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HEAT EXCHANGER ASSEMBLY AND METHOD OF FORMING SAME

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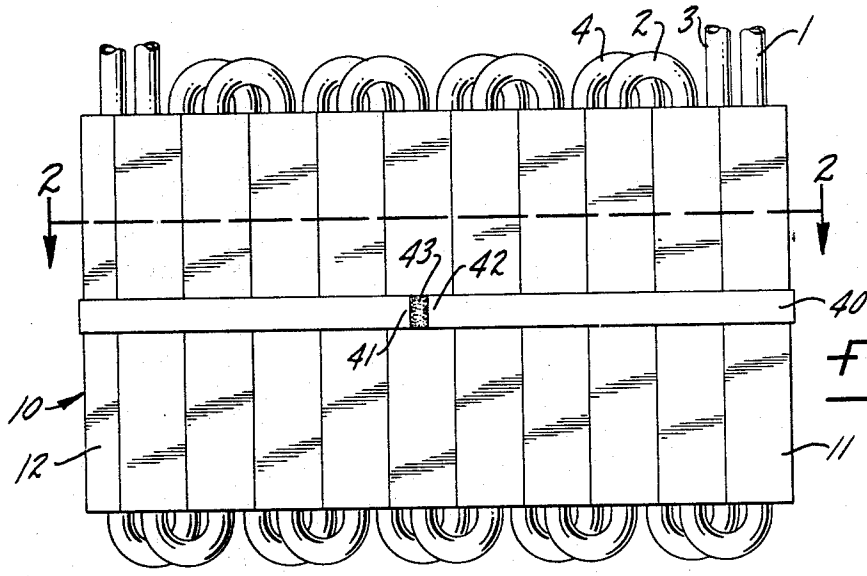


Fig. 1.

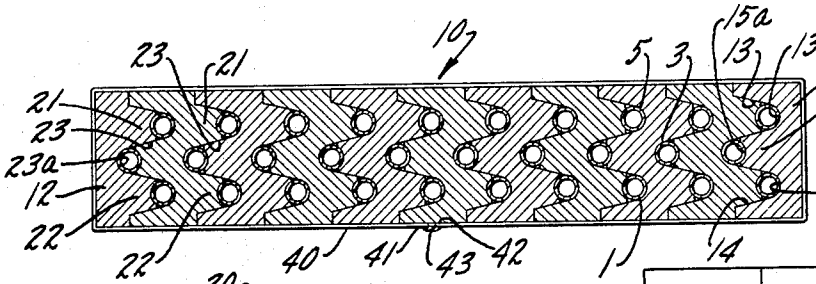


Fig. 2.

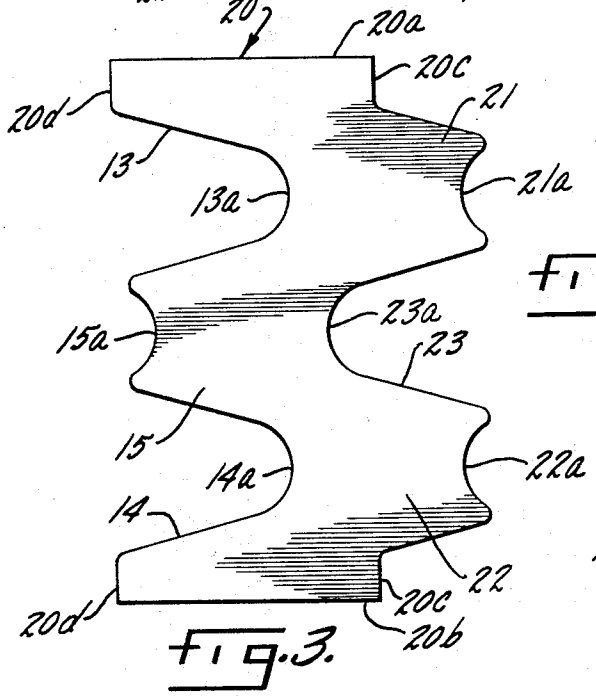


Fig. 3.

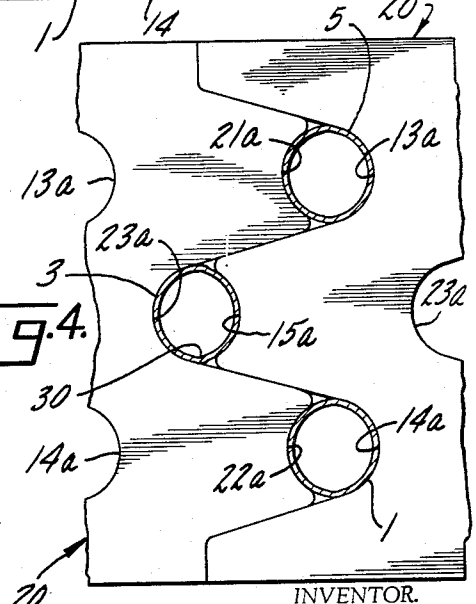


Fig. 4.

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HEAT EXCHANGER ASSEMBLY AND METHOD OF FORMING SAME

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This invention relates to heat exchangers and has particular relation to the construction of a heat exchanger assembly.

Conventionally, in forming a heat exchanger, a plurality of pipes or conduits are prepositioned and a block of metal, such as aluminum, is cast about and within the spaces between such conduits. Such assemblies have proved susceptible to difficulties in manufacture and use. One example of such difficulties lies in the necessity for prepositioning the tubes or pipes and holding the same in the desired position during the pouring or casting operation. Another difficulty results from the pouring of extremely hot metal into contact with such tubes, leading to efforts to preheat the tubes prior to the casting operation. A further difficulty results from the creation of internal voids within a cast block about the heat exchanger tubes, such voids creating the possibility that refrigerant and the material to be cooled, for example, may become intermixed if openings should occur in such tubes and be communicated through such voids. Another difficulty lies in the fact that the pouring or casting operation may cause individual tube segments to move slightly from the desired position, thus leading to variants in the amount of heat transfer occurring across the entire structure. Additionally, the bursting of an exposed tube portion in prior assemblies which employ a cast housing block results in the necessity for discarding the entire assembly. Accordingly, it is a purpose of the invention to provide a heat exchanger assembly effective to overcome the foregoing difficulties.

Similarly, heat exchangers have been formed by soldering, brazing or otherwise attaching a plurality of tubes in contiguous relationship, but skilled workmanship is required. Temperature transfer may also be accomplished by immersion of coils in a bath and by wrapping coils externally about a tank. It is a purpose of the invention to provide a simplified, easily constructed, economical temperature transfer assembly and method which shall be effective to fully accomplish the temperature transfer function of such prior devices.

Another purpose is to provide a heat exchanger assembly of minimum cost in construction and operation.

Another purpose is to provide a heat exchanger assembly including means for insuring identical spacing between heat exchanger tubes across the entire assembly.

Another purpose is to provide a heat exchanger assembly having maximum contact and heat transfer capacities.

Another purpose is to provide a heat exchanger assembly which may be readily disassembled for repair or replacement of elements therein.

Another purpose is to provide a heat exchanger assembly including means preventing intermixing of fluid or materials flowing therethrough.

Another purpose is to provide a heat exchanger assembly including elements effective to insure correct, uniform spacing during the construction of said assembly.

Another purpose is to provide a heat exchanger assembly including a plurality of interfitting block elements formed of extruded aluminum.

Another purpose is to provide a method of forming a heat exchanger assembly at minimum cost and maximum effectiveness.

Another purpose is to provide a method of forming a heat exchanger assembly wherein block elements are inserted among a plurality of tubes and said tubes are thereafter compressed.

Another purpose is to provide a method of forming a heat exchanger assembly which includes the steps of positioning a plurality of block elements in loosely interfitting relationship with each other and with a plurality of heat exchanger tubes and thereafter pressing said block elements into interfitting contacting relationship.

Another purpose is to provide a method of forming a heat exchanger assembly which includes the steps of positioning a plurality of block elements in loosely interfitting relationship with each other and with a plurality of heat exchanger tubes and thereafter pressing said block elements into interfitting contacting relationship and compressing a portion of said tubes between adjacent block elements to insure effective temperature-transferring contact therebetween.

Other purposes will appear from time to time during the course of the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings, wherein:

FIGURE 1 is a side elevation;

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a detail view illustrating a portion of the invention; and

FIGURE 4 is a partial top plan view illustrating a detail of the invention.

Like parts are indicated by like numerals throughout the specification and drawings.

Referring now to the drawings, and particularly to FIGURE 1 thereof, it will be observed that a first conduit or tube **1** is bent upon itself to form a plurality of reverse hairpin turns, such as those indicated at **2**. While nine such turns are shown, it will be realized that the number thereof may vary without departing from the nature and scope of the invention. A second tube **3** is shown in FIGURE 1. A corresponding number of turns **4** are formed in the tube **3** and the tube **3** is offset in one plane from the tube **1** while lying in a plane parallel to that occupied by the tube **1**. While it does not appear in FIGURE 1, because it is masked by tube **1**, a third tube **5** is shown in the cross-sectional view of FIGURE 2, it being understood that the tube **5** has an equal number of turns, such as those shown at **2** and **4**, and that the tube **5** lies in a plane paralleling those of tubes **1** and **3** and in a plane aligned with that occupied by tube **1**. While there is thus shown a set of three tubes, namely tubes **1**, **3** and **5**, it will be understood that the number thereof may vary beyond two without departing from the nature and scope of the invention. It is convenient, for example, to consider the tube **3** as carrying refrigerant, the tube **1** as carrying soda and the tube **5** as carrying water. Such arrangement is particularly useful, for example, in the soda fountain field.

A securing and temperature-transfer block is indicated generally by the numeral **10**. The block **10** is comprised of a pair of end block members **11**, **12**. The end block members **11**, **12** have substantially planar or smooth outer surfaces. The inner surface of the block **11** has a conformation including a pair of spaced generally V-shaped valleys or wells **13**, **14**. The wells **13**, **14** have curved bottom sections **13***a*, **14***a*, respectively. Between the wells **13**, **14** the block **11** has a central frusto-conical ridge portion **15**. The end surface of ridge **15** is concave as indicated at **15***a* and terminates at a point short of a line drawn between the upper ends of the outer walls of valleys **13**, **14**.

Between the end block elements **11**, **12** the member **10** includes a plurality of identically formed spacing and

heat-transfer blocks **20**, one of which is illustrated in FIGURE 3. Each of the blocks **20** has one of its surfaces formed in the manner described above with respect to end block **11**, i.e. such surface includes the valleys **13**, **14** and the central ridge **15** with the curved surfaces **13***a*, **14***a*, **15***a*. The opposite surface of each of the blocks **20**, however, is formed to include a pair of spaced frustoconical ridges **21**, **22** with a V-shaped valley **23** formed therebetween. The valley **23** has a curved bottom surface **23***a* which extends to a point inwardly beyond the base of the ridges **21**, **22**. Each of the ridges **21**, **22** is inwardly spaced from the adjacent side wall surface **20***a* and **20***b*, respectively, of the block **20**. The outer end surface of the ridges **21**, **22** is concaved as indicated at **21***a*, **22***a*. It will be observed that the surfaces **13***a*, **21***a* are coaxial and that the same is true of the surfaces **14***a* and **22***a* and of the surfaces **15***a* and **23***a*. Similarly, the inclined side walls of ridges **21** and **22** are inclined at identical angles with the side walls of valleys **13**, **14** and that the side walls of ridge **15** are inclined at angles identical with those of the valley **23**. Hence the ridges **21**, **22** of a given block **20** are formed and adapted for smooth, continuous mating temperature-transfer contact with the valleys **13**, **14** of an adjacent block and the ridge **15** is formed and adapted for smooth, continuous mating temperature-transfer contact with the walls of valley **23** of an adjacent block. It will be noted that the corners adjacent the concave surfaces **15***a*, **21***a* and **22***a* are rounded and that opposite parallel surfaces **20***c*, **20***d* are dimensioned and positioned for mating contact with corresponding surfaces of adjacent blocks. Hence the ridges **21**, **22** of a particular block **20** may be mated with the valleys **13**, **14** of block **11**; a series of blocks **20**, the number varying as may be desired without departing from the nature and scope of the invention, may then be sequentially mated with the ridges **21**, **22** of each subsequent block mating with the valleys **13**, **14** of an adjacent block and ridges **21**, **22** of block **12** may be mated with the valleys **13**, **14** of the last such block **20**. It will be noted that the block **12** has a smooth outer surface and an inner surface bearing the ridges **21**, **22** with valley **23** therebetween.

It will be noted, for example as indicated at **30**, that the portions of the tubes **1**, **3**, **5**, which are between opposed surfaces of adjacent block elements **20**, have been deformed therebetween from a normally circular cross-sectional configuration into a slightly oval cross-sectional configuration providing maximum temperature-transfer contact between adjacent blocks and the tube portions therebetween. A slight flowing of the material of the tubes **1**, **3**, **5** is permitted to occur into the limited space created by the curved edges of the ridge concaves **21***a*, **22***a*, **15***a*. Similarly, the contact surfaces between adjacent blocks **20** are substantial and close fitting to provide for maximum heat-transfer from refrigerant tube **3** through the aluminum of blocks **11**, **12** and **20** to the tubes **1**, **5**.

It will be understood, of course, that the contact and heat-transfer association of the end blocks **11**, **12** with adjacent blocks **20** corresponds to the association of individual adjacent blocks **20**.

Surrounding the outer smooth surfaces of the blocks **11**, **20**, **12** is a strap or securing member **40**. The strap **40** is of continuous extension and formed of suitable metal subject, for example, to welding. The opposite ends **41**, **42** of the strap **40** are brought into opposed relationship after the strap **40** has been wrapped or bent about the plurality of the blocks **11**, **20**, **12** and the edge portions **41**, **42** are secured together, preferably by welding, as indicated at **43**. The welding of the edge portions **41**, **42** causes a shrinkage in the material of strap **40** and a consequent tightening thereof about and against the blocks **11**, **20**, **12**.

The method of forming the heat exchanger of the invention comprises the steps of positioning a plurality of heat exchanger coils, such as those formed by the tubes **1**, **3**, **5**, in substantially the spaced position desired, thereafter inserting between adjacent individual coils thereof a sufficient number of blocks **20** to provide for contact with aligned central portions of each of said coils. End blocks **11**, **12** are then positioned in contact with the end portions of the tubular coils and the strap **40** is placed about the plurality of blocks **20** and end blocks **11**, **12**. The strap **40** is then drawn together to compress the blocks **11**, **20**, **12** into full contact position with each other and to compress the portions of the tube coils trapped between opposed surfaces of said blocks, to deform said tube portions and to provide maximum heat-transfer contact between said tube portions and the blocks in contact therewith and between the individual blocks, the blocks being identical and automatically providing uniform spacing between all tube portions within the assembly block thus formed.

The individual blocks **11**, **20**, **12** are formed of extruded aluminum. Hence a sufficient number of block elements **11**, **20**, **12** may be formed and provided to equal an assembly block **10** of a particular size at a cost approximating one-third that of a cast block of said size.

If one of the tubes **1**, **3**, **5** should become damaged or burst, it is only necessary to disengage the strap **40**, slide a sufficient number of the blocks **20** out of engagement with adjacent blocks and with adjacent coil portions, repair or replace the tube and replace the blocks. If desired, all of the blocks may be separated and an entire new coil positioned to replace the defective coil, the blocks thereafter being repositioned between the coils and joined together by strap **40** as above described, the same being accomplished with a minimum of simple tools and manual effort. Since the block elements **11**, **20**, **12** are extruded, the problem of voids in the material of block **10** is eliminated. The contact surfaces of individual block elements is of substantial extension and sufficient tightness as to provide full temperature-transfer across block **10** and to preclude the flow of material between parallel tube coils should a break occur in the tube coil portions enclosed within the assembly block **10**. Since the block elements **11**, **20**, **12** are at room temperature, as are the tube coils **1**, **3**, **5**, it will be seen that no temperature variance problem exists in the method or steps of forming the heat exchanger. Similarly, since the contacting portions of blocks **11**, **20**, **12** are identical, no possibility of variance in spacing between adjacent coils exists.

There is claimed:

1. A heat exchanger comprising a plurality of offset tube coils, a plurality of block elements, each of said block elements being positioned adjacent and in direct heat-transfer contact with opposed portions of each of said tube coils, each of said tube coils having the entire outer surface of its major portion in direct heat-transfer contact with opposed block element portions, each of said block elements being in heat-transfer contact with at least one adjacent block element and means retaining all of said block elements in said direct heat-transfer contact relationship, whereby heat may be transferred from one to another of said tube coils through said block elements.

2. A temperature-transfer assembly including a plurality of tube coils, a plurlity of block elements interspersed among said tube coils, means compressing said block elements into contact with said coils and with each other to form a substantially solid block, said block enclosing substantially the entirety of said coils whereby temperature may be transferred from one to another of said coils through said block.

3. A temperature-transfer assembly including a plurality of tube coils, a plurality of block elements interspersed among said tube coils, means compressing said block elements into contact with said coils and with each other to form a substantially solid block and to deform portions of said coils between asid block elements.

4. A temperature-transfer assembly including a plurality of tube coils, a plurality of identical block elements interspersed among said tube coils, means compressing said block elements into contact with said coils and with each other to form a substantially solid block, said block enclosing substantially the entirety of said coils whereby temperature may be transferred from one to another of said coils through said block.

5. The structure of claim 4 wherein each said block element has a pair of substantially smooth side walls, and conformations formed on the opposite surfaces between said side walls, the conformations formed on one of said surfaces including a pair of spaced, parallel ridges inwardly offset from said side walls and a valley formed between said ridges, the conformations of the opposite surface of said block including a pair of spaced valleys inwardly offset from said side walls and a ridge between said valleys.

6. The structure of claim 4 wherein each said block element has a pair of substantially smooth side walls, and conformations formed on the opposite surfaces between said side walls, the conformations formed on one of said surfaces including a pair of spaced, parallel ridges inwardly offset from said side walls and a valley formed between said ridges, the conformations of the opposite surface of said block including a pair of spaced valleys inwardly offset from said side walls and a ridge between said valleys, the surfaces of said first-named ridges being formed and adapted for mating, heat-transfer contact with the surfaces of said last-named valleys, the surfaces of said first-named valley being formed and adapted for mating heat-transfer contact with the surfaces of said last-named ridge.

7. The structure of claim 4 wherein each said block element has a pair of substantially smooth side walls, and conformations formed on the opposite surfaces between said side walls, the conformations formed on one of said surfaces including a pair of spaced, parallel ridges inwardly offset from said side walls and a valley formed between said ridges, the conformations of the opposite surface of said block including a pair of spaced valleys inwardly offset from said side walls and a ridge between said valleys, said ridges having a height less than the depth of said valleys whereby a space is created when a set of said blocks is mated.

8. The structure of claim 4 wherein each said block element has a pair of substantially smooth side walls, and conformations formed on the opposite surfaces between said side walls, the conformations formed on one of said surfaces including a pair of spaced, parallel ridges inwardly offset from said side walls and a valley formed between said ridges, the conformations of the opposite surface of said block including a pair of spaced valleys inwardly offset from said side walls and a ridge between said valleys, said ridges having a height less than the depth of said valleys whereby a space is created when a set of said blocks is mated, said space having a width less than the diameter of the tubes to be enclosed therewithin.

9. The structure of claim 4 wherein each said block element has a pair of substantially smooth side walls, and conformations formed on the opposite surfaces between said side walls, the conformations formed on one of said surfaces including a pair of spaced, parallel ridges inwardly offset from said side walls and a valley formed between said ridges, the conformations of the opposite surface of said block including a pair of spaced valleys inwardly offset from said side walls and a ridge between said valleys, said first-named valley having a base positioned within the plane occupied by said side walls, said last-named ridge having its end surface positioned within the plane occupied by said side walls.

10. The method of forming a heat exchanger which comprises the steps of positioning a plurality of serpentine tube coils having alternating straight and curved portions in parallel, spaced, offset relationship, slidably positioning a plurality of solid block elements between opposed portions of said coils in loose contact with substantially the entirety of said tube straight portions and with each other, thereafter compressing said block elements together to bring each of said block elements into mating, heat-transfer contact with adjacent block elements and with said tube coil portions and securing said block elements in said mating, heat-transfer contact relationship.

11. The method of forming a heat exchanger which comprises the steps of positioning a plurality of tube coils having straight portions in parallel, spaced, offset relationship, enclosing said coil straight portions by placing a plurality of identical solid block elements among and about said coil portions, pressing said block elements together to form a substantially continuous solid block of heat-transfer material, to bring said block elements into mating, heat-transfer contact with each other and in heat-transfer contact with portions of said coils therebetween.

12. The method of forming a heat exchanger which comprises the steps of positioning a plurality of tube coils in parallel, spaced, offset relationship, placing a plurality of identical block elements among said coils, pressing said block elements together to form a substantially continuous solid block of heat-transfer material, to bring said block elements into mating, heat-transfer contact with each other and in heat-transfer contact with portions of said coils therebetween and to deform said coil portions.

13. The method of forming a heat exchanger which comprises the steps of positioning a plurality of tube coils in parallel, spaced, offset relationship, placing a plurality of identical block elements among said coils, pressing said block elements together to form a substantially continuous solid block of heat-transfer material, to bring said block elements into mating, heat-transfer contact with each other and in heat-transfer contact with portions of said coils therebetween and to deform said coil portions, and removably locking said block elements in said position.

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Disclaimer

3,295,598.—*John A. Metzger*, Glenview, Ill. HEAT EXCHANGER ASSEMBLY AND METHOD OF FORMING SAME. Patent dated Jan. 3, 1967. Disclaimer filed Jan. 15, 1969, by the inventor and the assignee, *Stanley Knight Corporation.*

Hereby enter this disclaimer to claims 1, 2, 3, 11, 12 and 13 of said patent. [*Official Gazette June 17, 1969.*]