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HEAT EXCHANGER CORE STRUCTURE

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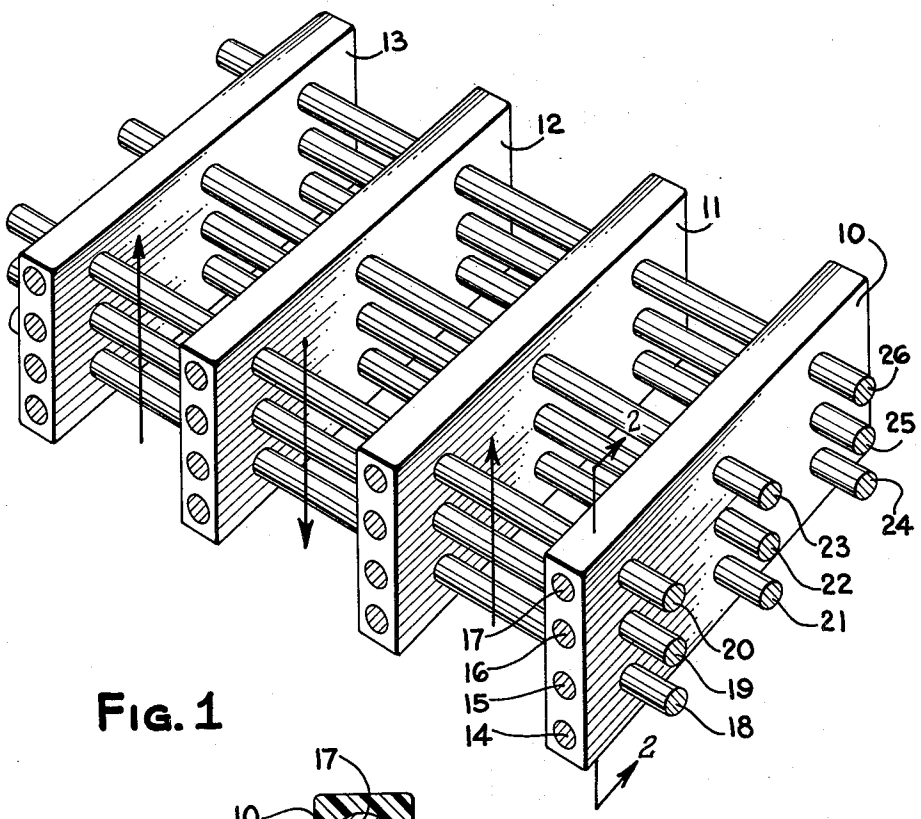


FIG. 1

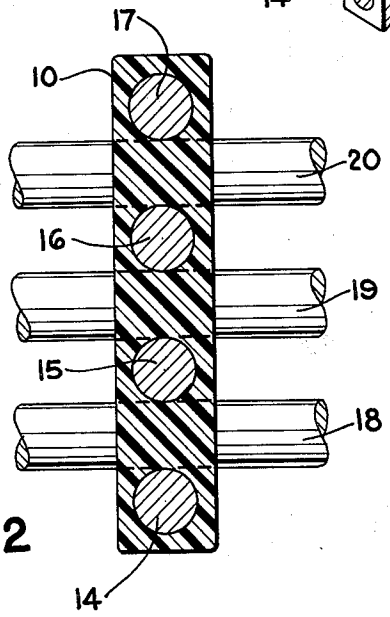


FIG. 2

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HEAT EXCHANGER CORE STRUCTURE

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This invention generally relates to heat exchanger structures, and more particularly concerns an improved heat exchanger core structure.

This application is a continuation-in-part of applicant's co-pending application entitled "Heat Exchanger and Method of Making Same," filed May 10, 1954, and assigned Serial Number 428,516, now abandoned.

Heat exchanger core structures must necessarily conform to certain heat transfer design criteria in order that effective and efficient heat exchanger operation may be obtained. In addition, however, to heat transfer considerations, heat exchanger cores must be constructed so as to comply with demanding environmental variables and still be of a practical construction enabling a relatively low manufacturing cost.

With regard to the environmental application requisites, it is well known that most present day exchangers are oftentimes subjected to extremely high pressure differentials existing across separation walls. It will further be appreciated that sudden pressure variations may be encountered in any particular application. Another environmental consideration is, of course, the temperature problem inherently a part of heat exchanger operation. Thus, the pressure differentials and the pressure and temperature variations existing across separation walls of the heat exchanger core necessarily require that wall constructions be employed which will withstand the resultant variable and continuous stresses imposed.

Another problem in heat exchanger application design relates to vibration imparted to the separation walls as a result of fluid movement across the extended surface or fins of the heat exchanger extending between the walls. Of course, in instances where the heat exchanger is to be installed in any type of moving structure, the vibrational forces imposed are more extreme and more difficult to calculate and counteract in terms of structure design.

A structural failure of the separation wall as a consequence of the above described stresses would result in leakage between fluid passages. Such leakage would render the heat exchanger useless and its operation dangerous.

With respect to economical problems, it is, of course, apparent that for practical purposes the heat exchanger core must be susceptible of manufacture at a relatively low cost. Associated with economical production are factors relating to a minimum overall dimension and minimum dimensions of the various materials used which will still result in an efficient heat exchanger core capable of withstanding the environmental conditions imposed upon it as heretofore discussed.

With the above in mind, it is an object of the present invention to provide an improved heat exchanger core structure which yields more effective heat transfer, less flow resistance, and more efficient heat exchanger operation relative to heat exchanger units presently available.

Another object of the present invention is to provide an improved heat exchanger core structure which includes separation walls capable of withstanding variable and extreme pressure and temperature differentials and shocks.

Another object of the present invention is to provide a heat exchanger core structure which embodies separation walls capable of withstanding fluid vibrational forces as well as vibrational stresses which may be encountered as a consequence of the particular application.

Another object of the present invention is to provide a heat exchanger core structure capable of maintenance-free operation over an extended period of time.

Still another object of the present invention is to provide a heat exchanger core structure, which is designed for relatively low cost manufacture and yet which complies with the aforegoing objects.

Still another object of the present invention is to provide a heat exchanger core structure which may be manufactured with relatively small overall dimensions and yet provide relatively high capacity heat exchanger characteristics.

These and other objects and advantages of the present invention are generally attained by providing a heat exchanger core structure which includes spaced, substantially parallel walls of monolithic plastic material defining therebetween fluid flow passages. Spaced carrier and reinforcing members are immersed in and pass internally through the walls in directions parallel to the passages. Heat conductive members extend in sealed and bonded relationship transversely through the walls and across the passages and are juxtaposed in spaced relationship alternately between each pair of the carrier members. With this type of structure, the heat conductive members and carrier members are, respectively, structurally supported by each other within the wall.

In a preferred construction, the carrier members and heat conductive members are each formed of rectilinear wires. Also, in a preferred construction, the plastic material comprises a thermo-setting resin.

A better understanding of the present invention will be had by reference to the drawings showing merely one illustrative embodiment, and in which:

FIGURE 1 is an isometric view of a heat exchanger core in accordance with the present invention; and,

FIGURE 2 is an enlarged sectional view taken in the direction of the arrows 2—2 of FIGURE 1.

Referring now to the drawings, there is shown in FIGURE 1 a heat exchanger core structure according to the present invention including a plurality of separation walls **10**, **11**, **12**, and **13**. In actual application, the core structure would be embodied in a heat exchanger frame and formed with manifold units so as to have one fluid flowing, for example, in the direction of the upwardly pointing arrows of FIGURE 1 and another fluid flowing in the direction of the downwardly pointing arrow of FIGURE 1.

Since each of the separation walls is constructed in the same manner, a description of the separation wall **10** will suffice for a description of the other separation walls **11**, **12**, and **13** shown in FIGURE 1. The separation wall **10** has disposed internally therein a plurality of spaced carrier members **14**, **15**, **16**, and **17** extending in parallel alignment throughout the length of the wall **10**. In a preferred embodiment, the carrier members are formed of lengths of rectilinearly arranged heat conductive wire.

The heat conductive members or wires **18** through **26** extend transversely across the separation wall **10** in sealed relationship therewith. The wires **18** through **26** continue across the fluid passage defined between the separation walls **10** and **11** and similarly extend transversely through the separation walls **11**, **12**, and **13** and across the fluid passages defined by the separation walls **11**—**12**, and **12**—**13**.

The interrelationship and co-functioning of the heat conductive members and carrier members together, which are stacked in alternately contacting sequence with the particular wall structure may best be described by reference to FIGURE 2 and a discussion of the heat conductive member **18**, **19**, and **20** with respect to the wall structure

10 and the carrier members 14, 15, 16, and 17. Each of the heat conductive members or wires extends through the wall 10 in juxtaposed relationship in between a pair of spaced carrier members. Thus, the wire 18 is interposed between and substantially in contact with carrier members or wires 14 and 15; similarly, the wire 19 is interposed between and in contact with wire members or carriers 15 and 16; and, the wire or heat conductive member 20 is interposed between and in contact with carrier members 16 and 17. Thus, the carrier members 14 through 17, respectively, serve to space and structurally stabilize the heat conductive mmebers 18 through 20. Correspondingly, the heat conductive members 18 and 20 serve to structurally support and space the carrier members.

A second function of the carrier members 14 through 17 is to serve as a network or grid for formation of an integral, monolithic wall structure 10. The wall 10 is preferably formed from a plastic material which in its initial application has liquid or semi-liquid characteristics such that it may be effectively formed to the shape shown in FIGURES 1 and 2 in sealed relationship about the transversely extending heat conductive members and at the same time so as to imbed the carrier members therein. Towards this end, the wall 10 desirably comprises a thermo-setting plastic material which under normal ambient conditions is in a semi-liquid state but which will harden or set when subjected to a given temperature. Of course, various methods may be employed to form the wall 10. For example, the carrier members 14 through 17 may be respectively coated with the plastic material before the alternating structure of carrier members and heat conductive members is formed, or the plastic material forming the wall 10 may be added after the carrier members and heat conductive members have been assembled in the final form as shown in the drawings. With both methods, the plastic sealing material flows together to form a monolithic solid wall structure. Regardless of the method used, the carrier members serve as a network cohesively holding and forming the wall structure 10 to the shape desired until the sealing material or plastic is rigidized by heat or other treatment.

In addition to functioning both as spacers for the heat conductive members and as a carrying grid for the wall material, the wires or carrier members 14, 15, 16, and 17 contribute in at least two other important respects relative to overall heat exchanger performance. In this regard, the carrier members 14 through 17 function as strengthening and reinforcing members after the plastic becomes set or hardened. As such, the carrier members not only reinforce the walls 10, 11, 12, and 13, but also co-operate with the heat conductive members and sealing material to structurally support the final heat exchanger assembly.

Furthermore, the carrier members when formed of heat conductive wire material, as in a preferred embodiment, because of their juxtaposed relationship alternately between the transverse heat conductive members serve as a second heat transfer assembly in a plane or loci of planes perpendicular to the loci of planes established by the heat conductive members. Thus, not only does heat transfer occur between fluid passages through the heat conductive members 18, 19, and 20 directly but also indirectly through the carrier members which are, respectively, in contact with the heat conductive members.

By employing a one-piece or integrated monolithic, plastic wall structure 10, it is also feasible to form a permanently sealed relationship with the heat conductive

members 18, 19, and 20 extending therethrough, and to maintain this relationship even with extremes in temperature and pressure variations as well as under conditions when the separation walls and overall heat exchanger structure may be subjected to excessive vibrational forces. Thus, no mechanical joining methods are used which may be subject to failure under stress or which require frequent maintenance procedures. By using a plastic material for the wall 10, the wall 10 will flex and give according to the environmental conditions without the possibility of leakage or damage despite any unusual force differentials to which it may be subjected.

It is, of course, apparent that by using heat conductive members in the form of wires a maximum amount of heat transfer surface is obtained with a minimum of resistance to fluid flow with the result that an effective and efficient heat transfer unit is feasible. By employing carrier members in the form of wires 14, 15, 16, and 17 of the same material as the transverse heat conductive members 18 through 20, for example, it is apparent that a very economical and rugged heat exchanger may be constructed.

There are disclosed and claimed in applicant's Patents, No. 3,048,341 and No. 3,046,639, a machine and a method, respectively, for forming core structures of the type disclosed and claimed herein.

It will be evident from the foregoing description that many minor changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. In a heat exchanger core structure: a plurality of spaced apart, leak-tight separation walls at least partially defining fluid passages, each of said walls comprising a jointless, homogeneous structure of plastic sealing and bonding material having internally embedded therein a plurality of reinforcing and carrier members of substantially uniform cross section spaced laterally throughout the height of said wall and extending lengthwise of the wall substantially parallel thereto; and heat-conductive members traversing all of said walls in a plurality of rows and in sealed and bonded relationship therewith, and passing through all of said passages and directly exposed therein, said rows of heat-conductive members and said reinforcing and carrier members being stacked in alternating contacting sequence, thereby to space and support each other throughout the height of each of said walls and to form internally reinforced walls.

2. A heat exchanger core structure according to claim 1, in which said plastic sealing and bonding material consists of a thermosetting resin.

3. A heat exchanger core structure according to claim 1, said carrier members and said heat-conductive members comprising straight lengths of wire.

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