Oct. 13, 1942. R. H. McKIBBEN ET AL 2,298,895

METHOD OF MAKING HEAT EXCHANGE UNITS

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Fig. 1.

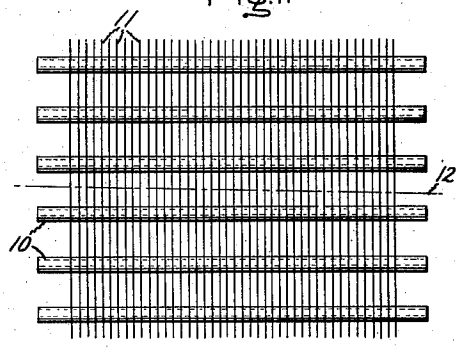


Fig. 2.

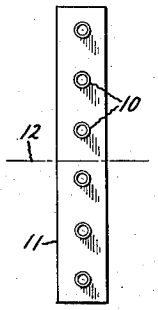
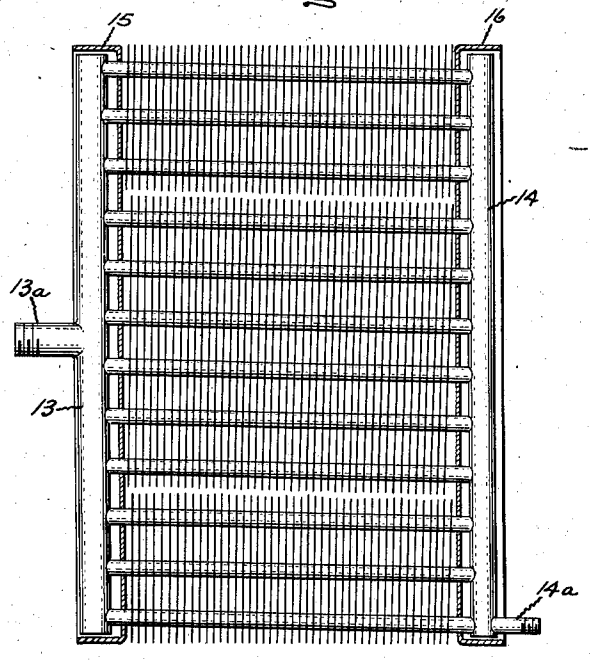


Fig. 3.



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Fig. 4.

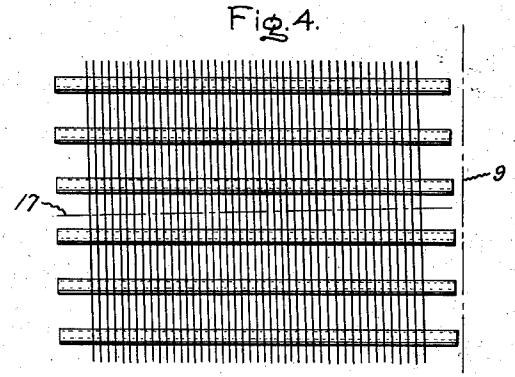


Fig. 5.

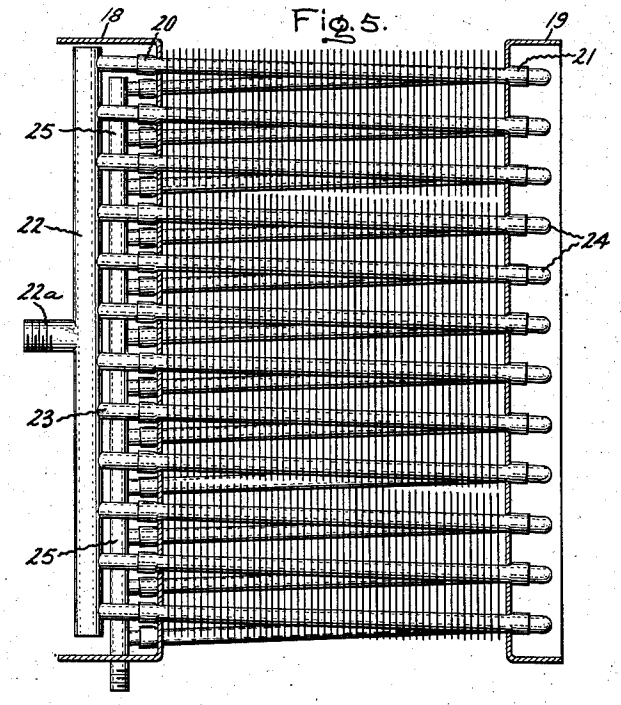


Fig. 7.

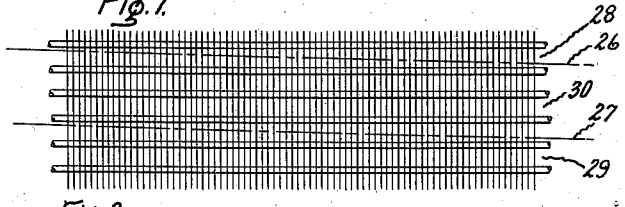


Fig. 6.

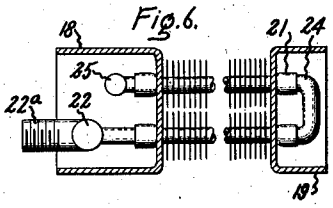
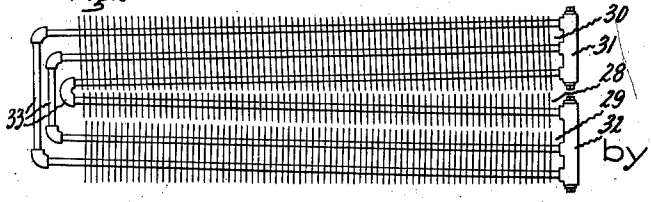


Fig. 8.



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING HEAT EXCHANGE UNITS

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Application February 28, 1942, Serial No. 432,814

9 Claims. (Cl. 29—157.3)

This invention relates to heat exchange units of the type having self-draining tubes, and particularly to a method of constructing such units.

Finned tube heat exchange units are frequently built by providing a plurality of parallel tubes and stacking a plurality of fins on the tubes, each fin extending across all the tubes and having suitable openings to receive the tubes. For manufacturing purposes it is desirable that all the fins be of identical construction so that they may be made with the same tools and so that when they are stacked on the tubes they extend at right angles to the axes of the tubes and form a rectangular unit. In steam heating systems, for example, it is desirable that the several tubes of the heat exchange unit or radiator be pitched at an angle from the horizontal so that water condensed in the tubes cannot collect therein, thus preventing a reduction of the effective heat transfer surface and also avoiding the possibility of damage due to freezing of trapped water during winter weather. The tubes of the usual rectangular bank of tubes may be given the desired pitch by slanting the unit. However, in many installations it is not practical to have an entire unit including the steam and exhaust headers arranged at an angle to the vertical. Furthermore, if the unit is arranged in the usual rectangular duct as employed in forced air circulating systems, it is desirable that the duct be arranged with its sides vertical, and consequently, if the unit is tilted at an angle, it becomes necessary to fill the triangular spaces thus formed in order to minimize the bypassing of air around the fins. Another method of constructing the heat exchange unit so that tubes have the required pitch is to vary progressively the positions of openings in the fins and to stack the fins on the unit at the desired angle so that the fins provide a rectangular outline and the tubes extend at an angle through the bank of fins. This construction, however, is objectionable since it involves the stacking of the fins at an angle other than a right angle and also requires differences in locations of the holes in the several fins. Accordingly, it is an object of this invention to provide an improved method for constructing a heat transfer unit of the self-draining type such that identical fins may be employed in the construction and so that the completed unit is rectangular in outline.

Further objects and advantages of this invention will become apparent as the following description proceeds, and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of this invention reference may be had to the accompanying drawings in which Fig. 1 is a front elevation view of a bank of finned tubes formed in an initial step of the invention; Fig. 2 is an end view of the bank of fins shown in Fig. 1; Fig. 3 is a front elevation view of a complete heat transfer unit constructed in accordance with the invention; Figs. 4 and 5 are views similar to Figs. 1 and 3 illustrating steps in a modification of the invention; Fig. 6 is a top plan view of the heat transfer unit shown in Fig. 5; and Figs. 7 and 8 are diagrammatic views of a further modification of the invention.

Briefly, the heat transfer unit disclosed in the drawings is constructed by first stacking a plurality of identical fins in spaced relation on a plurality of parallel tubes, the fins being arranged at right angles to the tubes. The fins of the bank of tubes thus formed are then cut longitudinally between two of the tubes and at an angle to the axes of the tubes equal to the desired pitch of the tubes in the completed self-draining unit. Two parallel upright end-plates are then provided and the tubes are connected between the plates with the cut edges of the fins at right angles to the axes of the plates so that the tubes are pitched at the desired angle from one plate toward the other. The cut edges of the two sections of the bank of tubes are arranged at the top and bottom respectively of the completed unit so that the outline of the completed unit presents a minimum rectangle. If it is desired to eliminate entirely the triangular spaces between the fins and the end-plates, the bank of tubes as originally constructed may be canted or deformed so that it has an outline in the form of a parallelogram the sides of which are pitched from the horizontal at an angle corresponding to the desired pitch of the tubes. The bank of tubes may then be dipped in solder or otherwise suitably retained in its new form and a cut made between two of the tubes at right angles to the fins. When the two portions thus formed are interchanged and built into a complete unit the outline of the finned structure will be rectangular with the tubes pitched at the desired angle.

Referring now to Figs. 1 and 2, a plurality of straight tubes 10 is arranged in parallel spaced relationship and a plurality of fins 11 having holes punched therein corresponding to the positions of the tubes is stacked on the tubes at

right angles thereto, the fins being spaced apart to provide air passages through the unit between the fins and normal to the tube axes. The fins may be secured to the tubes in any suitable manner such as by soldering or by expanding the tubes in the openings of the fins or by any other method commonly employed for this purpose. The completed unit is then divided into two banks or portions by cutting the fins between two of the tubes longitudinally of the axes of the tubes and at an angle equal to the desired pitch of the tubes in the completed self-draining unit. In the bank illustrated in the drawings the fins are cut along a line 12, the cuts of the individual fins being at right angles to the longitudinal edges of the fins as indicated on the end fin shown in Fig. 2. An inlet header 13 having an inlet connection 13a and an outlet header 14 having an outlet connection 14a are then provided as shown in Fig. 3 and also end-plates or boxes 15 and 16 which enclose the headers 13 and 14, respectively. The headers, as well as the end-plates, may serve as supports. The positions of two portions of the bank of tubes formed as shown in Fig. 1 are then interchanged, and the separated portions are connected between the headers 13 and 14 and the plates 15 and 16 with the cut edges of the banks at the top and bottom respectively of the headers, the cut edges of the fins along the line 12 being arranged at right angles to the axes of the headers so that the left-hand ends of the tubes which communicate with the header 13 are higher than the right-hand ends of the tubes which communicate with the header 14. The end-plates 15 and 16 are, of course, provided with suitable openings to allow the tubes to pass therethrough, and the entire assembly presents a rectangular appearance. The spaces between the end fins and the plates 15 and 16 are relatively small and do not decrease the effective heat transfer area, while the fins extend completely across the spaces at the top and bottom of the unit so that there is a minimum open face area. In Fig. 3 the two portions of the bank of Fig. 1 have been shown mounted at the top and bottom of a unit the middle portion of which comprises a single bank identical with the bank shown in Fig. 1, but which has not been cut; the middle bank being mounted with its tubes parallel to the tubes of the top and bottom banks or portions. The triangular spaces between the end fins of the middle bank and the plates 15 and 16 are relatively small, and furthermore, the ends of the tubes extend through these spaces so that the spaces do not, in fact, present a completely open portion of the face area.

It is thus clear that a self-draining unit of any desired size may be built up by providing two top and bottom bank portions in the manner described in connection with Figs. 1 and 2 by inserting therebetween any suitable number of intermediate banks of rectangular form like that of the complete unit of Fig. 1. When a smaller unit is desired it is, of course, unnecessary to provide the intermediate or middle bank of tubes.

Should it be desired to eliminate entirely the small triangular spaces between the end-plates 15 and 16 an additional step may be employed as illustrated in Figs. 4 and 5. In Fig. 4 the bank of tubes has been shown with the upper portion of the bank of tubes pressed or canted slightly to the left, as indicated by the position of the tube ends with respect to a vertical dotted line 9, so that a parallelogram is formed the angles of which differ from a right angle by the amount of pitch desired in the tubes of the finished heat transfer unit. The bank of tubes as shown in Fig. 4 is preferably dipped in solder or otherwise suitably retained as a rigid unit after it has been formed as shown in Fig. 4, and the fins between two of the tubes are then cut along a line such as indicated at 17, the cut being at right angles to the fins and, therefore, at the desired angle of pitch with respect to the tubes. After the two portions of the bank have been formed in this manner they may be placed in a complete heat transfer unit as indicated in Fig. 5. The heat transfer unit of Fig. 5 comprises front and rear sections as clearly shown in Fig. 6, both sections having their tubes slanted at the desired pitch. In Fig. 5, for purposes of clearness, no attempt has been made to illustrate the fins on the rear bank. The heat transfer bank comprises end-plates or boxes 18 and 19, and the heat transfer units formed as shown in Fig. 4 are placed at the top and bottom respectively with the fins parallel to the upright sides of the plates 18 and 19 and the cut edges at right angles to the plates. The left and right ends of the tubes are then belled as indicated at 20 and 21, respectively, and an inlet header 22 having an inlet connection 22a is connected to the several left-hand ends of the tubes by suitable connectors 23. The right-hand ends of the tubes of the front bank are connected by end-turns 24 to the rear bank as clearly shown in Fig. 6, the rear bank having its tubes pitched in the opposite direction from the front bank so that there is a continuous slope from the left-hand tube of the front bank to the left-hand tube of the rear bank. The left-hand ends of the rear bank are connected to an outlet header or manifold 25. The central section of the heat transfer surface shown in Fig. 5 is a complete bank constructed as shown in Fig. 4, this middle section being inserted between the two cut sections in the same manner as the middle section of the heat transfer unit shown in Fig. 3, it being obvious that this section is not necessary if a smaller unit is required or that further sections may be added if it is desired to form a larger unit.

Figs. 7 and 8 illustrate a further modification of the invention whereby a single bank of tubes is cut and rearranged to have one set of tubes pitched toward one end of the bank and another set pitched toward the other end of the bank, the tubes being connected by return bends so that each tube comprises a continuous hairpin conduit. In the illustrated construction, which is somewhat diagrammatic, the three central tubes are separated from the original rectangular bank by two cuts along lines 26 and 27 longitudinally of the tubes and at the desired angle of pitch. The two outer portions of the bank formed by the two cuts and indicated at 28 and 29 correspond to the two sections formed in Fig. 1 and may be interchanged and assembled in the same manner as the sections in Fig. 1 to provide a rectangular bank, as shown in the lower portion of Fig. 8. The separated central portion indicated at 30 may then be inverted and placed on top of this bank so that the tubes thereof are pitched in the opposite direction to that of the tubes in the bank comprising sections 28 and 29, the angle between the tubes in the lower bank and those in the upper being twice the angle of pitch. An inlet header 31 may be connected to the upper set of tubes 30 and an outlet header

32 to the lower set so that steam or other fluid may pass from the inlet header through one set of tubes and through return bends 33 and the other set of tubes to the outlet header. This provides a simple arrangement making it possible to locate both headers at the same end of a unit having a bank of finned tubes which may be included within a minimum rectangle.

From the foregoing it is apparent that this invention provides an improved and easily applied method for constructing a bank of finned tubes of the self-draining type and that this bank provides the desired rectangular outline required for installation particularly in forced air circulating ducts of rectangular cross-section and that a minimum rectangle is secured.

While this invention has been described in connection with a particular form of self-draining unit, other applications will readily be apparent to those skilled in the art. It is, therefore, not desired to limit this invention to the particular construction shown and described, and it is intended in the appended claims to cover all modifications within the spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a bank of finned tubes having the form of a parallelogram and comprising a plurality of parallel straight tubes and substantially parallel elongated fins mounted on said tubes transversely thereof, cutting said bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, and interchanging the relative positions of said portions and assembling said portions to provide the top and bottom sections of a finished bank of tubes having the desired pitch for drainage and which bank may be included within a minimum rectangle.

2. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a bank of finned tubes having the form of a parallelogram and comprising a plurality of parallel straight tubes and substantially parallel elongated fins mounted on said tubes transversely thereof, cutting said bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, interchanging the relative positions of said portions, and assembling said portions between two opposite parallel elongated supporting members with the cut sides of said portions at right angles to the longitudinal axes of said supporting members to provide the top and bottom sections of a finished bank whereby said tubes are pitched from one of said members to the other at the desired angle for drainage and whereby the finished bank of tubes may be included within a minimum rectangle.

3. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a rectangular bank of finned tubes comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right angles to the axes thereof, cutting said rectangular bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, and interchanging the relative positions of said portions and assembling said portions to provide a finished bank of tubes having the desired pitch for drainage and which bank may be included within a minimum rectangle.

4. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a rectangular bank of finned tubes comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right angles to the axes thereof, cutting said rectangular bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, interchanging the relative positions of said portions, and assembling said portions between two opposite parallel elongated supporting members with the cut sides of said portions at right angles to the longitudinal axes of said supporting members whereby said tubes are pitched from one of said members to the other at the desired angle for drainage and whereby the finished bank of tubes may be included within a minimum rectangle.

5. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a rectangular bank of finned tubes comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right angles to the axes thereof, deforming said bank so that it forms a parallelogram the angles of which differ from right angles by the desired angle of pitch of the tubes, retaining said bank in its deformed position and cutting said bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, and interchanging the relative positions of said portions and assembling said portions to provide a finished bank of tubes having the desired pitch for drainage and which bank may be included within a minimum rectangle.

6. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a rectangular bank of finned tubes comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right angles to the axes thereof, deforming said bank so that it forms a parallelogram the angles of which differ from right angles by the desired angle of pitch of the tubes, retaining said bank in its deformed position and cutting said bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, interchanging the relative positions of said portions, and assembling said portions between two opposite parallel elongated supporting members with said fins parallel to said members whereby said tubes are pitched from one of said members to the other at the desired angle for drainage and whereby the finished bank of tubes may be included within a minimum rectangle.

7. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a plurality of banks of finned tubes each comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right

angles to the axes thereof, cutting one of said banks of finned tubes between two of the tubes thereof longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said one bank, assembling said two portions and the remaining one or ones of said plurality of banks between two opposite parallel plates with said portions arranged adjacent the top and bottom respectively of said plates and with the cut sides of said portions at right angles to the axes of said plates and on the top and bottom sides respectively of said top and bottom portions, said assembling step including locating said remaining bank or banks between said portions and arranging all of the tubes of said banks at said desired angle of pitch from one of said plates to the other, whereby the finished bank of tubes may be included within a minimum rectangle.

8. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing a rectangular bank of finned tubes comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right angles to the axes thereof, cutting said rectangular bank of finned tubes between two of said tubes longitudinally at an angle equal to the desired pitch of the tubes of the completed unit to form two separate portions of said bank, interchanging the relative positions of said portions and assembling said portions between two parallel tube sheets with the cut sides of said portions at the top and bottom of said tube sheets and at right angles to the planes of said tube sheets, arranging headers at the ends of said tubes outside said tube sheets and connecting said tubes in communication with said headers, whereby the tubes are pitched from one of said headers to the other at the desired angle for drainage, and whereby the cut edges of said fins are substantially flush with the tops and bottoms respectively of said tube sheets.

9. The method of constructing a heat transfer unit including a bank of finned tubes of the self-draining type which comprises providing an elongated bank of finned tubes comprising a plurality of parallel straight tubes and parallel elongated fins mounted on said tubes at right angles to the axes thereof, removing a group of tubes from said bank by cutting said fins longitudinally of said tubes at an angle equal to the desired pitch of the tubes of the completed unit and along lines on either side of said group of tubes whereby said bank is divided into three portions, interchanging the relative positions of said portions and assembling said portions with the cut sides of two of said portions along the outer sides of the completed unit and parallel to one another and with the other portion arranged between said two portions, whereby the tubes in said group of tubes are pitched at the desired angle in one direction and the tubes in the other portions of said bank are pitched at the desired angle in the other direction, and connecting the ends of said tubes by return bends to provide continuous hairpin conduits pitched downwardly throughout their length, the completed bank being thereby assembled so that it may be included within a minimum rectangle.

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