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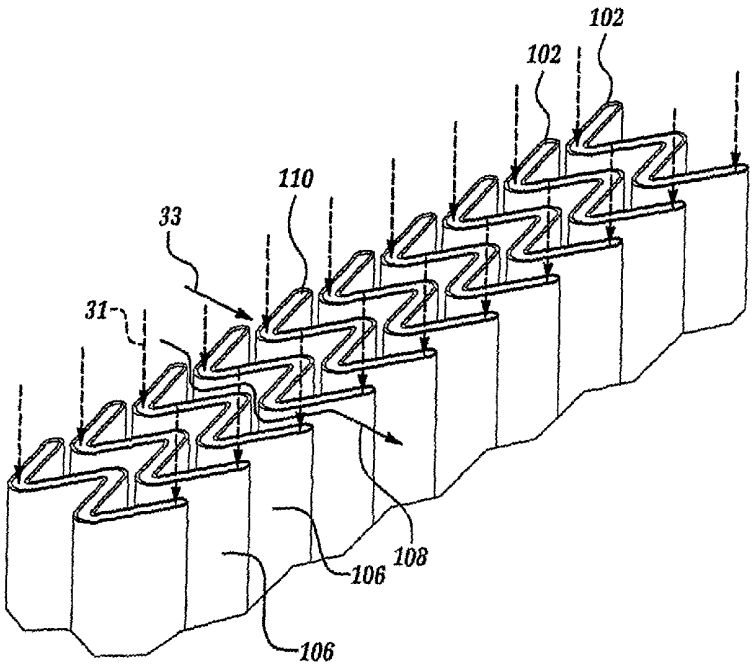
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(54) Title: HEAT EXCHANGER ASSEMBLY AND A METHOD FOR EFFICIENTLY TRANSFERRING HEAT



(57) Abstract: A fin-less and seamless heat exchanger (10) having several tubes, such as tubes (12), which cooperatively form at least one serpentine flow path, such as path (35), which allows heat to be efficiently and cost effectively transferred to fluid movably contained in the tubes, such as tubes (12).

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HEAT EXCHANGER ASSEMBLY AND A METHOD FOR EFFICIENTLY TRANSFERRING HEAT

(1) FIELD OF THE INVENTION

The present invention generally relates to a heat exchanger assembly and a method for transferring heat and more particularly, to a heat exchanger assembly which allows heat to be efficiently and cost effectively transferred to a fluid in a desired manner.

(2) BACKGROUND OF THE INVENTION

A heat exchanger, sometimes referred to as a radiator, typically includes several channels or tubes through which a fluid selectively flows. Heat which is generated by a device or assembly (e.g., an engine) is transferred to or "exchanged with" the movably contained fluid and the fluid is then cooled and communicated to a reservoir, thereby allowing the fluid to cool before it "re-circulates" through the exchanger. The transfer or the exchange of heat is typically enhanced by "fins" or other members which cooperatively interconnect the tubes and which increase the amount of surface area that the produced heat contacts and/or the amount of time that the produced heat is in heat exchanging contact with the tubes and the heat exchanger assembly.

While prior heat exchangers do allow for the selective transfer or exchange of heat in the previously delineated manner, they suffer from some drawbacks. For example and without limitation, these prior heat exchangers are relatively complicated to manufacture due to the relatively large number of required components, are not highly efficient (e.g., only a relatively small portion of the heat is actually transferred to the air), and are highly susceptible to damage and leakage caused, for example and without limitation, by a break in one of the numerous welded tubular seams required by conventional heat exchange manufacturing processes.

There is therefore a need for a heat exchanger which overcomes some or all of the previously delineated drawbacks of prior heat exchangers and for a method for transferring or exchanging heat which overcomes some or all of the previously delineated drawbacks of prior methods.

SUMMARY OF THE INVENTION

It is a first object of the present invention to provided a heat exchanger and a method for exchanging heat which overcomes some or all of the previously delineated drawbacks of prior heat exchangers and prior methods for exchanging heat.

It is a second object of the present invention to provide a substantially "fin-less" heat exchanger which allows for the efficient transfer or exchange of heat type energy, where the term "fin-less", in one non-limiting embodiment, means the substantial absence of a member or members which interconnectively couple fluid containing tubes or members.

It is a third object of the present invention to provide a heat exchanger which is relatively low in cost and complexity and which allows heat type energy to be efficiently transferred or exchanged.

It is a fourth object of the present invention to provide a substantially seamless heat exchanger which reliably, efficiently, and cost-effectively allows heat type energy to be transferred or exchanged in a desired manner.

It is a fifth object of the present invention to provide a method for transferring and/or exchanging heat in a cost effective and reliable manner.

It is a sixth object of the present invention to provide a heat exchanger which is rugged, has a relatively long operating life, is reliable, and has the ability to withstand relatively large amounts of pressure.

According to a first aspect of the present invention, a heat exchanger is provided. The heat

exchanger includes several serpentine tubes, each of the serpentine tubes having a first end which is coupled to a first header assembly and a second and opposed end which is coupled to a second header assembly.

According to a second aspect of the present invention, a method is provided for exchanging heat. The method comprises the steps of providing a first and a second header assembly; providing fluid; providing several serpentine tubes; coupling each of the serpentine tubes to the first and second header assemblies; providing fluid; causing the fluid to flow through the first header assembly, through the tubes, and then through the second header assembly, and causing air to pass between said tubes, thereby transferring said heat from said fluid to said air.

These and other features, aspects, and advantages of the present invention will become apparent from a reading of the following detailed description of the preferred invention and by reference to the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is perspective view of a heat exchanger which is made in accordance with the teachings of the preferred embodiment of the invention;

Figure 2 is a cross-sectional view of the heat exchanger which is shown in Figure 1 and which is taken along view line 2-2;

Figure 3 is a perspective view of a heat exchanger which is made in accordance with the teachings of a second embodiment of the invention;

Figure 4 is a cross-sectional view of a heat exchanger which is shown in Figure 3 and which is taken along view line 4-4;

Figure 5 is a perspective view of a heat exchanger which is made in accordance with the teachings of a third embodiment of the invention;

Figure 6 is a cross sectional view of the heat exchanger which is shown in Figure 5 and which is taken along view line 6-6;

Figure 7 is a perspective view of a heat exchanger which is made in accordance with the teachings of a fourth embodiment of the invention; and

Figure 8 is a cross sectional view of the heat exchanger which is shown in Figure 7 and which is taken along view line 8-8;

Figure 9 is a perspective view of a heat exchanger which is made in accordance with the teachings of a fifth embodiment of the invention; and

Figure 10 is a cross sectional view of the heat exchanger which is shown in Figure 9 and which is taken along view line 9-9.

Figure 11 is a cross sectional view of heat exchanger tubes which for use within the heat exchanger shown in Figure 9 and which are formed in accordance with the teachings of an alternate embodiment of the invention.

Figure 12 is a cross sectional view of heat exchanger tubes which for use within the heat exchanger shown in Figure 9 and which are formed in accordance with the teachings of an alternate embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring now to Figures 1 and 2, there is shown a heat exchanger 10 which is made in accordance with the teachings of the preferred embodiment of the invention. Particularly, heat exchanger 10 includes several substantially identical serpentine or convoluted tubes 12 (e.g., tubes having heat exchanging/receiving surfaces which are not wholly contained within a single plane). That is, each tube 12 is relatively thin and integrally forms or includes several substantially identical protruding and equally spaced portions 14 and a narrow

and outwardly extending ridge portion 16. Adjacent portions 14 of a tube 12 are integrally connected by a portion 17 which is substantially similar to portion 16.

Further, as shown, the cross sectional area of each portion 14 is generally bulbous or substantially oval and each portion 14, of a tube 12, is generally symmetrical about an axis 18 which also and substantially comprises the longitudinal axis of symmetry of the corresponding cross sectional area of the portion 16 of that tube 12 (e.g., the term "corresponding" means that the referenced cross sectional area of portion 16 is substantially co-planar to the referenced cross sectional area of the portion 14). In the preferred embodiment of the invention, each portion 14 has a substantially identical and generally oval shaped cavity 20 which is longitudinally coextensive to the portion 14 and which terminates upon opposed and open ends 22, 24 of the portion 14. Ends 22, 24 therefore allow material and/or fluid to enter and traverse the cavity 20.

Opposed ends 22, 24 are respectively sealingly secured within header assemblies 26, 28 by a "friction fit", brazing, welding, and/or by use of conventional fasteners or sealer type members and header assembly 26 is coupled to a source of fluid (not shown) by conduit assembly 30 and header assembly 28 is coupled to the same source of fluid (not shown) by conduit assembly 32. In

one non-limiting embodiment, header assembly 26 and conduit assembly 30 may be integrally formed and cooperatively comprise a single assembly and header assembly 28 and conduit assembly 32 may also be integrally formed in this manner. In yet another embodiment, header assembly 26, 28 and conduit assembly 30, 32 may each be integrally formed with assembly 10. In this manner, fluid 31 is communicated into the tubes 12 by the cooperation of conduit assembly 30, header assembly 26, and open ends 22. The communicated fluid 31 turbulently traverses the tubes 12 before exiting the heat exchanger 10 by the use of open ends 24 and header assembly 28. In this manner, the fluid 31 may be heated, exit the heat exchanger 10, and communicated into the source for later use in a "recirculating manner".

Particularly, in the preferred embodiment of the invention, each portion 14 of a tube 12 is placed between portions 14 of adjacent tubes 12, thereby allowing a convoluted or serpentine flow path, such as flow path 35, to be created, thereby increasing the amount of time that the warm air 33 (the air which "carries" the heat which is generated by the device or assembly) remains in heat exchanging contact with the tubes 12, thereby obviating the need for fins or similar assemblies and allowing the heat exchanger to have a relatively uncomplicated overall design. Moreover, the tubes 12 may be extruded and/or

constructed by traditional brazing, welding, or other tube forming techniques (such as folding), thereby obviating the need for tubular seams, thereby reducing failure or fluid leakage and increasing resistance to internal pressure. The contained fluid may therefore traverse the heat exchanger 10 at a relatively high pressure which allows for a relatively efficient heat transfer. Tubes 12 may also, in another non-limiting embodiment, be integrally formed with header assemblies 26, 28. Hence, the radiator or heat exchanger comprises a substantially "seamless" and "fin-less" design and the path of fluid 31 is substantially perpendicular and/or orthogonal to the path of the air 33 and the relatively wide body surface 9 of each tube 12 is also generally parallel to and in operative heat exchanging contact with the flow of the air 33, thereby allowing the hot air 33 to flow along the wide body surface 9. Unlike prior heat exchangers, the tubes 12 of heat exchanger 10 form heat exchanging surfaces that are oriented in a substantially non-parallel direction to the direction of the flow of air 33 through exchanger 10. The convoluted and non-uniform airflow path formed by these surfaces provides increased air turbulence and better contact between the air and the surfaces, thereby increasing the heat exchange efficiency.

According to a second and non-limiting embodiment of the invention, a heat exchanger or radiator 60, as shown best in Figures 3 and 4, may be created. Particularly, radiator 60 includes several substantially identical tubes 62 which are substantially similar in function to the previously described tubes 12 but which each respectively have several protruding and substantially equidistantly spaced portions 64 having a substantially shaped diamond cross sectional area. Adjacent portions 64, of a tube 62, are integrally connected by a portion 65 which is substantially similar to portion 17. Unlike the tubes 12, however, these tubes 62 do not have a portion which is similar to portion 16 of tubes 12. As with the embodiment shown in Figures 1 and 2, each portion 64 is operatively placed between portions 64 of adjacent tubes 62, thereby causing the formation of serpentine or convoluted flow paths 68. Due to the absence of portions which are similar to portion 16, recessed pockets 69 which allow larger amounts of the surface area of tubes 62 to be exposed to the heated air 33 are formed within heat exchanger 60. Unlike prior heat exchangers, the tubes 62 form heat exchanging surfaces that are oriented in a substantially non-parallel direction to the direction of the airflow 33. The convoluted and non-uniform airflow path formed by these surfaces provides increased air turbulence and better

contact between the air and the surfaces, thereby increasing the heat exchange efficiency.

According to a third and non-limiting embodiment of the invention, a radiator or heat exchanger 70, as shown best in Figures 5 and 6, may be created. Particularly, radiator 70 includes tubes 72 which are substantially identical to tubes 12 but which have protruding portions 74 having a substantially diamond shaped cross sectional area.

According to a fourth and non-limiting embodiment of the invention, a radiator 80, as shown best in Figures 7 and 8, may be created. Particularly, radiator 80 includes several substantially identical tubes 82 which convey fluid 31 from header assembly 26 to header assembly 28 and which respectively having a substantially oval shaped and generally hollow middle portion 84 and substantially planar projection members 86 which protrude from the portion 84. Member 86 of adjacent tubes 82 cooperatively intermesh to form serpentine or convoluted path 88.

According to a fifth non-limiting embodiment, a radiator 90, as shown best in Figures 9 and 10 may be created. Particularly, radiator 90 includes several substantially identical tubes 92 have a substantially similar "S" or "worm shape" body 96 which cooperatively form convoluted or serpentine flow paths 98. Each body 96 further includes a pair of linearly coextensive and

generally hollow portions 99, 100 which are disposed on opposed side portions of the body 96 and which receive fluid 31.

According to an alternate embodiment of radiator 90, tubes 92 are replaced with tubes 102 shown in Figure 11. Tubes 102 have substantially similar "W" or "zig-zag" shape bodies 106 which cooperatively form convoluted or serpentine flow paths 108. Each body 106 includes a generally "W"-shaped hollow channel which receives fluid 31. According to yet another embodiment of radiator 90, tubes 92 are replaced with crimped tubes 112 shown in Figure 12. Tubes 112 have substantially similar "W" or "zig-zag" shape bodies 116 which cooperatively form convoluted or serpentine flow paths 118. Each body 116 further includes several linearly coextensive and generally hollow portions 120 - 128, which are disposed on opposed side portions of the body 116 and which receive fluid 31.

It should be appreciated that air 33 may be replaced by other cooling mediums in other embodiments of the foregoing heat exchangers. For example and without limitation, in one non-limiting embodiment, air 33 is replaced by water, glycol or other coolant fluids and is used to cool a fluid 31 such as oil.

It is to be understood that the invention is not limited to the exact embodiment or construction which has

been illustrated and discussed above, but that various changes and modifications may be made without departing from the spirit and the scope of the invention as is more fully delineated in the following claims.

WHAT IS CLAIMED IS:

(1) A heat exchanger comprising at least one convoluted tube; and a pair of header assemblies which are coupled to said at least one convoluted tube.

(2) The heat exchanger of Claim 1 wherein said at least one convoluted tube includes at least one protruding portion having a substantially bulbous cross sectional area and forming a substantially oval shaped cavity which is substantially and linearly coextensive to said at least one convoluted tube.

(3) The heat exchanger of Claim 1 wherein said at least one convoluted tube includes at least one protruding portion having a substantially bulbous cross sectional area and forming a substantially diamond shaped cavity which is substantially and linearly coextensive to said tube.

(4) The heat exchanger of Claim 2 wherein air is selectively impressed upon the heat exchanger along a certain direction and wherein fluid is communicated into said at least one tube along a direction which is substantially orthogonal to said direction.

(5) The heat exchanger of Claim 3 wherein air is selectively impressed upon the heat exchanger along a certain direction and wherein fluid is communicated into said at least one tube along a direction which is substantially orthogonal to said direction.

(6) A heat exchanger comprising a plurality of tubes which cooperatively form a plurality of generally serpentine flow paths.

(7) The heat exchanger of Claim 6 wherein said at least one convoluted tube includes at least one protruding portion having a substantially bulbous cross sectional area and forming a substantially oval shaped cavity which is substantially and linearly coextensive to said tube.

(8) The heat exchanger of Claim 6 wherein said at least one convoluted tube includes at least one protruding portion having a substantially bulbous cross sectional area and forming a substantially diamond shaped cavity which is substantially and linearly coextensive to said tube.

(9) The heat exchanger of Claim 7 wherein air is selectively impressed upon the heat exchanger along a certain direction and wherein fluid is communicated into said at least one tube along a direction which is substantially orthogonal to said direction.

(10) The heat exchanger of Claim 8 wherein air is selectively impressed upon the heat exchanger along a certain direction and wherein fluid is communicated into said at least one tube along a direction which is substantially orthogonal to said direction.

(11) The heat exchanger of Claim 6 wherein each of said plurality of tubes includes an oval and hollow shaped

first portion and generally planar portions which orthogonally project from said first portion.

(12) The heat exchanger of Claim 6 wherein each of said plurality of tubes has a relatively wide body along which heat traverses.

(13) A heat exchanger which receives a flow of a cooling medium, said heat exchanger comprising a plurality of heat exchange surfaces which are orientated in a substantially non-parallel direction to said flow of said cooling medium.

(14) The heat exchanger of claim 13 wherein said cooling medium comprises air.

(15) The heat exchanger of claim 14 wherein said cooling medium comprises a coolant fluid.

(16) A heat exchanger having a plurality of heat exchanging surfaces which cooperatively form a substantially non-uniform path through which a cooling medium flows.

(17) The heat exchanger of claim 16 wherein said cooling medium comprises air.

(18) The heat exchanger of claim 17 wherein said cooling medium comprises a coolant fluid.

(19) A method for dissipating heat from a device, said method comprising the step of:

causing said heat to be transferred to air;

providing tubes;

causing said tubes to cooperatively form at heater serpentine flow path; and

causing said heated air to traverse said at least one serpentine flow path.

(20) The heat exchanger of Claim 19 wherein each of said tubes includes at least one protruding portion having a substantially bulbous cross sectional area and forming a substantially oval shaped cavity which is substantially and linearly coextensive to said tube.

(21) The heat exchanger of Claim 19 wherein each of said tubes includes at least one protruding portion having a substantially bulbous cross sectional area and forming a substantially diamond shaped cavity which is substantially and linearly coextensive to said tube.

(22) The heat exchanger of Claim 20 wherein air is selectively impressed upon the heat exchanger along a certain direction and wherein fluid is communicated into said tubes along a direction which is substantially orthogonal to said direction.

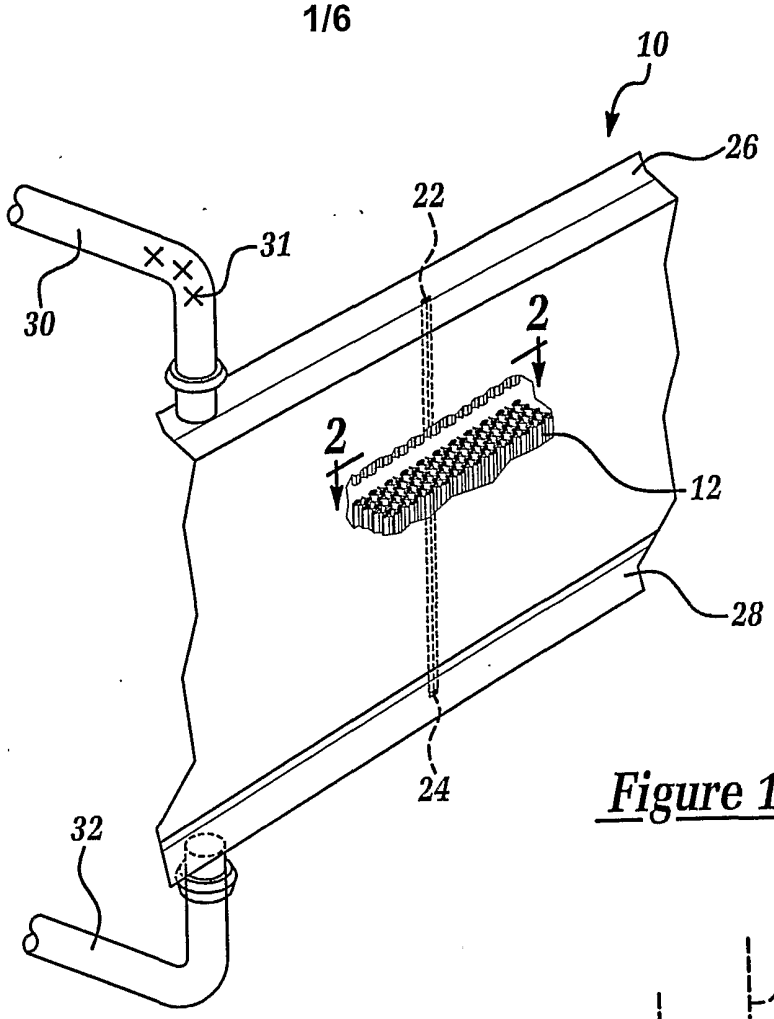


Figure 1

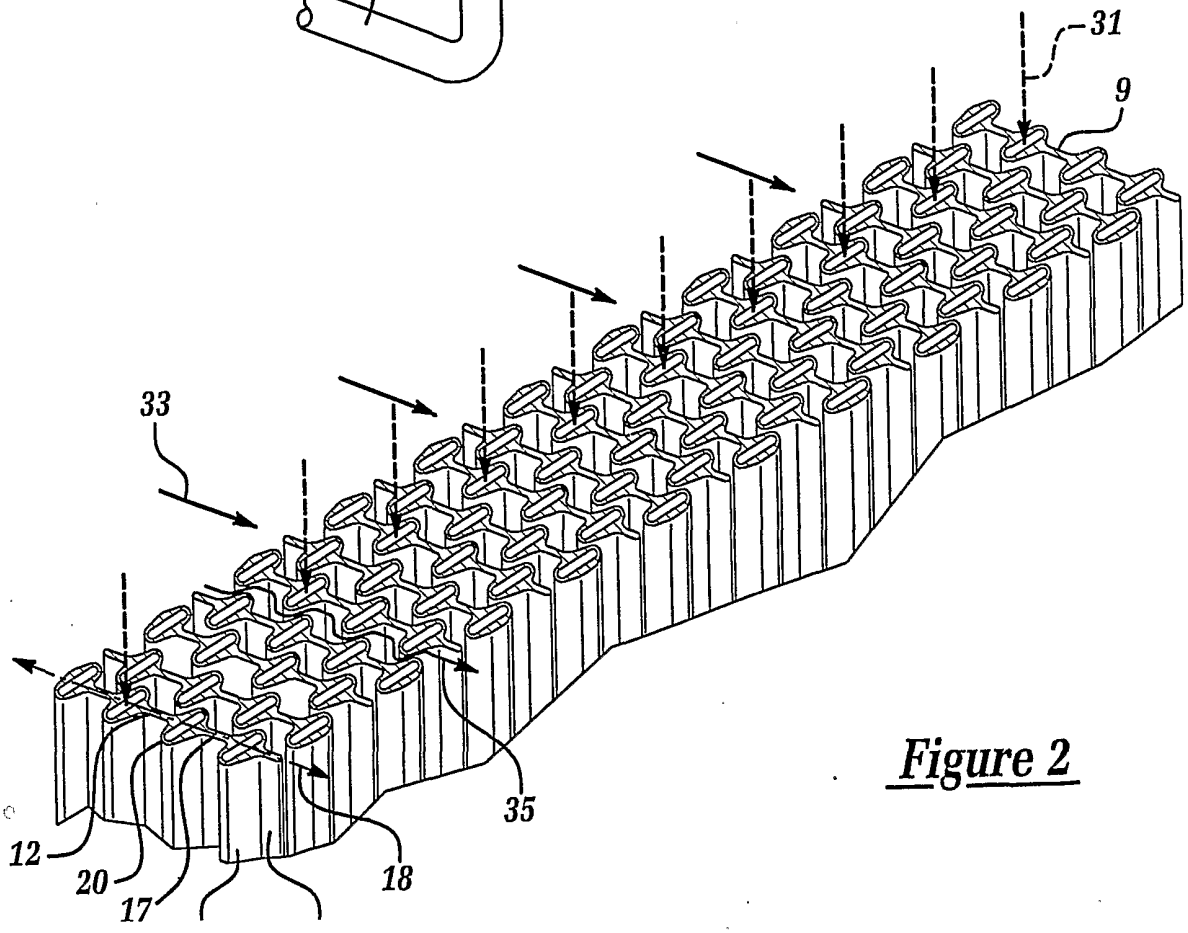


Figure 2

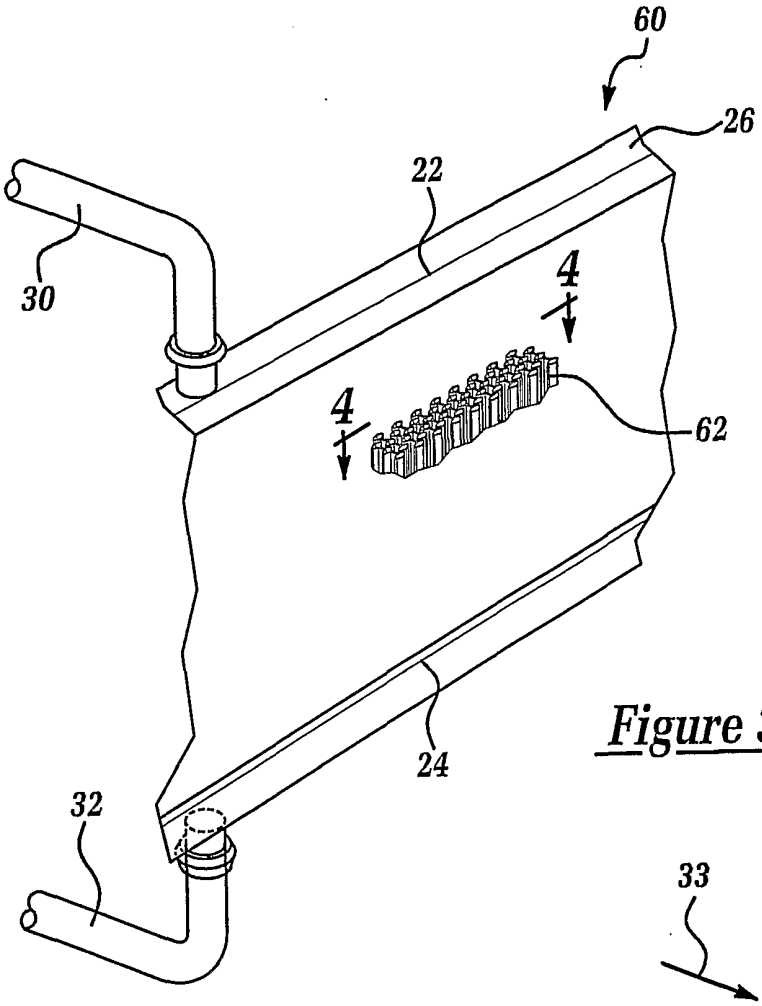


Figure 3

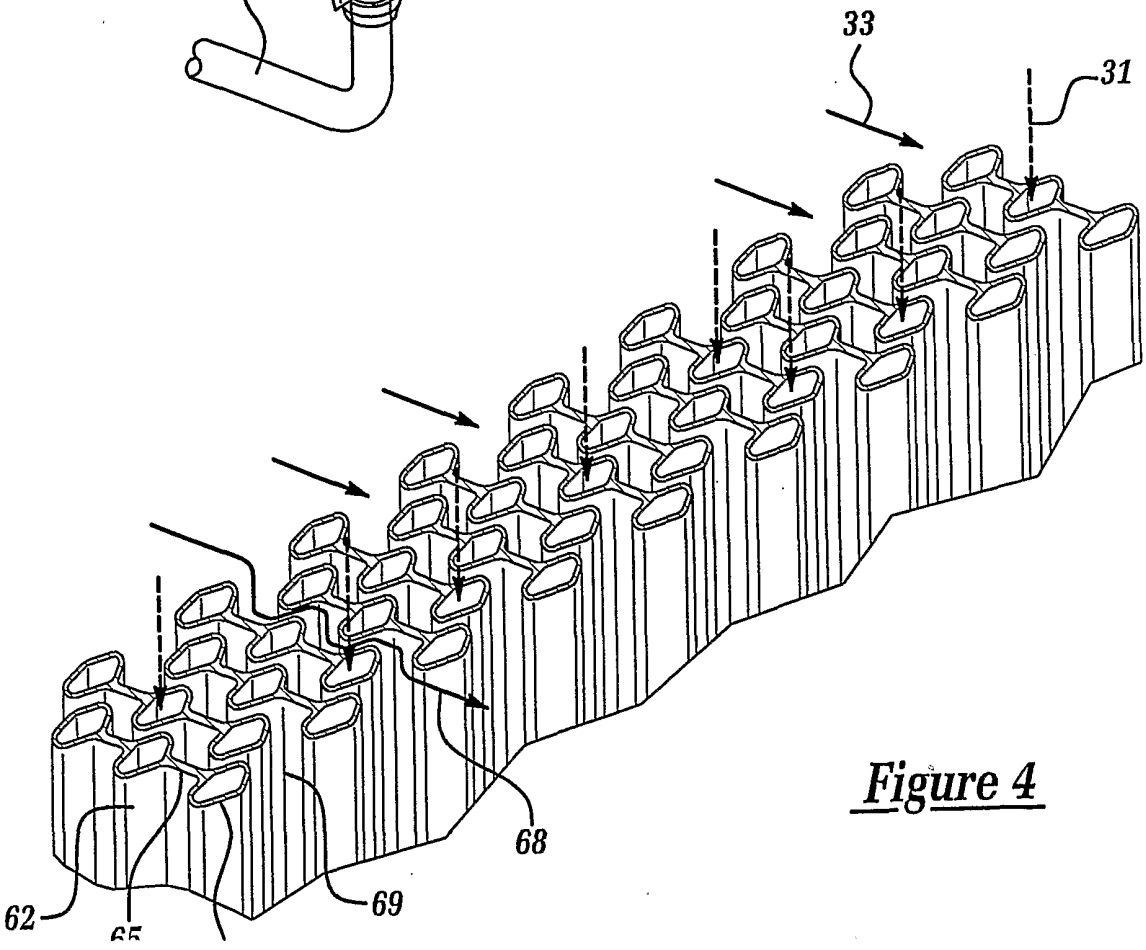


Figure 4

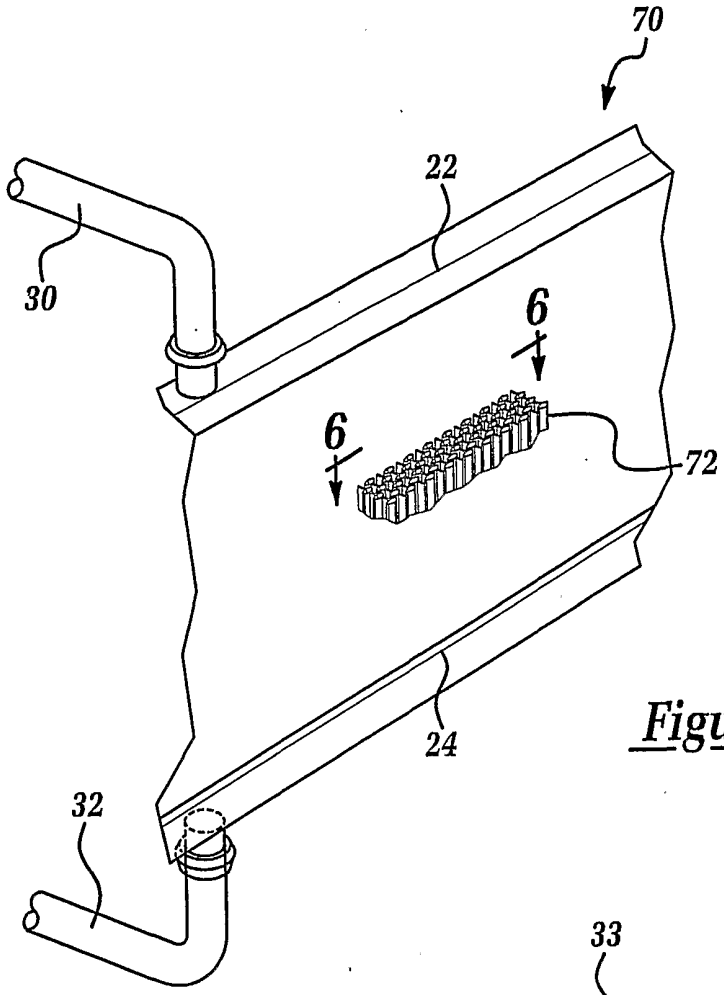


Figure 5

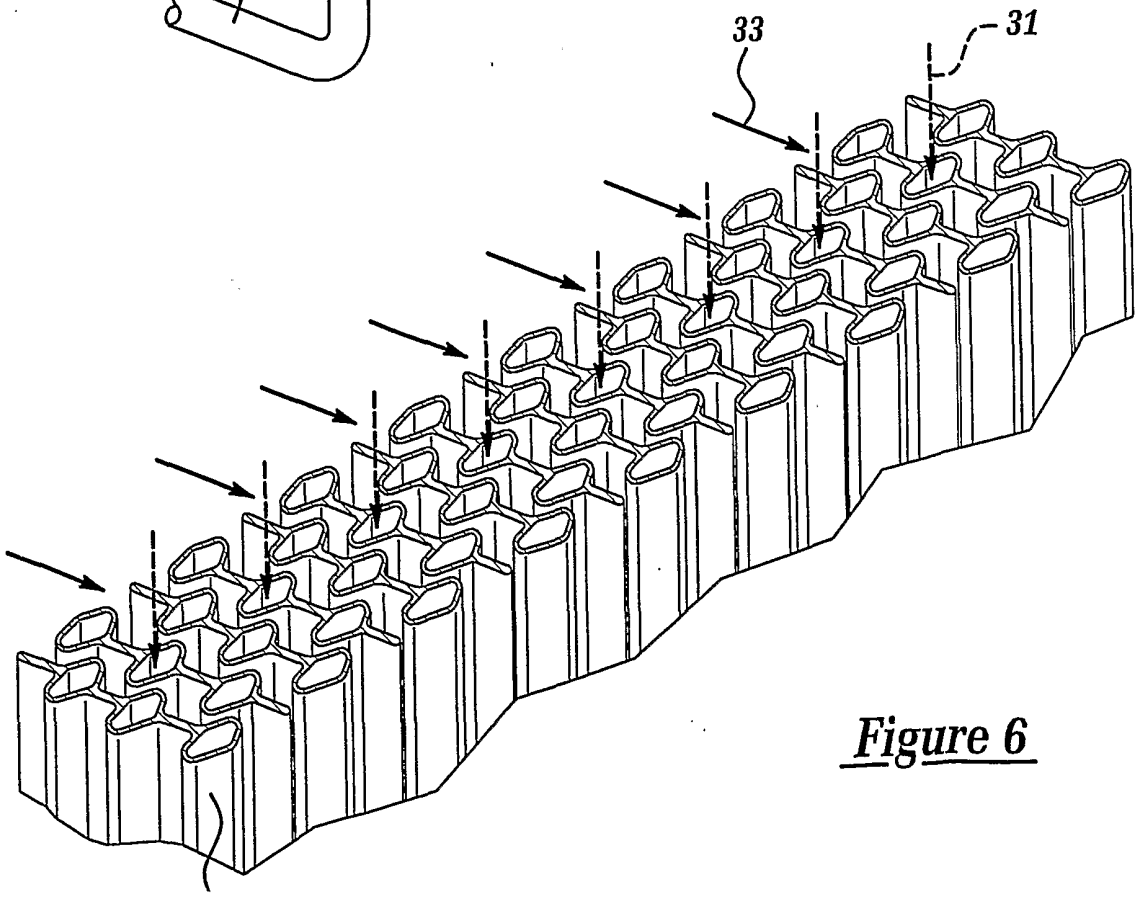


Figure 6

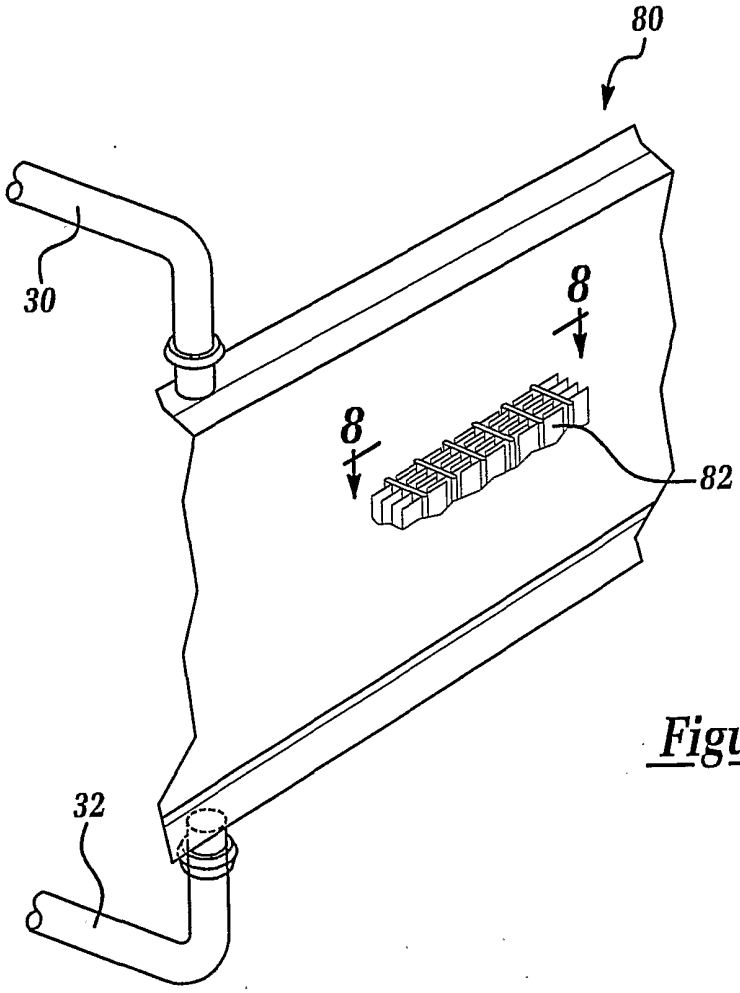


Figure 7

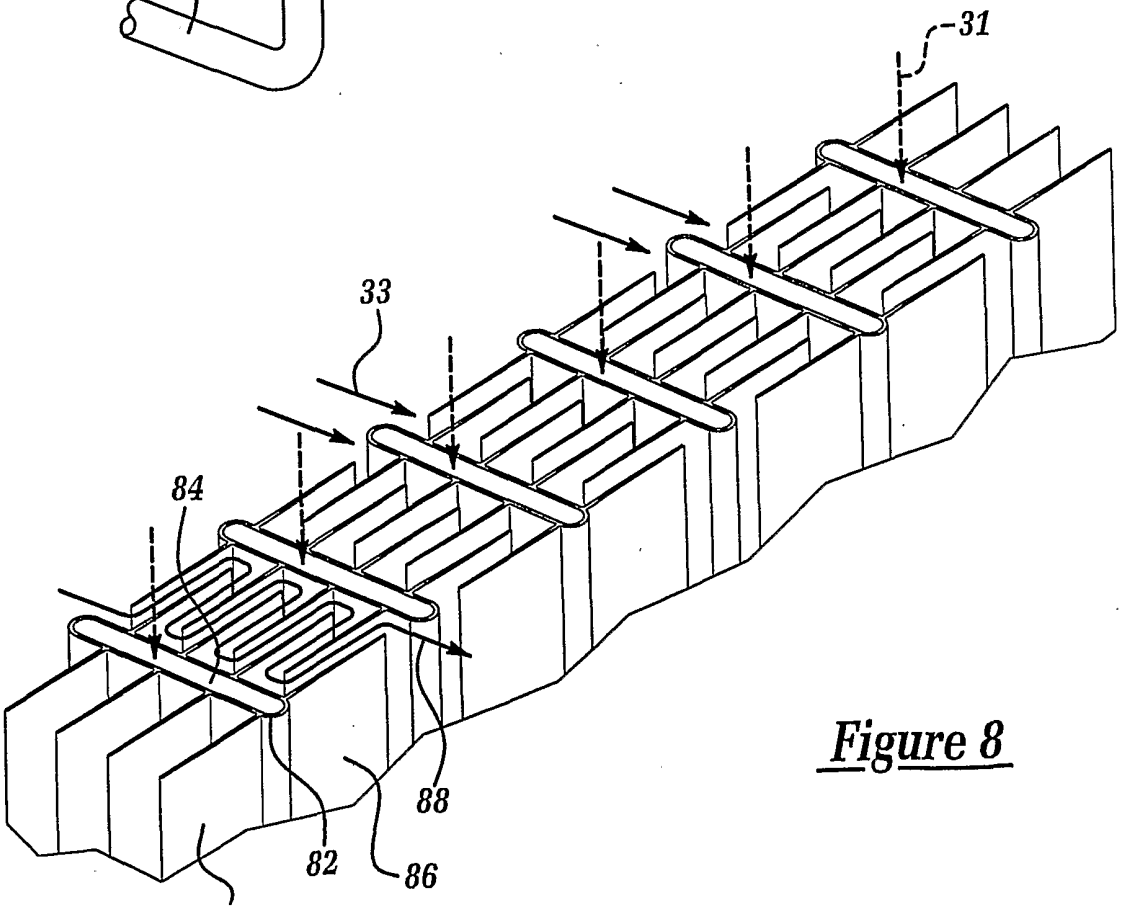


Figure 8

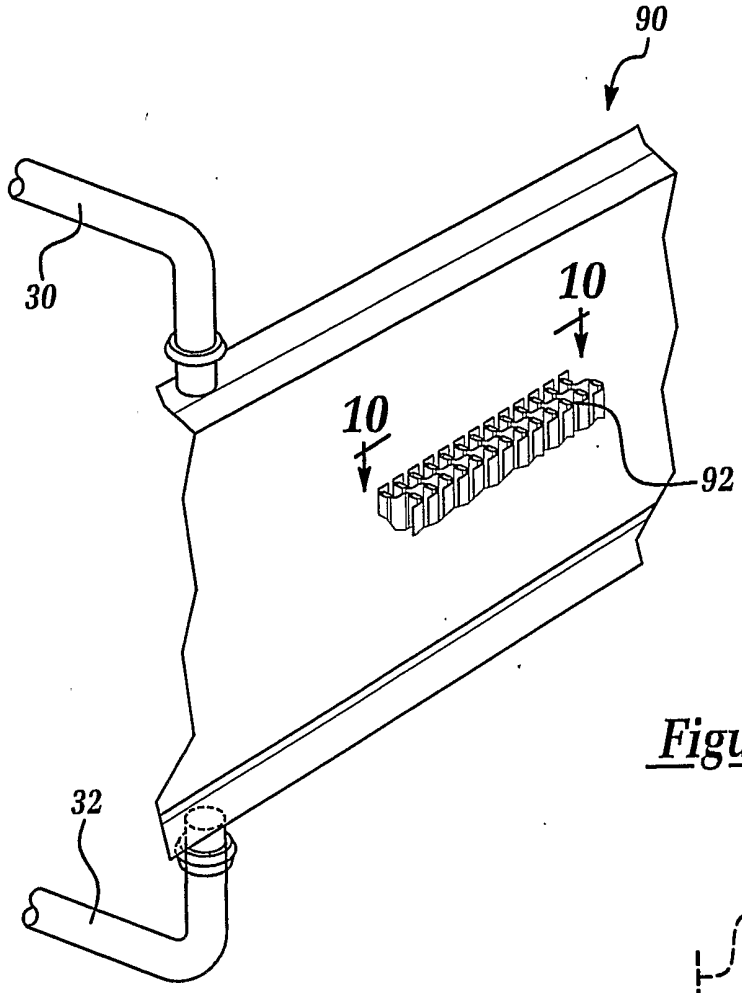


Figure 9

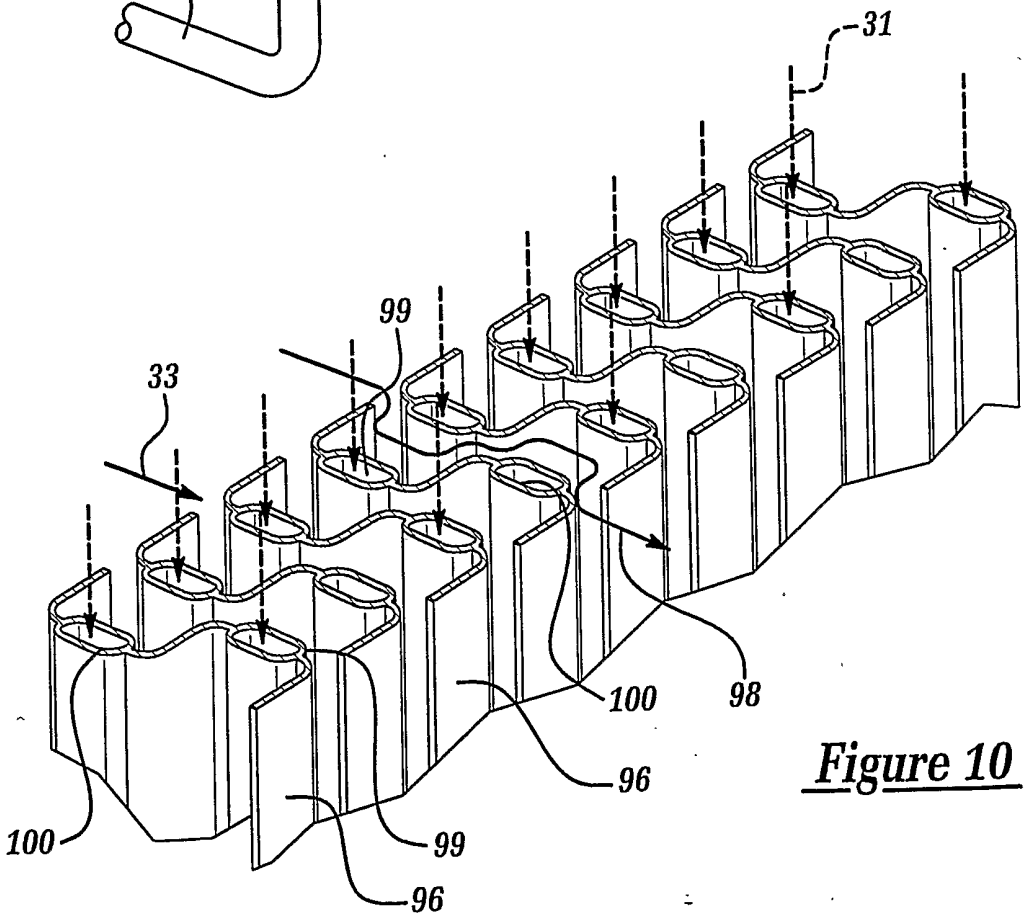


Figure 10

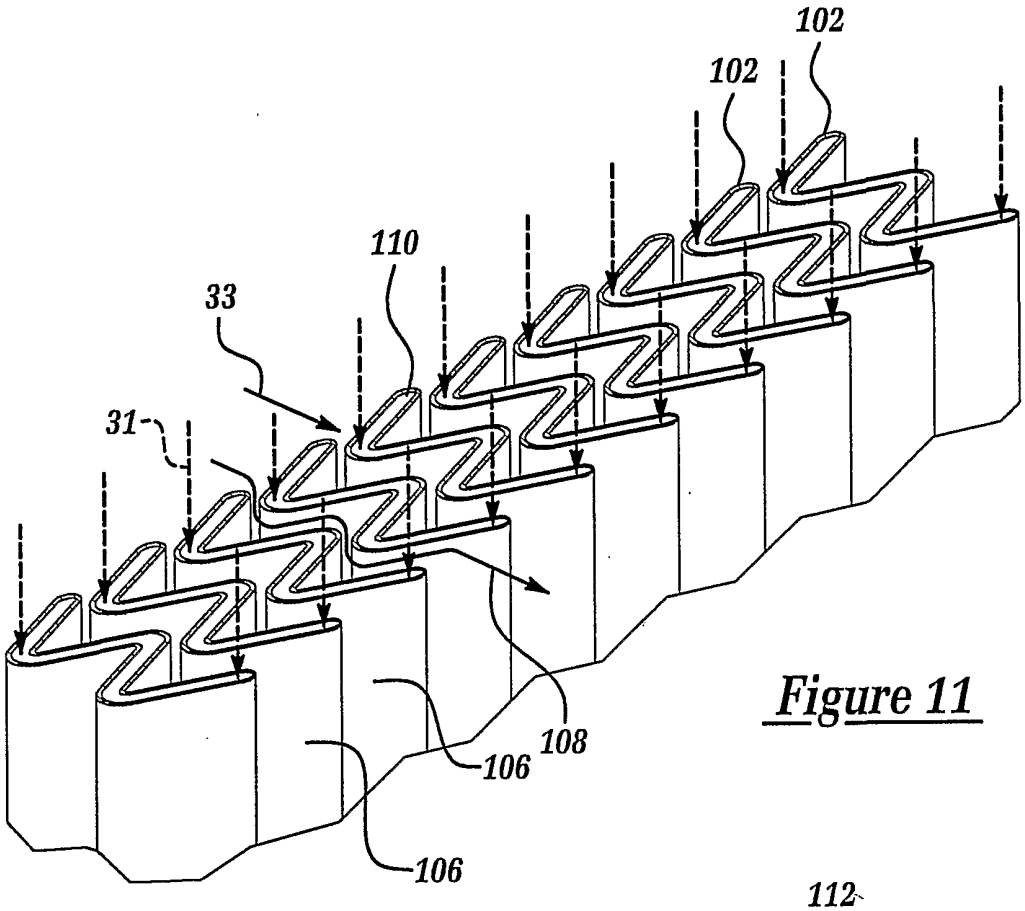


Figure 11

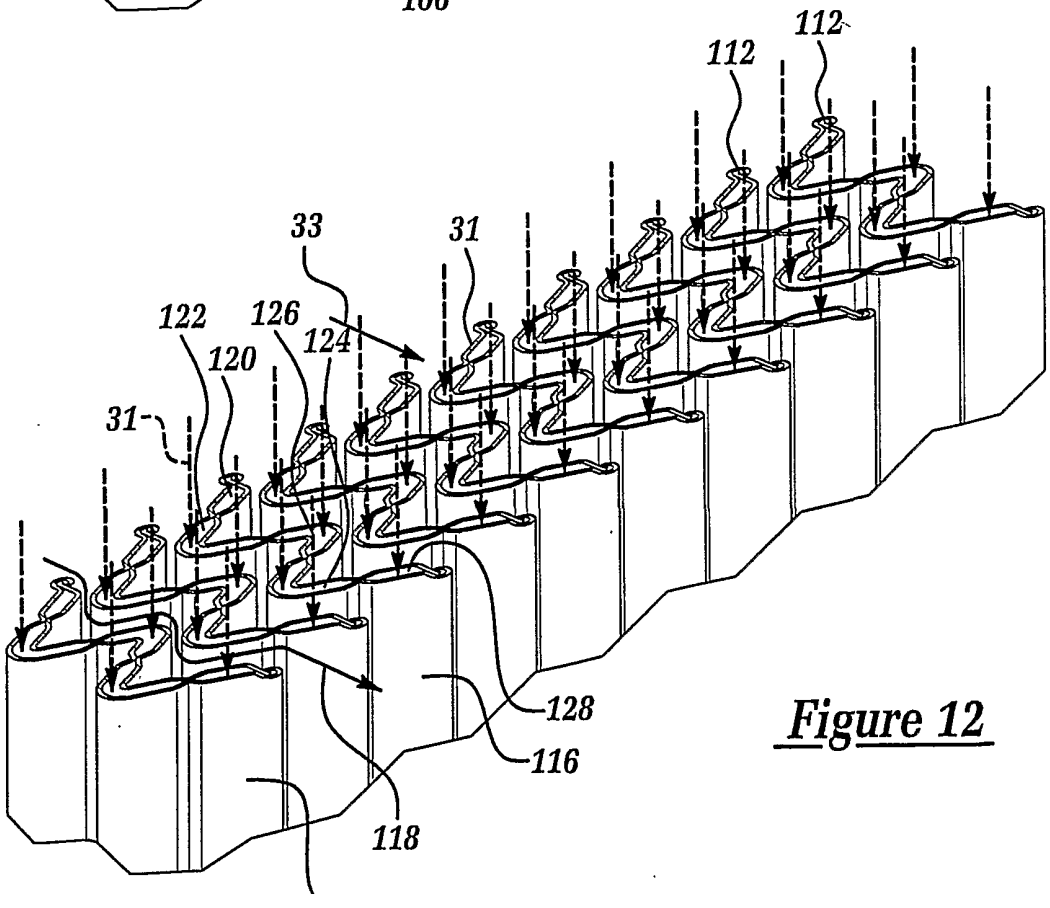


Figure 12