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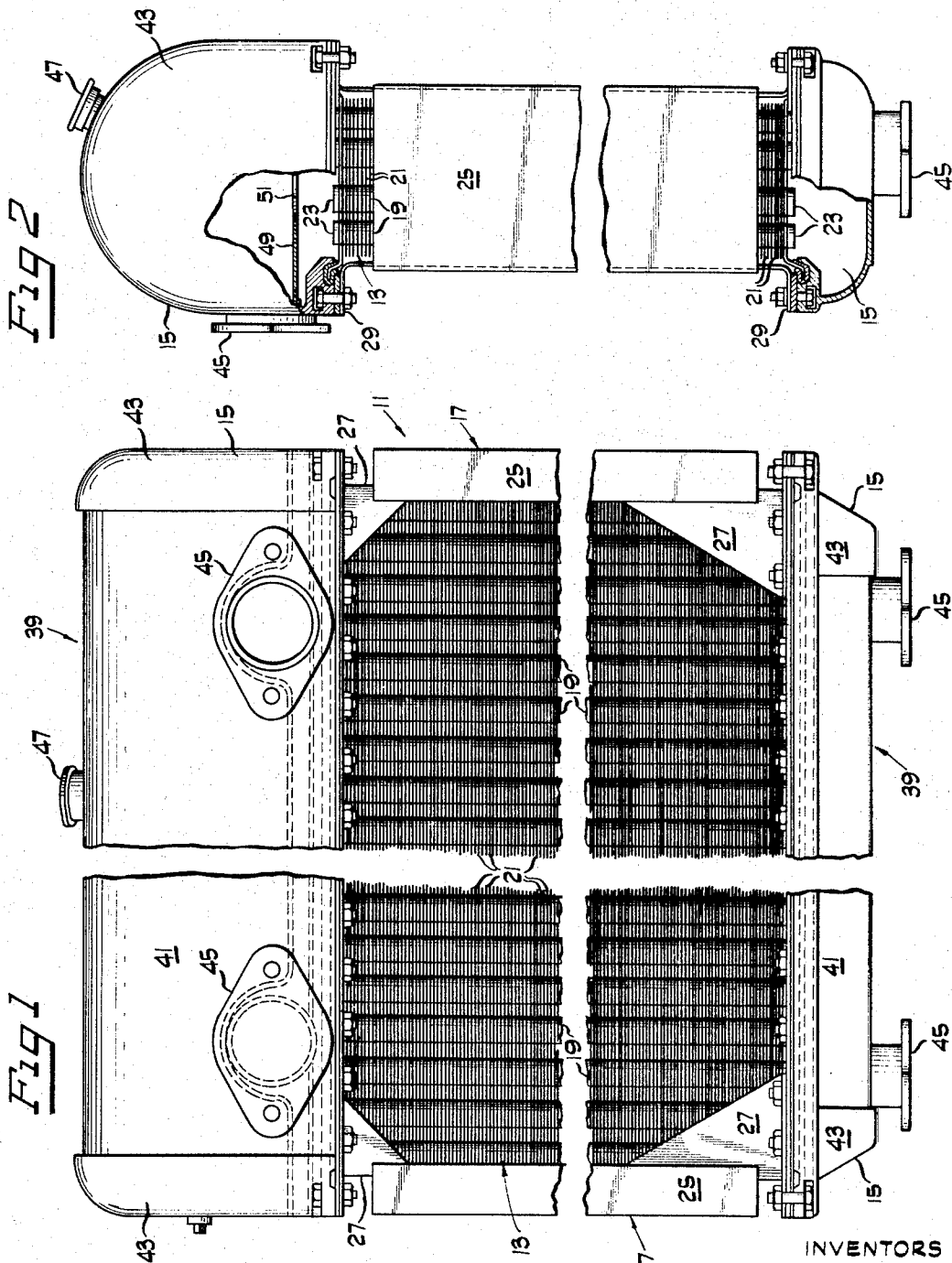
D. M. DONALDSON ET AL

3,415,315

HEAT EXCHANGER

Filed June 29, 1966

2 Sheets-Sheet 1



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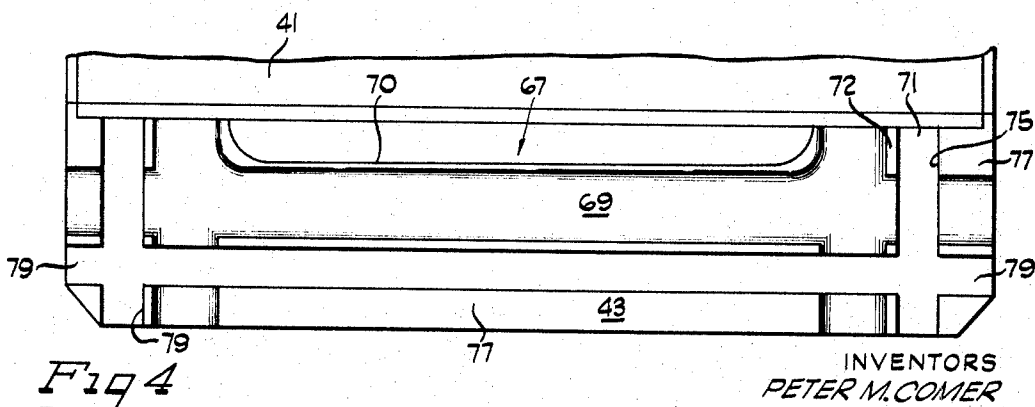
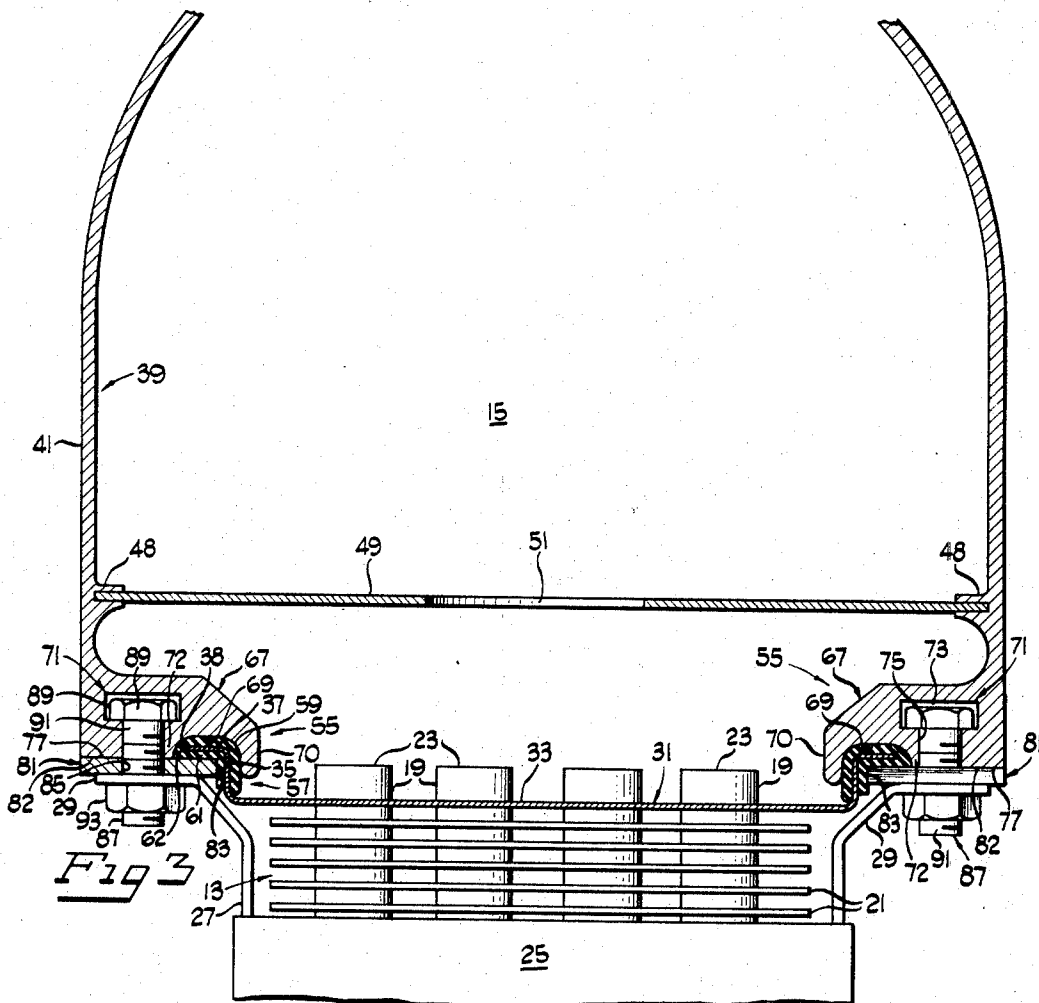
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2 Sheets-Sheet 2



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HEAT EXCHANGER

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ABSTRACT OF THE DISCLOSURE

A heat exchanger for use in a cooling system such as an automotive cooling system. The heat exchanger includes a plurality of coolant tubes and at least one header connected to the coolant tubes for distribution of coolant to the tubes. The header includes a rigid base plate connected to the coolant tubes in liquid-tight relation, a header body secured to the base plate to define a header volume open to the coolant tubes, a resilient seal member disposed between the base plate and the header body to provide a liquid-tight seal completely insulating the header from the base plate, means secured to the header body and insulated from the base plate by the seal member for compressing the seal member between the header body and the base plate to provide the seal.

This invention relates to heat exchangers, more particularly it relates to heat exchangers of the type commonly used in cooling systems for internal combustion engines.

Conventional heat exchangers for internal combustion engines, or radiators, as they are commonly referred to, generally include distribution headers extending longitudinally across opposed ends of a heat transfer core which provide fluid communication between coolant tubes within the core and the remainder of the cooling system. The headers generally include a flat base plate provided with apertures through which the coolant tubes extend and to which they are soldered or otherwise secured in liquid-tight relation. A separately formed header body is secured to the base plate along its outer periphery in liquid-tight relation to define the header volume.

Each base plate and header body is provided with an external peripheral flange which includes a plurality of spaced apart bolt holes. Clamping bolts extend through the bolt holes, and secure the header body to the base plate. To insure a liquid-tight joint, a gasket is provided between the flange of the base plate and the flange of the header body.

As can be appreciated, several significant problems arise in the construction of heat exchangers having headers such as those described.

First, the clamping bolts provide a direct connection between the header and the base plate and even though a gasket is interposed between these components, the possibility of galvanic corrosion exists. This problem limits the choice of materials which may be used in the construction of the header components. For this reason, use of materials for header bodies such as aluminum, in conjunction with copper and brass cores and base plates, has not been practical.

Another serious disadvantage of the conventional bolt-flange-gasket arrangement, is that the gasket, commonly made from an impregnated cork, must be pierced at regular intervals to receive the clamping bolts. Should dehydration of the gasket occur, or if uneven clamping between adjacent bolts exists, leakage will occur between the header and base plate flanges. Also, the necessity of proper alignment of the holes in the flanges and gasket complicates the assembly procedures used to construct the headers.

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Further, since it is necessary to provide drilled holes to receive the clamping bolts it is obvious that the flanges must be external to the header bodies. This arrangement adds to the over-all width of the radiator assembly creating a problem where space limitations are critical.

Accordingly, it is the principal object of the present invention to provide an improved form of heat exchanger.

It is another object of the present invention to provide an improved form of heat exchanger having a header construction suitable for utilization of dissimilar metals in heat exchanger components.

It is a still further object to provide an improved heat exchanger header construction which eliminates the need for an external bolt flange to provide a liquid-tight seal between a header body and a base plate.

It is another object of the invention to provide a heat exchanger having an improved header construction which includes a seal interposed between a header body and a base plate which completely insulates the components from each other.

It is a still further object of the invention to provide a heat exchanger having an improved header construction wherein the alignment of components for assembly is simplified.

These and other objects and advantages of the present invention will become apparent with reference to the following description and the accompanying drawings.

In the drawings:

FIGURE 1 is a fragmentary elevational view of a heat exchanger incorporating various of the features of the invention.

FIGURE 2 is a side elevational view, partially in section of the apparatus of FIGURE 1.

FIGURE 3 is a sectional view on an enlarged scale of a portion of the apparatus shown in FIGURE 2.

FIGURE 4 is a bottom view of a portion of a header for a heat exchanger constructed in accordance with the present invention.

Very generally, the present invention is directed to a heat exchanger having a header construction which includes a base plate connected to coolant tubes of a heat exchanger core and a separately formed header body which defines a header volume with the base plate. A clamping and sealing arrangement is provided which includes a continuous, resilient seal member that completely insulates the header body from its base plate and provides a liquid-tight seal between these components.

Referring now to the drawings, and more particularly to FIGURE 1 there is illustrated a heat exchanger generally designated 11 which is constructed in accordance with, and illustrates the principles of the present invention. The heat exchanger 11 includes a core 13 having a substantially greater width than thickness. The core is interposed between a pair of distribution headers 15 extending longitudinally across opposite ends of the core. These headers are adapted for connection with a cooling system (not shown). A supporting frame 17 is connected between the headers in surrounding relation to the core and provides structural rigidity to the entire assembly.

As best seen in FIGURE 2, the core 13 includes a plurality of thin-walled flow tubes 19 preferably formed of copper or brass which are disposed within a matrix of closely spaced heat dissipating fins 21 extending transversely of the tubes 19. The tubes 19 include opposite open ends 23 connected in fluid communication with the headers 15 and receive fluid to be cooled from one of the headers and deliver the cooled fluid to the other header for distribution to the engine cooling system.

The supporting frame 17 seen in FIGURES 1 and 2 is connected between the headers and provides structural rigidity for the heat exchange core. The frame 17 may

also be adapted to support the entire heat exchanger structure in a vehicle. This frame includes longitudinally extending side supports 25 which extend along opposite ends of the core 13. Corner braces 27 secured to the side supports 25 are positioned at opposite ends of the side supports and include bolt flanges 29 which are secured to the headers 15 in a manner which will be explained.

As seen in FIGURE 3 the headers 15 connected to opposite ends of the core 13 include a base plate 31 through which the tube ends 23 extend into fluid communication with the interior of the headers and to which they are secured in liquid-tight relation by any conventional means as soldering, brazing or the like. The base plate is preferably formed of copper, brass or other similar material.

The top and bottom headers serve respectively as distribution chambers for the delivery of fluid to be cooled to the core and collection of cooled fluid from the core. Therefore, their structural details with respect to an understanding of the present invention are to be considered as substantially identical. The following description of header construction is therefore representative of both distribution headers unless otherwise specifically stated.

As seen in FIGURE 3 the base plate 31 includes a planar section 33 through which the flow tubes 19 extend. An upstanding rim 35 is provided around the entire periphery of the planar section 33 and terminates in an outwardly directed flange 37 having a peripheral edge 38. The outwardly directed flange 37 is disposed parallel to, and spaced from the planar section 33 and is supported in that relationship by the rim 35.

A header body 39 defining the header volume is secured to the base plate 31 in liquid-tight relation. The header body best illustrated in FIGURES 1 and 2 includes an elongated central portion 41 extending across the width of the core. The central portion 41 is enclosed at each end by an end cap 43 secured in liquid-tight relation as by soldering, brazing or any other appropriate form of bonding. It is contemplated that the header body may be made of any suitable material such as aluminum. With such material the elongated central portion 41 may be made of an extrusion and the end caps may be cast or otherwise suitably formed. As has been indicated, utilization of the present invention eliminates the danger of galvanic corrosion and therefore aluminum or other similar materials may readily be used with copper or brass base plates.

Each of the headers 15 is provided with a flanged aperture 45 for connection of the header to the engine cooling system. One of the headers additionally includes a flanged filling port 47 which provides access to the cooling system for adding coolant. This header, which in FIGURES 1 and 2 is the top header, and includes a longitudinally extending baffle 49 which divides the header into two chambers, one adjacent to tube ends 23 and one adjacent to the filling port 47. This baffle improves the efficiency of flow of the fluid from the cooling system to the core 13 and reduced the possibility of flow concentration in only portions of the core.

The baffle includes a plurality of apertures 51 which provide fluid communication between the separated chambers in order that added coolant may readily enter the system. Also, as coolant temperature increases the resulting expansion of the fluid volume is accommodated by the chamber adjacent the filling port.

When utilizing a central portion 41 made by extrusion a pair of extruded channels such as the channels 48 shown in FIGURE 3 may be used to support the baffle 49. With this arrangement the baffle 49 is inserted into position between the opposed channels prior to assembly of the end caps 43 onto the central body portion. Alternatively, the baffle may be secured by welding or other similar fabrication process.

In accordance with the present invention and as best seen in FIGURE 3 the header body 39 is secured in liq-

uid-tight relation to the base plate 31 utilizing a clamping and sealing arrangement generally designated 55.

The sealing arrangement 55 includes a continuous resilient channel shaped seal member 57 disposed in overlying relation to the outwardly directed flange 37 of the base plate 31. The resilient seal member includes a first portion 59 disposed in overlying relation to one side of the flange 37 and a second portion 61 disposed in overlying relation to the opposite side. The first and second portions of the seal member are connected by a center portion 62 which wraps around the edge 38 of the base plate flange 37. With this arrangement the entire flange 37 is surrounded by the resilient seal member 57. The first and second portions of the resilient seal member are of a length greater than the outwardly directed flange 37 and therefore also extend in a direction from the flange toward the planar surface 33 in overlying relation to opposite sides of the upstanding rim 35. The sealing member may be made of any suitable material such as neoprene or plastic which is impervious to the fluid being sealed, and which also exhibits electrical non-conductive or insulating properties.

The clamping and sealing arrangement 55 further includes a flange 67 formed about an open end of the header body 39. This flange is directed inwardly toward the base plate flange 37.

It should be noted that since the flange 67 is inwardly directed, that is, extending inwardly from the external surface of the header body, a configuration is provided which does not increase the width of the headers as would be the case if an external bolt flange were utilized.

In constructing headers incorporating the features of the present invention, it is readily appreciated that the flange 67 may be conventionally formed upon the elongated central portion 41 during the extrusion process or it may be separately formed and secured by soldering or other bonding processes.

As best seen in FIGURE 4 the inwardly directed flange 67 may be formed upon the end caps 43 when they are cast or otherwise fabricated so that when the end caps are secured to the elongated central portion 41 a complete flange 67 is formed about the entire open end of the header body.

The inwardly directed flange 67 includes a continuous seal contacting surface 69 which extends about the entire flange in a generally rectangular pattern. That is to say, generally longitudinally along the width of the core 13 viewed in FIGURE 1 as well as transversely across the thickness of the core as viewed in FIGURE 2. The seal contacting surface 69 is disposed in overlying contact with the first portion 59 of the resilient seal member 57 and is separated from the outwardly directed flange 37 of the base plate by the first portion 59.

The flange 67 further includes a depending lip 70 forming a continuation of the surface 69 which overlies the upstanding rim 35 of the base plate. The lip 70 is separated from the rim 35 by the portion of the first portion 59 of the resilient seal member which overlies the upstanding rim. A second lip 72 spaced outwardly of the lip 70 and forming a second continuation of the seal surface 70 overlies the peripheral edge 38 of the outwardly directed flange 37. The lip 72 is separated from the edge 38 by the central portion 62 of the resilient seal member.

Thus, the seal contacting surface is generally channel shaped and includes a surface overlying one side of the base plate flange and separated from the flange by the resilient seal member, a surface overlying the upstanding rim 35 and separated from the rim by the resilient seal member, and a surface overlying the edge 38 and separated from the edge by the resilient seal member.

Outwardly of the seal surface 69 there is formed in the flange 67 a slot 71 having a cross section in the form of a T and including a cross portion 73 and a shank portion 75. A portion of the flange 67 defining the shank portion 75 of the T slot 71 is provided with a planar stop

surface 77. This surface may extend between the perimeter of the header body 39 and the shank portion 75 of the slot 71. The surface may additionally extend inwardly to form the terminus of the lip 72 although such a relationship is not essential. It is only necessary that the lip 72 be of sufficient length to retain the central portion 62 of the resilient seal member.

The planar stop surface 77 is spaced from the continuous seal contacting surface 69 a distance which is greater than the thickness of the outwardly directed flange 37 of the base plate 31, but less than the over-all thickness of the flange 37 and first and second portions 59 and 61 of the continuous resilient seal member 57. The significance of this relationship will become apparent shortly.

As previously stated and as best seen in FIGURE 4 the end caps 43 secured to the elongated central portion 41 to form the complete header body include the inwardly directed flange 67 and therefore are provided with the seal contacting surface 69 depending lip 70, T slot 71 and stop surface 77. When the header body end caps 43 are assembled to the elongated central portion 41 a complete rectangular flange 67 is formed defining a continuous seal surface 69 a continuous rectangular shaped T slot 71 and a continuous stop surface 77. To make possible the assembly of the headers in accordance with the principles of the present invention, the end caps include T slot extensions 79 which provide necessary access to the slot for reasons that will become apparent.

A clamping ring 81 is disposed adjacent the stop surface 77. This ring may be a continuous, generally rectangular, member or may be made of a plurality of sections. The clamping ring includes a surface 82 which is in overlying contact with the stop surface 77 and also the second portion 61 of the continuous seal member 57. The clamping ring is separated from the outwardly directed flange 37 of the base plate 31 by the second portion 61 of the resilient seal member and from the upstanding rim 35 by the portion of the second portion of the seal member which overlies the rim 35. The flange 37 of the base plate and the first and second portions 59 and 61 of the resilient seal member 57 are thus retained between the seal surface 69 and the clamping ring 81. Since the distance between the stop surface 77 and the seal contacting surface 69 is less than the cumulative thickness of the outwardly directed flange 37 and the first and second portions of the seal member 57, the resilient seal member is placed under compression providing a liquid-tight seal between the base plate and header body.

Additionally, the upstanding rim 35 is effectively retained between an inner edge 83 of the clamping ring 81 and the depending lip 70 of the flange 67. The edge 83 is separated from the upstanding rim 33 by the portion of the resilient seal member 37 that overlies the rim. The distance between the edge 83 and lip 70 is less than the cumulative thickness of the rim 33 and the first and second portions 59 and 61 of the seal member and the seal member is therefore placed under compression. Proper positioning of the header body with respect to the base plate is thereby established.

Since neither the clamping ring 81 nor the flange 67 contact the base plate 31, the entire header body is insulated from the base plate and the danger of galvanic corrosion is avoided. Dissimilar metals may readily be used thus manufacturing processes such as extrusion of components may be utilized.

To retain the clamping ring 81 in position against the stop surface 77 and in sealing contact with the seal member 57 a plurality of apertures 85 are provided about the clamping ring at regular intervals. A plurality of clamping bolts 87 are disposed about the clamping ring 81 and provide the clamping force necessary to retain the header body and base plate 31 in liquid-tight sealing engagement. Each of the bolts 87 include an enlarged head portion 89 disposed in the enlarged cross portion 73 of T slot and a shank portion 91 which extends through

the shank portion 75 of the T slot and through one of the apertures 85 of the clamping ring. The shanks of the bolts are appropriately threaded and nuts 93 are secured to the bolts to urge the clamping ring into contact with the planar stop surface 77.

This arrangement eliminates the problem of uneven clamping of the seal member. As the nuts 93 are tightened the clamping ring is brought into contact with the stop surface 77. Further movement of the clamping ring toward the flange 67 is prevented by the stop surface and uneven clamping is precluded. Since the bolts 87 are disposed in the T slots 71 alignment of the components forming the header is greatly simplified. The bolts may be moved freely along the T slot into proper alignment with apertures 83 of the clamping ring. Further since the bolting is accomplished at a point spaced from the resilient seal member rather than through a cork gasket as has been done in conventional bolt flange arrangements the danger of inadvertent damage to the gasket is eliminated and the criticality of the alignment procedure is substantially reduced. The bolts are placed into the T slots through the T slot extensions 79 as best seen in FIGURE 4.

As seen in FIGURE 3 the connection of the supporting frame 17 to the headers to provide a rigid support for the core 13 is accomplished with the use of the clamping bolts 87. The bolt flanges 29 of the corner braces 27 are disposed in alignment with the clamping ring 81 in contact with the surface of the clamping ring opposite to the surface contacting the header body flange 67. Appropriately positioned apertures are formed in the bolt flanges 29 and the clamping bolt shanks extend not only through the apertures 85 of the clamping ring but also through the bolt flanges 29. Fastening of the nuts 93 to the bolts 87 thereby not only accomplished assembly of the header body to the base plate but also secures the supporting frame 17 to the headers providing the necessary rigidity to the entire structure.

To further simplify the assembly procedures the relative width of the enlarged cross portion 73 of the T slot 71 and the distance across flats of the enlarged head portion 89 of the bolts 87 may be such that once the bolts are positioned within the T slots they may not be rotated. In this manner fastening of the nuts 93 to the bolts 87 may be accomplished efficiently.

As can readily be appreciated the present invention provides an improved heat exchanger construction which was readily adapted for use of dissimilar metals in header construction and includes an improved sealing and clamping arrangement which simplifies assembly procedures and provides a satisfactory and reliable liquid-tight seal.

Various of the features of the invention have been particularly shown and described. However, it should be obvious to one skilled in the art that numerous modifications may be made without departing from the spirit and scope of the invention.

We claim:

1. A heat exchanger having, a plurality of hollow coolant tubes, at least one header comprising a rigid base plate connected to said coolant tubes in liquid-tight relation, a header body secured to said base plate to define a header volume open to said hollow coolant tubes, and a clamping and sealing arrangement comprising a resilient seal member encompassing the edges of said base plate and disposed between said base plate and said header body providing a liquid-tight seal therebetween and completely insulating said header body from said base plate, and means secured to said header body and insulated from said base plate by said seal member compressing said seal member between said header body and said base plate.

2. A heat exchanger as claimed in claim 1 wherein said base plate is made of metal and said header is made of dissimilar metal.

3. A heat exchanger as claimed in claim 1 wherein said resilient seal member is imperforate.

4. A heat exchanger as claimed in claim 3 wherein said means secured to said header body includes a plurality of retention bolts disposed externally of said header volume in spaced relation to said resilient member.

5. A heat exchanger as claimed in claim 1 wherein said base plate includes a peripheral flange directed outwardly toward said header body; said continuous resilient seal member surrounds said peripheral flange and includes a first portion overlying one side of said flange and a second portion overlying an opposite side thereof, and wherein said clamping and sealing arrangement includes a flange formed on said header body including a seal contacting surface disposed in overlying contact with said first portion of said resilient seal member and separated from said one side of said base plate flange by said first portion of said resilient seal member, and said means connected to said header body contacting said second portion of said seal member urging said seal contacting surface of said header body flange and said one side of said base plate flange into sealing engagement with said first portion of said resilient seal member.

6. A heat exchanger as claimed in claim 5 wherein said means urging said seal contacting surface and said one side of said base plate flange into sealing engagement with said first portion of said resilient seal member includes a clamping ring secured to said header body and including a surface disposed in overlying sealing engagement with said second portion of said resilient seal member, said surface of said clamping ring being separated from said opposite side of said base plate flange by said resilient seal member.

7. A heat exchanger as claimed in claim 6 wherein said base plate includes a planar section connected to said coolant tube in liquid-tight relation an upstanding rim surrounding said planar section, said rim supporting said peripheral flange in spaced relation to said planar section and said peripheral flange terminating in a peripheral edge, said resilient seal member includes a central portion overlying said edge of said peripheral flange, said flange formed on said header body includes a depending tab defining a continuation of said seal contacting surface overlying a side of said upstanding rim of said base plate and separated therefrom by a portion of said first portion of said resilient seal member.

8. A heat exchanger as claimed in claim 7 wherein said flange formed on said header body includes a second depending tab defining a continuation of said seal contacting surface overlying said edge of said peripheral flange and separated therefrom by said central portion of said resilient seal member.

9. A heat exchanger as claimed in claim 6 wherein said clamping ring is provided with a plurality of apertures disposed about said ring, said flange formed on said header body is inwardly directed toward said base plate flange and defines a slot formed outwardly of said seal contacting surface, said slot having an enlarged cross portion and a shank portion extending therefrom in approximate alignment with said apertures formed in said clamping ring, and a plurality of clamping bolts disposed in said slot each said bolt including an enlarged head portion disposed in said enlarged cross portion of said slot and a threaded shank portion extending through said shank portion of said slot and through one of said apertures in said clamping ring, each one of said bolts further including a threaded nut secured to said shank portion urging said clamping ring toward said header body flange to effect sealing engagement of said seal surface, said base plate flange and said clamping ring surface with said first and second portions of said resilient seal member.

10. A heat exchanger as claimed in claim 9 wherein said base plate includes a planar section connected to said coolant tube in liquid-tight relation, an upstanding rim surrounding said planar section, said rim supporting said peripheral flange in spaced relation to said planar section and said peripheral flange terminating in a peripheral

edge, said resilient seal member includes a central portion overlying said edge of said peripheral flange, said flange formed on said header body includes a depending tab defining a continuation of said seal contacting surface overlying a side of said upstanding rim of said base plate and separated therefrom by a portion of said first portion of said resilient seal member, and said flange formed on said header body includes a second depending tab defining a continuation of said seal contacting surface overlying said edge of said peripheral flange and is separated therefrom by said central portion of said resilient seal member.

11. A heat exchanger as claimed in claim 9 wherein said header body flange includes a stop surface spaced from said seal contacting surface a distance greater than the thickness of said base plate flange and less than the combined thickness of said base plate flange and said first and second portions of said resilient seal member and said clamping ring includes a surface urged into contact with said stop surface by said clamping bolts limiting movement of said clamping ring in a direction toward said header body flange establishing sealing engagement between said base plate flange, said seal contacting surface, said clamping ring surface, and said first and second portions of said resilient seal member.

12. A heat exchanger as claimed in claim 11 wherein said base plate includes a planar section connected to said coolant tube in liquid-tight relation, an upstanding rim surrounding said planar section, said rim supporting said peripheral flange in spaced relation to said planar section and said peripheral flange terminating in a peripheral edge, said resilient seal member includes a central portion overlying said edge of said peripheral flange, said flange formed on said header body includes a depending tab defining a continuation of said seal contacting surface overlying a side of said upstanding rim of said base plate and separated therefrom by a portion of said first portion of said resilient seal member, and said flange formed on said header body includes a second depending tab defining a continuation of said seal contacting surface overlying said edge of said peripheral flange and is separated therefrom by said central portion of said resilient seal member.

13. A heat exchanger as claimed in claim 12 wherein said clamping ring includes an edge spaced from said tab of said header body flange defining a continuation of said seal contacting surface overlying said one side of said upstanding rim of said base plate, said edge overlying an opposite side of said upstanding rim and being separated therefrom by a portion of said second portion of said resilient seal member, and wherein the distance between said edge of said clamping ring and said surface defined by said depending tab of said header body flange is greater than the thickness of said rim, but less than the combined thickness of said rim and seal first and second portions of said resilient seal member.

14. A heat exchanger as claimed in claim 1 wherein said heat exchanger includes such headers disposed at opposite ends of said coolant tubes.

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