of of the second tube in the second bank, all of the internal tubes in the unit being thus connected end to end in series. By reason of this opposite inclination of the tubes, the front end of each tube in the second bank is disposed at lower elevation than the front end of the corresponding tube in the first bank, and because of the inclination of the return connections there is also a difference in elevation between the rear ends of the tubes joined by each return connection, the difference in elevation between the front ends of the corresponding tubes in the two banks being considerably greater than between the rear ends of said tubes. Therefore if the bottom faces of the headers of the top unit and the top faces of the headers of the lower unit, on which the top unit rests, were horizontal crosswise of the tubes, the spacing between the adjacent tubes of the stacked units would be greater than the spacing between the tubes in each unit. In such case, a special return connection having a different length or arrangement from the other return connections 15 would have to be employed to connect the bottom tube of the upper unit with the top tube of the lower unit.

In order to obviate this and keep the spacing between adjacent tubes in different stacked units the same as between the tubes in each unit, and to enable like return connections 15 to be used throughout and to be similarly arranged and uniformly spaced, the top and bottom faces of the headers are not horizontal, but the tops 17 of the headers of each unit are higher in the vertical plane of the first bank of tubes than in the vertical plane of the other bank and the bottoms 18 of the headers are correspondingly formed to fit the top ends of the headers of a lower unit. Preferably, as shown in the drawings, the top and bottom ends of the headers are of stepped formation crosswise. While this stepped formation locates the opposite ends of the joints between the headers of adjacent sections at different elevations, nevertheless the headers have flat horizontal faces abutting and resting one upon the other which insures a firm rigid support for one section upon the other. The sections can be secured together in their stacked relation by any suitable means as for example by bolts 19 secured in perforated lugs or flanges 20 on the abutting top and bottom ends of the headers.

Because of this stepped form of the headers, a supporting base is preferably provided having end standards or parts 21 and 22, the upper ends of which are of similar stepped formation to fit the bottoms of the headers of the heat exchange unit that rests thereon. The unit may be secured on this base in any suitable manner, as by means of bolts 23 secured in registering holes in the bottom flanges of the headers and in the tops of the standards. As shown, the base standards 21 and 22 are connected by a tie and brace rod 24. The base, however, could be of any suitable construction providing seats conforming to the shape of the lower ends of the headers of the unit resting thereon.

Preferably the top ends of the headers of the uppermost unit are surmounted by crown pieces 25 and 26 each of which has a stepped bottom which conforms to the stepped upper end of the header on which it is secured as by means of bolts 27 or other suitable means. These crown pieces 25 and 26 are provided with vertical walls or plates 28 and 29, the top edges of which are of similar shape and disposed at the same elevation, so that the front and rear ends of the heat exchange device will be of the same height and of the same top formation.

When the heat exchange device consists of only one unit, the crown pieces are secured on top thereof, whereas when the device comprises two or more units, the crown pieces are secured on top of the uppermost unit. Therefore the device, whether composed of one, or more than one unit, will be of similar shape and appearance except as to height.

It will be understood that the outer tubes 10 are connected at their ends to the front and rear headers by suitable packing glands 30 (see Fig. 2) or otherwise to provide liquid tight joints between the outer tubes of the inner walls of the front and rear headers; and that the internal tubes 13, which extend through the headers, have liquid tight joints with the outer walls of the front and rear

headers formed by packing glands 31 or otherwise, so that the heating or cooling medium cannot leak from headers through the joints between the tubes and the headers. These parts may be of the usual or any suitable constructions.

Also the return connections 15 for joining the ends of the internal tubes may be of any usual or suitable construction and connected to the ends of the tubes in any usual or suitable manner. Preferably, however, each of the return connections comprises an inner member 35 which is secured to the adjacent ends of two of the internal tubes by suitable packing glands 36, and a movable cap or cover 37 carried by a yoke 38 which is hinged at one end to the base member 35 and is adapted to be releasably secured at the other end to the base member by a hinged clamping screw and thumb nut 39 by means of which the movable caps can be tightly clamped against the base member to form the return passage between the tubes. These caps can be readily opened or moved to afford access to the internal tubes and to the return connections for cleaning the tubes and return connections.

The tubes of the device are preferably enclosed by a top cover 40 and side cover plates or walls 41. The top cover extends between and connects the front and rear crown pieces, to which the cover may be secured by screws or other suitable fastenings 42, and the side walls 41 extend from the front headers to the rear headers and may be secured at their ends to the front and rear headers by screws or other suitable fastenings 43. The side walls may also be secured along their top edges to the side edges of the cover 40 by screws or fastenings 44, and at their bottom edges to a bottom closure plate 45 extending beneath the tubes. Preferably the headers are provided at their opposite sides with vertical shoulders 46 against which the vertical ends of the side walls 41 abut with the outer faces of the ends of the side walls flush with the side faces of the headers. The cover, side and bottom plates, in conjunction with the front and rear headers and crown pieces thus form a tight casing enclosing the tubes. This casing hides the tubes and gives a neat attractive appearance to the device and also confines the air surrounding the tubes and reduces loss of heat from the tubes.

Inlet and outlet pipes for the supply and discharge of the cooling or heating medium which circulates through the headers and the outer tubes 10 can be connected with the device in any usual or suitable manner, for instance, the front header of each unit, as shown, is provided at one side thereof at its upper end with a threaded hole 50 and at the lower end of its opposite side with a threaded hole 51 for the connection of the pipes. The inlet pipes may be connected with the hole at one side of the header and the outlet pipe with the hole at the opposite side of the header depending upon the desired direction of flow of the heating or cooling medium upwardly or downwardly through the unit or as may be required depending upon the arrangement and connection of the device with the other associated apparatus.

We claim as our invention:—

1. In a heat exchange device, the combination of a plurality of units arranged one above another, each unit comprising front and rear headers, outer tubes connecting said headers and arranged in different banks, with the tubes in different banks oppositely inclined, said headers having passages for the circulation of a medium through said tubes, internal tubes arranged in said outer tubes, and return connections joining said internal tubes end to end, the return connections between the internal tubes of each unit and between the bottom tube of one unit and the top tube of the adjacent unit being of like dimensions and all being uniformly inclined.

2. A heat exchange device comprising a plurality of units arranged one above another, each unit comprising opposite headers, outer tubes connecting said headers, internal tubes arranged in said outer tubes, return connections joining said internal tubes end to end, the tubes of each unit being arranged in different banks with the tubes in the different banks oppositely inclined, the tubes of each unit and the adjacent tubes of adjacent units being uniformly spaced apart and the return connections between the internal tubes of each unit and between the bottom tube of one unit and the top tube of the adjacent unit being of like dimensions and all uniformly spaced apart and uniformly inclined.

3. A heat exchange device comprising a plurality of units each comprising opposite headers, outer tubes connecting said headers and arranged in different banks with the tubes in the adjacent banks oppositely inclined, an internal tube arranged in each of said outer tubes, and return connections joining said internal tubes end to end, said units being arranged one, above another with the headers of one unit mounted upon the headers of another unit, the joints between the headers of adjacent units being higher at one side of the units than at the other side of the units.

4. A heat exchange unit comprising opposite headers, outer tubes connecting said headers, said tubes being arranged in different banks with the tubes in different banks oppositely inclined, an internal tube arranged in each of said outer tubes, and return connections joining said internal tubes end to end, the top and bottom ends of said headers being higher adjacent one bank of tubes than adjacent another bank of tubes, a

supporting base for said unit having top faces complementary to the bottom ends of said headers and on which said headers are secured, and crown pieces mounted on the upper ends of said headers and having bottoms complementary to and secured upon the upper ends of said headers, the upper ends of the crown pieces on the opposite headers being of similar form and height.

5. A heat exchange unit comprising opposite headers, outer tubes connecting said headers and arranged in different vertical rows with the tubes in different rows oppositely inclined, an internal tube arranged in each of said outer tubes, and return connections joining said internal tubes end to end, the top and bottom ends of said headers being of stepped formation.

6. A heat exchange unit comprising tubes arranged in different banks with the tubes in different banks oppositely inclined, return connections joining said tubes end to end, and supports for the opposite ends of said tubes, the top and bottom ends of said supports being of stepped formation crosswise of said tubes.

7. In a heat exchange device, the combination of a unit comprising tubes arranged in different banks with the tubes in different banks oppositely inclined, return connections joining said tubes end to end and supports for the opposite ends of said tubes, the top and bottom ends of said supports being of stepped formation crosswise of said tubes and a supporting base for said unit having stepped portions complementary to said bottoms of said end support and on which said end supports are mounted.

8. A heat exchange device comprising separable units arranged one above another, each unit comprising a group of tubes and end supports for the tubes, the tubes being arranged in different banks with the tubes in different banks oppositely inclined, and return connections joining said tubes end to end, the return connections between the tubes of each unit and between the adjacent tubes of adjacent units being of like dimensions and uniformly arranged.

9. A heat exchange device comprising separable units arranged one above another, each unit compressing a group of tubes and end supports for the tubes, the tubes being arranged in different banks with the tubes in different banks oppositely inclined, and return connections joining said tubes end to end, the tubes of each unit and the adjacent tubes of adjacent units being uniformly spaced apart.

10. A heat exchange device comprising separable units stacked one upon another, each unit comprising a group of tubes and end supports for the tubes, the tubes being arranged in different banks with the tubes in each bank parallel and the tubes in different banks oppositely inclined, and return connections joining the tubes end to end, the tubes of each unit and the adjacent tubes of adjacent units being uniformly spaced apart and the return connections between the tubes of each unit and between the tubes of adjacent units being of like dimensions and uniformly arranged.

11. A heat exchange device comprising separate units stacked one upon another, each unit comprising tubes arranged in different banks with the tubes in each bank parallel and the tubes in different banks oppositely inclined, end supports for the tubes, and return connections joining the tubes end to end, the end supports of adjacent units being mounted one upon the other and the portions of the joints between said end supports of the units being at different elevations adjacent different banks of tubes.

12. A heat exchange device comprising separate units stacked one upon another, each unit comprising tubes arranged in different banks with the tubes in each bank parallel and the tubes in different banks oppositely inclined, end supports for the tubes, and return connections joining the tubes end to end, the end supports of adjacent units being mounted one upon the other and the joints between said end supports of the units being of stepped formation.

13. A heat exchange device comprising separate units stacked one upon another, each unit comprising tubes arranged one above another, return connections joining said tubes end to end, said tubes and return connections forming a continuously inclined passage, and end supports for said tubes, the end supports of adjacent units being mounted one upon another, and the joints between the end supports of the units being of stepped formation.

14. A heat exchange device comprising separate units stacked one upon another, each unit comprising tubes arranged in different banks with the tubes in each blank parallel and the tubes in different banks oppositely inclined, end supports for the tubes, return connections joining the tubes end to end, the end supports of adjacent units being mounted one upon the other, and the portions of the joints between said end supports of the units being at different elevations adjacent different banks of tubes, and an enclosure for the tubes of the device comprising a cover member above the tubes, and side walls joining the sides of said end supports and the sides of said cover member.

15. A heat exchange device comprising separate units stacked one upon another, each unit comprising tubes arranged in different banks with the tubes in each bank parallel and the tubes in different banks oppositely inclined, end supports for the tubes, return connections joining the tubes end to end, the end supports of adjacent units being mounted

one upon the other, and the portions of the joints between said end supports of the units being at different elevations adjacent different banks of tubes, crown pieces surmounting the said end supports, and an enclosure for the tubes of the device comprising a cover member joining said crown pieces above the tubes, and side walls joining the sides of said end supports and the sides of said cover member.

16. In a heat exchange device, the combination of a plurality of separable units arranged one above another, each unit comprising a group of tubes, and front and rear headers supporting said tubes and joining the tubes end to end, the tubes of each group being arranged in different banks oppositely inclined, and the tubes of each unit and the adjacent tubes of adjacent units being uniformly spaced apart.

17. In a heat exchange device, the combination of a plurality of separable units arranged one above another, each unit comprising a group of tubes, and front and rear headers supporting said tubes and joining the tubes end to end, the tubes of each group being arranged in different banks with the tubes of each bank parallel and the tubes in different banks oppositely inclined, and the tubes of each unit and the adjacent tubes of adjacent units being uniformly spaced apart.

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