United States Patent [19]

Sagan

[11] **3,854,529**

[45] **Dec. 17, 1974**

[54] **TUBE SUPPORT SYSTEM FOR A HEAT EXCHANGER**

[75] Inventor: **Stanley S. Sagan,** Springfield, Pa.

[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

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[21] Appl. No.: **397,492**

Related U.S. Application Data

[63] Continuation of Ser. No. 166,109, July 26, 1971, abandoned.

[52] **U.S. Cl.** **165/162,** 122/510, 165/67

[51] **Int. Cl.** **F28b 9/00**

[58] **Field of Search** 165/76, 162, 102, 67; 122/32, 510

[56] **References Cited**

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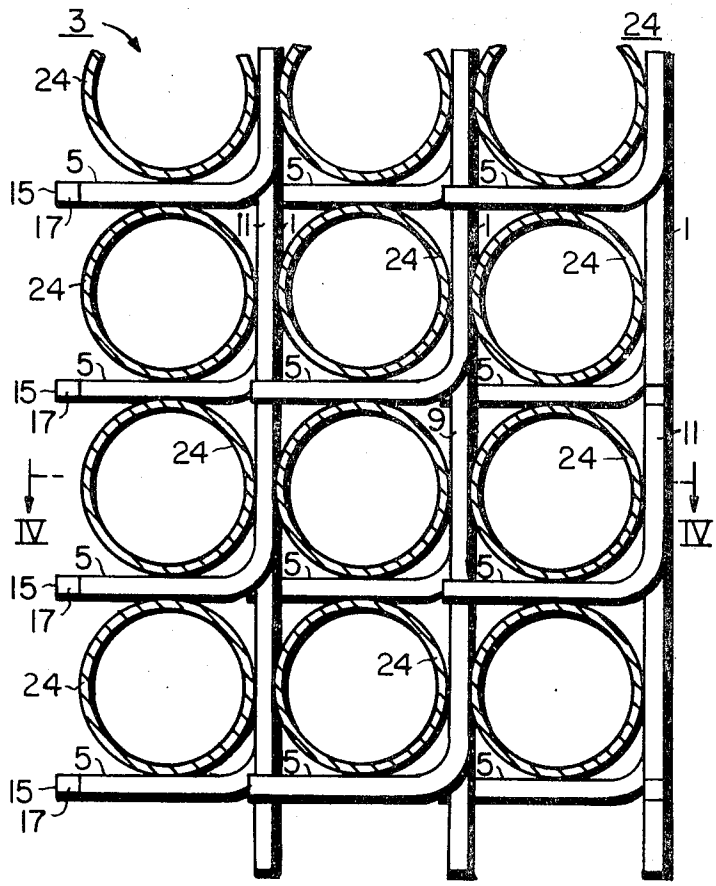
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Primary Examiner—Charles J. Myhre
Assistant Examiner—Theophil W. Streule, Jr.
Attorney, Agent, or Firm—F. J. Baehr, Jr.

[57] **ABSTRACT**

A plurality of bars having a plurality of arms extending at right angles thereto and disposed to register with notches in adjacent bars to provide a tube support system, which can be easily and economically applied to serpentine and other configurations of tubes to support the tubes in a heat exchanger.

4 Claims, 15 Drawing Figures



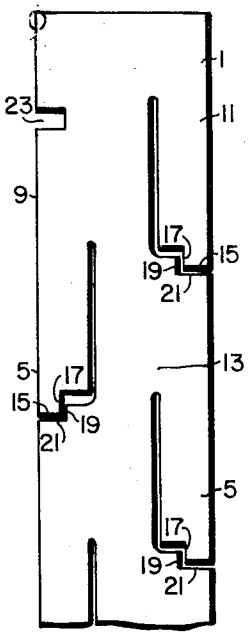


FIG. 1

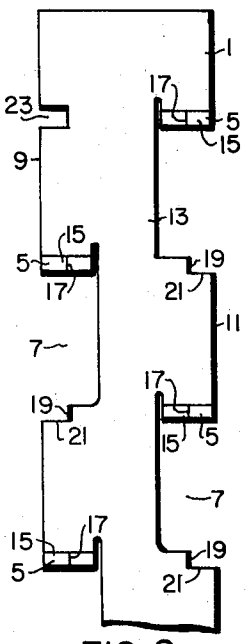


FIG. 2

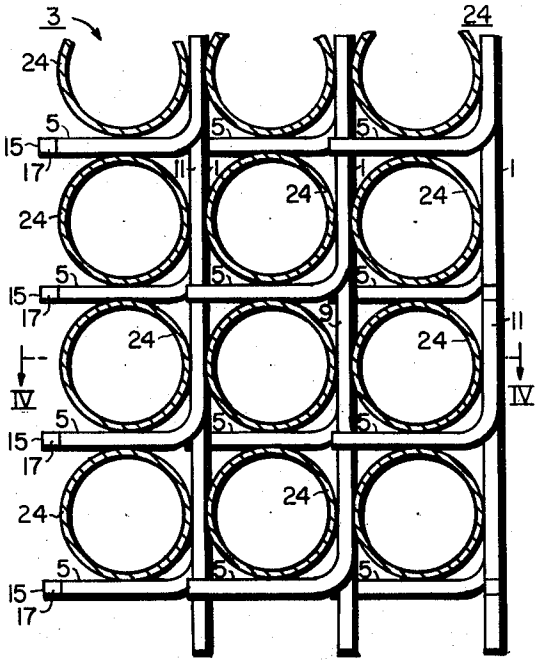


FIG. 3

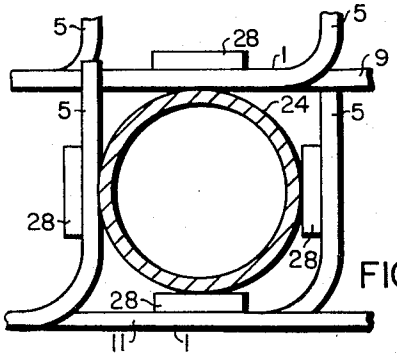


FIG. 8

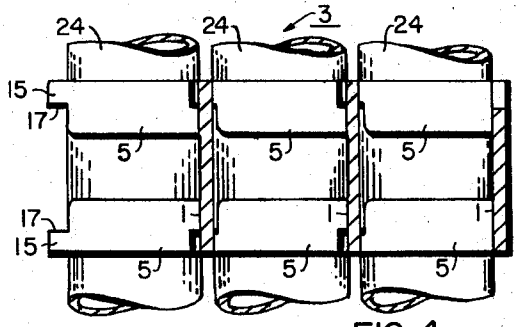


FIG. 4

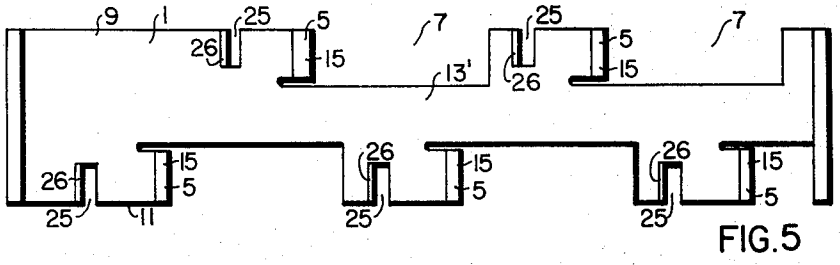


FIG. 5

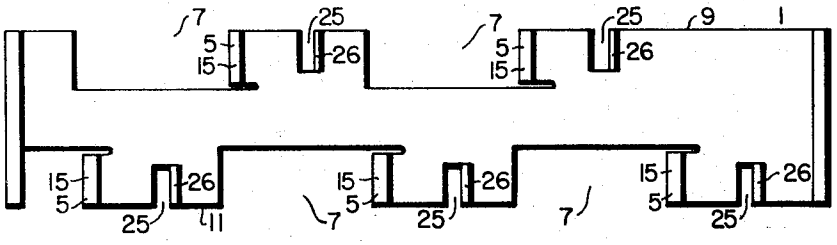


FIG. 6

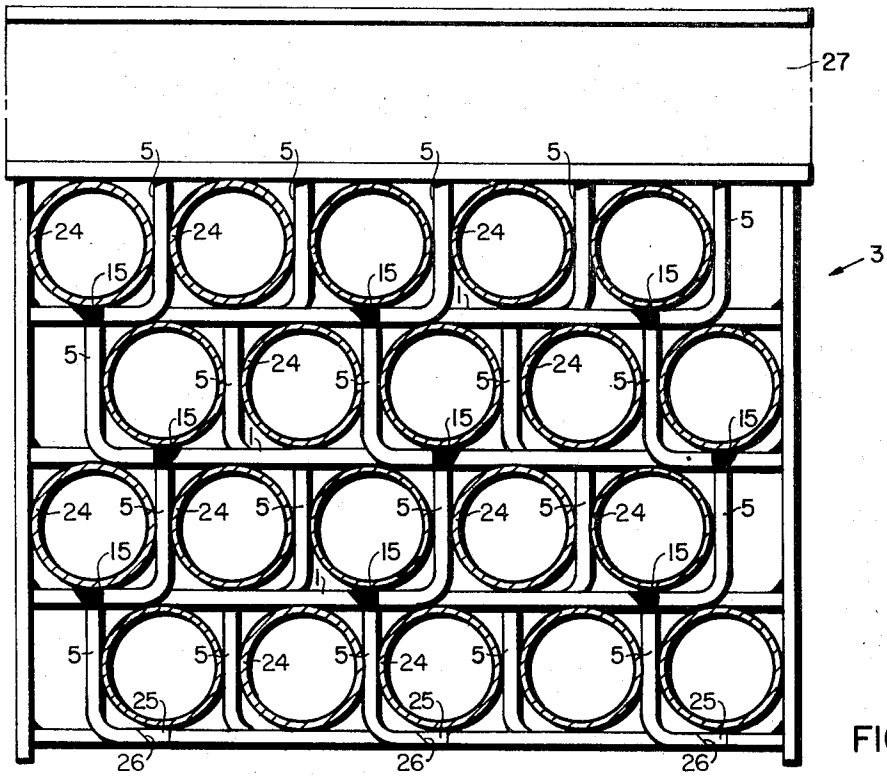


FIG.7

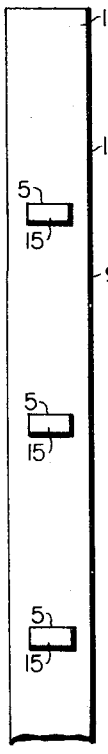


FIG.12

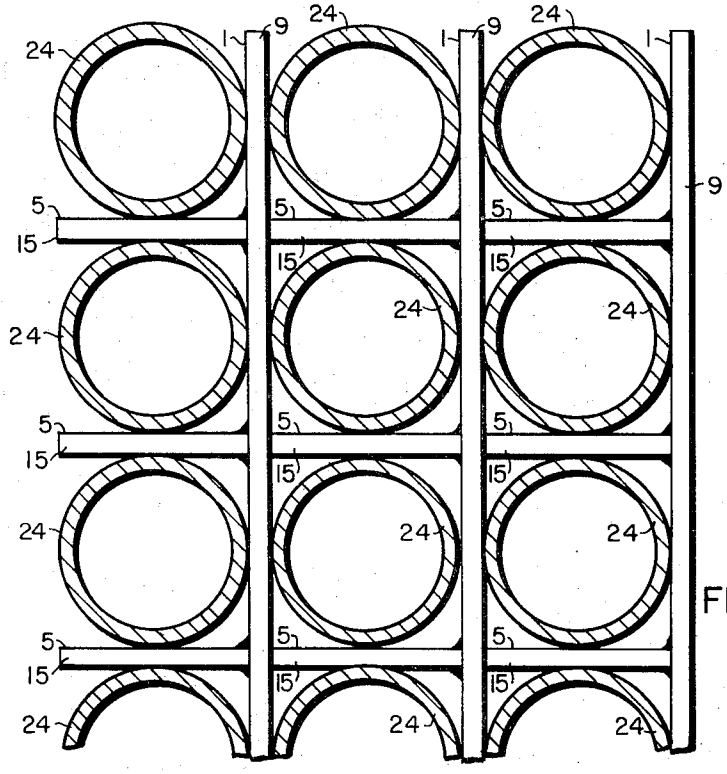


FIG.13

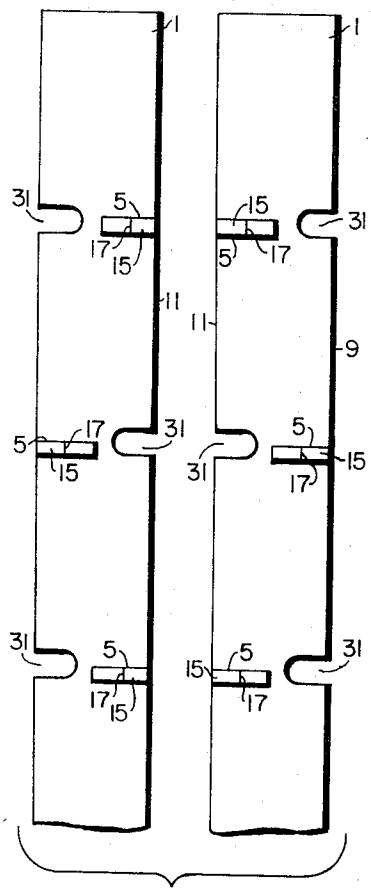


FIG. 9

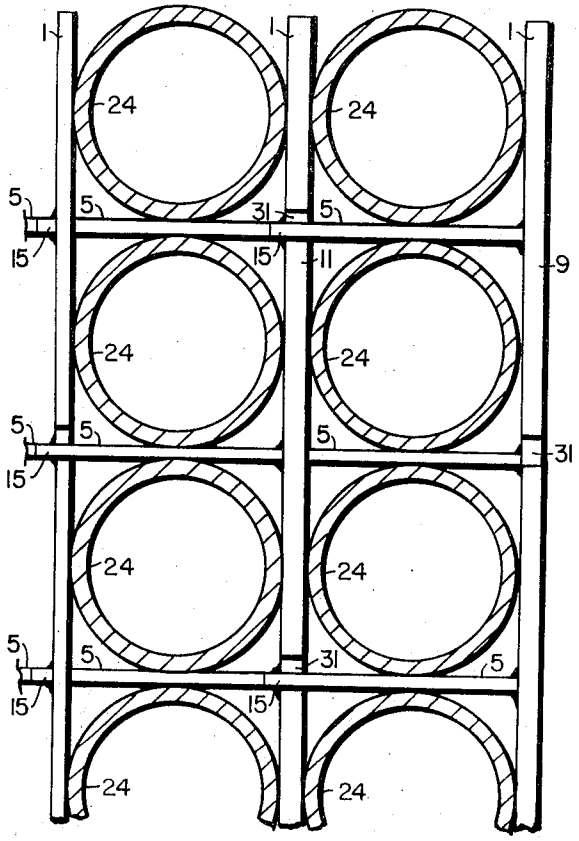


FIG. 11

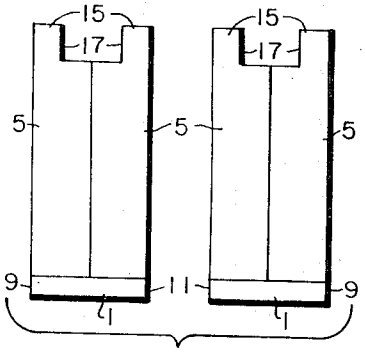


FIG. 10

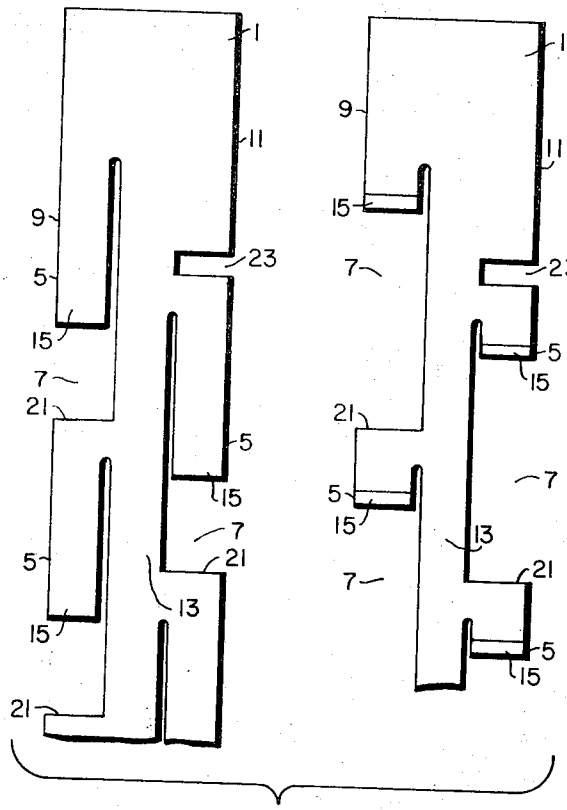


FIG. 14

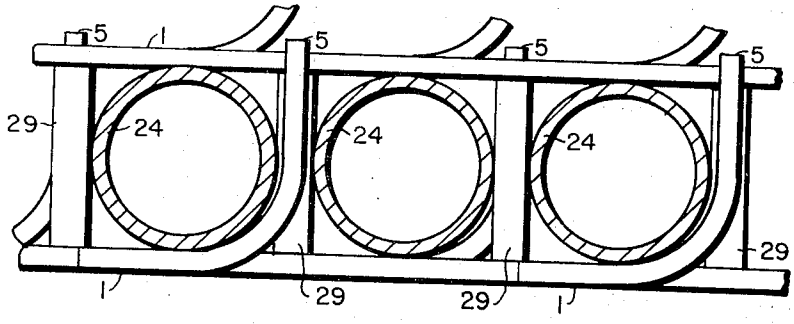


FIG. 15

TUBE SUPPORT SYSTEM FOR A HEAT EXCHANGER

This is a continuation, of application Ser. No. 166,109 filed July 26, 1971 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to heat exchangers and more particularly to tube support systems for heat exchangers.

With the increased use of heat transfer equipment and improvements in technology, tubular components of the present day heat exchangers incorporate numerous complex configurations such as, helically wound tubes, serpentine tubes and other arrangements.

Because of high performance requirements such modern heat exchangers are characterized by an unusually close packing of the tubes. Requirements for improved performance of modern heat exchanger systems, also dictate the use of tubes, which are provided with large welded fins. Tubes of such manufacture are unusually heavy and extremely awkward to handle when fabricating heat exchangers. Under such conditions the mounting of the tubes in conventional support plates having a plurality of holes is either impossible or becomes extremely difficult and prohibitively costly. Thus, a novel type of support structure, which is economical to produce and install in the heat exchanger; which will provide adequate support for the various complex configurations of tubes, when the heat exchanger is being manufactured and shipped, and which will also provide adequate support for the tubes and allow for thermal expansion, when the heat exchanger is in operation, is essential to present day heat transfer equipment.

SUMMARY OF THE INVENTION

In general, a tube support system made in accordance with this invention is utilized in a heat exchanger having a plurality of tubes. The tube support system comprises a plurality of flat bars. Each bar has a plurality of openings and arms disposed along each longitudinal margin thereof. The opening and arms on opposite margins are staggered and the arms extend from the bars in one direction and are generally normal thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of this invention will become more apparent from reading the following detailed description in connection with the accompanying drawings, in which corresponding reference numerals indicate corresponding portions in the various drawing, and in which:

FIG. **1** is a plan view of a support bar showing the arrangement of the cuts in the bar before arms are formed therein;

FIG. **2** is a plan view similar to FIG. **1** showing the formed arms;

FIG. **3** is an elevational view of an assembly of the support bars shown in FIGS. **1** and **2**;

FIG. **4** is a sectional view taken in line IV—IV of FIG. **3**;

FIG. **5** is a plan view of a modified support bar;

FIG. **6** is a plan view showing a mirror image of the support bar shown in FIG. **5**;

FIG. **7** is an elevational view showing an assembly of the support bar shown in FIGS. **5** and **6**;

FIG. **8** is an enlarged partial elevational view of a support system showing a modification thereto;

FIG. **9** is a plan view showing a pair of modified support bars;

FIG. **10** is a sectional view taken along line X—X of FIG. **9**;

FIG. **11** is an elevational view showing an assembly of the support bars shown in FIGS. **9** and **10**;

FIG. **12** is a plan view showing a modified support bar;

FIG. **13** is an elevational view showing an assembly of the support bars shown in FIG. **12**;

FIG. **14** is plan view showing a modified support bar; and

FIG. **15** is a partial elevational view of the support system showing another modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, FIG. **3** shows a plurality of support bars **1** forming a tube support structure or system **3**, each bar having a plurality of cut and bent portions, which form arms **5** and openings **7** disposed along each longitudinal margin **9** and **11** thereof. The cuts are generally L shaped; the bases of the L generally extend to the margins **9** and **11**, and the legs of the L are generally parallel to the margins **9** and **11**. The strips formed by the L-shaped cuts are bent to form the arms **5** and openings **7**. The arms **5** and openings **7** are disposed along opposite margins **9** and **11** and are staggered with respect to each other. The arms **5** are bent so as to be perpendicular or normal to the support bar **1**. Between the openings **7** and the arms **5** is a generally flat center portion **13** extending lengthwise of the support bars **1** forming a column. Tip or free ends **15** of the arms **5** are cut to form steps **17** and **19** in the tips **15** of the arms **5** and bottom of lower edges **21** of the openings **7**, respectively. The arms **5** and opening **7** along each margin **9** and **11** are spaced on equal pitches with the pitch of the arms and openings on one margin disposed one half pitch out of phase with the pitch of the arms and openings on the other margin.

To form the support structure **3** shown in FIG. **3**, one support bar is made to form the mirror image of the adjacent bar, that is, the arms **5** of one bar are bent to extend in one direction and the arms of the adjacent bar are bent in the opposite direction so that the tips **15** of the arms **5** of one bar register with the lower edge **21** of the opening **7** of the adjacent bar. Staggering the arms along each longitudinal margin and having the arms register with the lower edges **21** of the openings **7**, of the adjacent bar essentially eliminates all eccentric loading on the center column portion **13** of the support bars, when the center portions act as columns and are loaded in compression. It also eliminates bending moments in the center portion **13**, when the center portions are so disposed as to be in tension. Having the arms supported at each end also allows the use of thiner material, making the support bars more economical to produce.

As described hereinbefore, the tips **15** of the arms **5** and the bottom edges **21** of the openings **7** have steps **17** and **19** respectively formed thereon so that as the arms **5** register with the opening **7** in the adjacent bars

the steps 17 and 19 engage to space the support bars an equal distance apart.

A notch 23 is disposed in the upper end of each support bar 1 and extends to one margin 9 thereof for receiving the uppermost arm of an adjacent support bar. As shown in FIG. 3 the arms are so arranged that tubes 24 resting on the arms 5 are aligned in a plurality of planes normal to the bars or in planes parallel to the bars.

As shown in FIG. 4, the arms 5 of one support bar 1 interlock with an adjacent support bar to prevent movement in all directions except one, thus affording rapid and simple installation of the support bars after each row of tubes is installed.

FIGS. 5 and 6 show a modification of the support bar 1 shown in FIGS. 1 through 4. The support bars in FIGS. 5 and 6 each have notches 25 disposed between the arms 5 and extending to the longitudinal margins 9 and 11 for receiving the arms 5 of an adjacent support bar. One edge 26 of the notch 25 is beveled to facilitate welding of tips 15 of the arms 5 of the adjacent support bars. The support bars shown in FIG. 5 are mirror images of the support bars shown in FIG. 6 and the support bars shown in FIGS. 5 and 6 are alternately disposed in the support structure 3 shown in FIG. 7. The arms 5 and notches 25 are so disposed that the tubes 24 resting on the arms are arranged in adjacent rows and are staggered or are aligned in a plurality of planes forming an oblique angle with the tubes in any one row or with respect to the support bars.

In FIG. 7, the support bars are disposed parallel to an I-beam support 27, the tips 15 of the arms 5 of one support bar are welded to the I-beam 27, however, the support bars could be so disposed that they are perpendicular to the I-beam, the arrangement utilized being dictated by the sequence in which the tubes are installed in the heat exchanger.

FIG. 8 shows a tube 24 disposed between the arms 5 of a support bar 1 and between a pair of adjacent support bars. A pad 28 is placed on each arm 5 and on the support bars 1 between each arm to reduce the clearance between the tube 24 and the support bars 1 and the arms 5 so that the tube 24 and support bars form a continuous column for rigidity supporting the tubes during fabrication and shipping. The pads 28 may be made of a material, which can be consumed after the heat exchanger is put in service, i.e., hard wood blocks can be utilized and burned away so that in operation there is sufficient clearance to allow the tubes 24 to expand and contract with changes in temperature.

As shown in FIG. 15, thicker pads 29 may be interposed between the tubes 24 during fabrication to align and support the tubes so that the tubes do not rest on the arms 5 thus allowing the support bars to be easily slipped into place.

FIGS. 9 and 10 show a modification, wherein the arms 5 are formed from separate strips of material and are welded to the support bars 1. Notches or openings 31 are alternately arranged with the arms 1 and are disposed adjacent the arms 5 on opposite margins 9 and 11 of the support bars. Mirror images are again utilized so that the arms 5 of one bar will register with notches 31 of an adjacent bar. The tips 15 of the arms 5 have a step 17 disposed therein so that the arms interlock with openings 31 in adjacent support bars.

FIG. 11 shows a support structure 3 formed from the bars shown in FIGS. 9 and 10 disposed generally parallel to each other.

FIG. 12 shows another modification, wherein the arms 5 are spaced inwardly, an equal distance from the longitudinal margins 9 and 11 of the support bar. The arms are formed from separate strips of material welded to the support bar 1. The arms are spaced on an equal pitch to provide equal sized openings when the support bars are disposed adjacent one another to form the support structure 3 as shown in FIG. 13.

As shown in FIG. 14 the L-shape cuts provide an opening 7 prior to the forming of the arm 5, the opening 7 is enlarged when the arm is formed to provide staggered vertical rows, similar to those shown in FIG. 7, when these bars and their mirror images are assembled to form a support structure.

The support bars 1 having arms 5 made integral with the bar are made to close tolerances and are economical to produce in large quantities. Whereas, the support bars 1 formed by welding separate arms 5 to the bars are economical to produce, when a small quantity of the support bars are required. When formed from cold rolled bar, the surfaces of the support bar 5, which come in contact with tubes, are smooth, thus reducing the friction between the tubes and the support bars and allowing the tubes to slide freely across the surfaces to facilitate minor adjustments in the alignment of the tube ends during fabrication and when making repairs. When the support systems, hereinbefore described, are utilized to support finned tubes the arms are sufficiently broad to engage a plurality of the fins and thus, prevent damaging the fins during installation and when the unit is in operation. Such a support system also advantageously provides for:

1. complete preparatory manufacture of individual serpentine tubes (flat or helicoidal) in advance and independently of the final assembly of serpentine tube bundles;
2. installation of the serpentine tubes in simple consecutive steps to form the complete serpentine tube bundle assemblies;
3. adequate support for various tube configurations during fabrication and shipment; and
4. thermal expansion of the tubes when the heat exchanger is in operation.

What is claimed is:

1. A tube support system for a heat exchanger having a plurality of tubes, said tube support system comprising a plurality of bars, each bar having a plurality of openings and arms disposed along each longitudinal margin thereof, the openings and arms on opposite margins being staggered, the arms of each bar being integral therewith, being longer than the tube's diameter, extending from said bar in one direction, and being generally normal thereto, the arms disposed along one margin being out of phase one half a pitch with the arms disposed along the opposite margin, and adjacent bars being mirror images, so that tips of the arms fixed to one bar register with openings in an adjacent bar, whereby the bars interlock to form a rigid support system.

2. A tube support system as set forth in claim 1, wherein the tips of the arms have a step formed therein and the steps register with openings in an adjacent bar.

3. A tube support system for a heat exchanger having a plurality of tubes, said tube support system comprising a plurality of flat bars each bar having a plurality of cut and bent portions disposed along each longitudinal margin thereof, the cut and bent portions on opposite margins being staggered, the cut and bent portions being bent generally normal to said bar and extending a distance greater than the diameter of the tubes, and each bar having a generally flat center portion extending lengthwise thereof and being disposed between said cut and bent portions, the pitch of the cut and bent portions disposed on one margin being one half a pitch out of phase with the pitch of the cut and bent portions disposed on the other margin, the cut and bent portions of one bar being bent in one direction and the cut and bent portion of an adjacent bar being bent in the opposite direction, and the tip of the cut and bent portions of one bar register with edges of openings formed by the cut and bent portions of an adjacent bar whereby the bars interlock to form a rigid support system.

4. A tube support system as set forth in claim 3, wherein the cuts extend inward from the longitudinal margins forming a step as they progress inwardly and then extend lengthwise of the bars generally parallel to the longitudinal margins thereof to provide a step in the tips of the cut and bent portions which register with steps in the openings formed by the cut and bent portions to provide equal spacing between adjacent bars and interlocking of the bars.

* * * * *