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(54) **HEAT EXCHANGER SYSTEM**

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F28F 9/04 (2006.01)

(52) **U.S. Cl.** **165/174**; 165/178; 62/525

(58) **Field of Classification Search** 165/174, 165/178; 62/525

See application file for complete search history.

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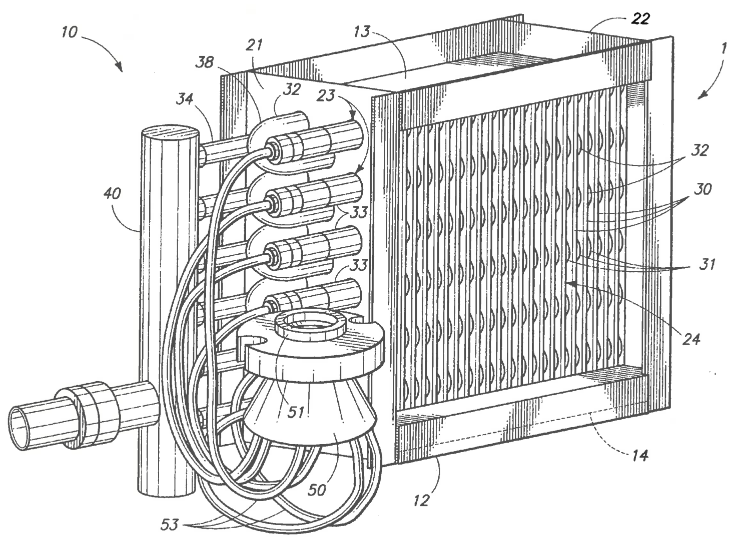
(57) **ABSTRACT**

A heat exchanger system is described and which includes a metal tubular heat exchanger; a fluid distributor conduit fabricated from a metal dissimilar to that of the heat exchanger, and wherein the fluid distributor conduit is connected in fluid flowing relation relative to the metal tubular heat exchanger; and a fluid distributor made of a metal that is similar to that of the fluid distributor conduit, and which is connected in fluid flowing relation relative to the fluid distributor.

8 Claims, 5 Drawing Sheets



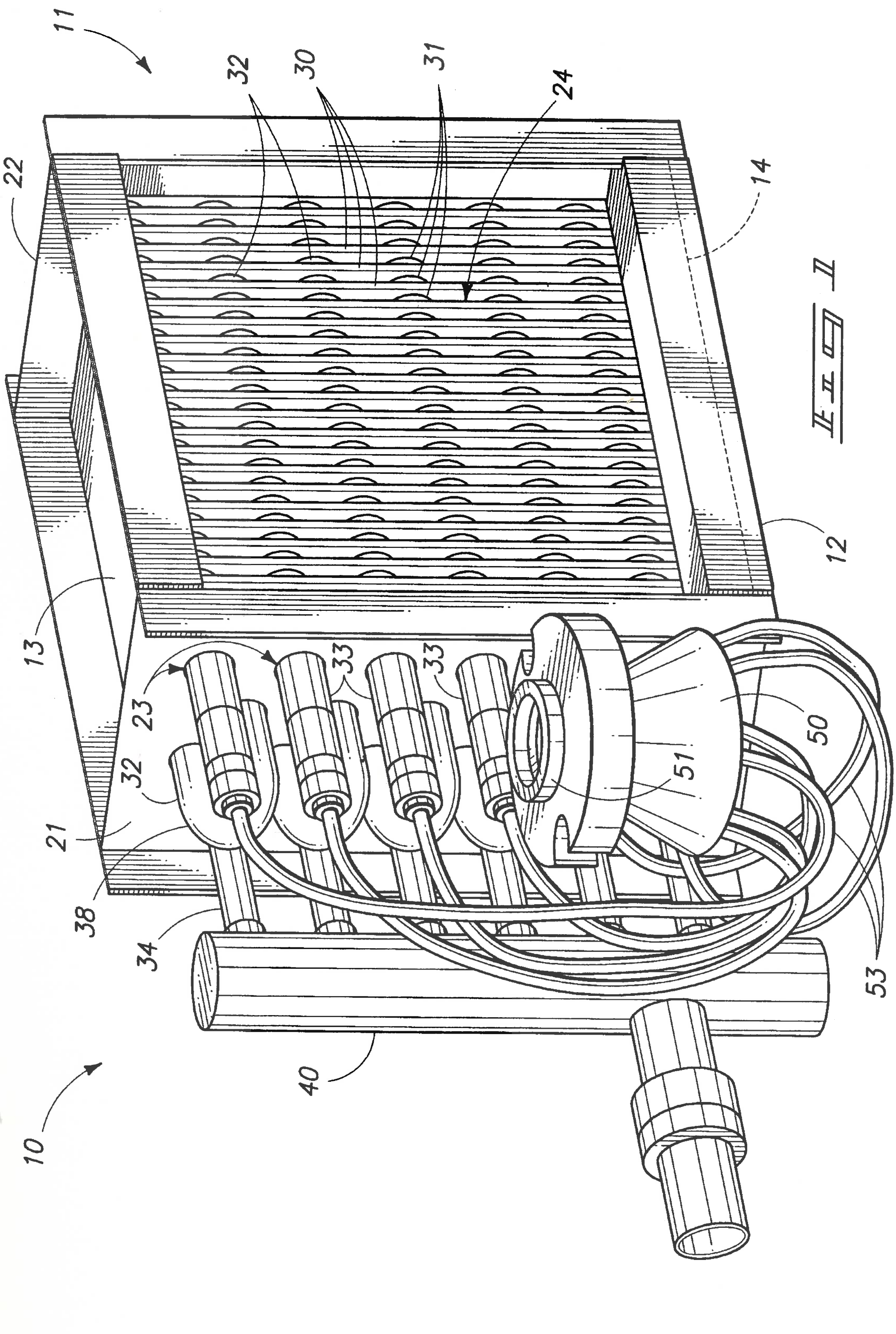


FIG. 1

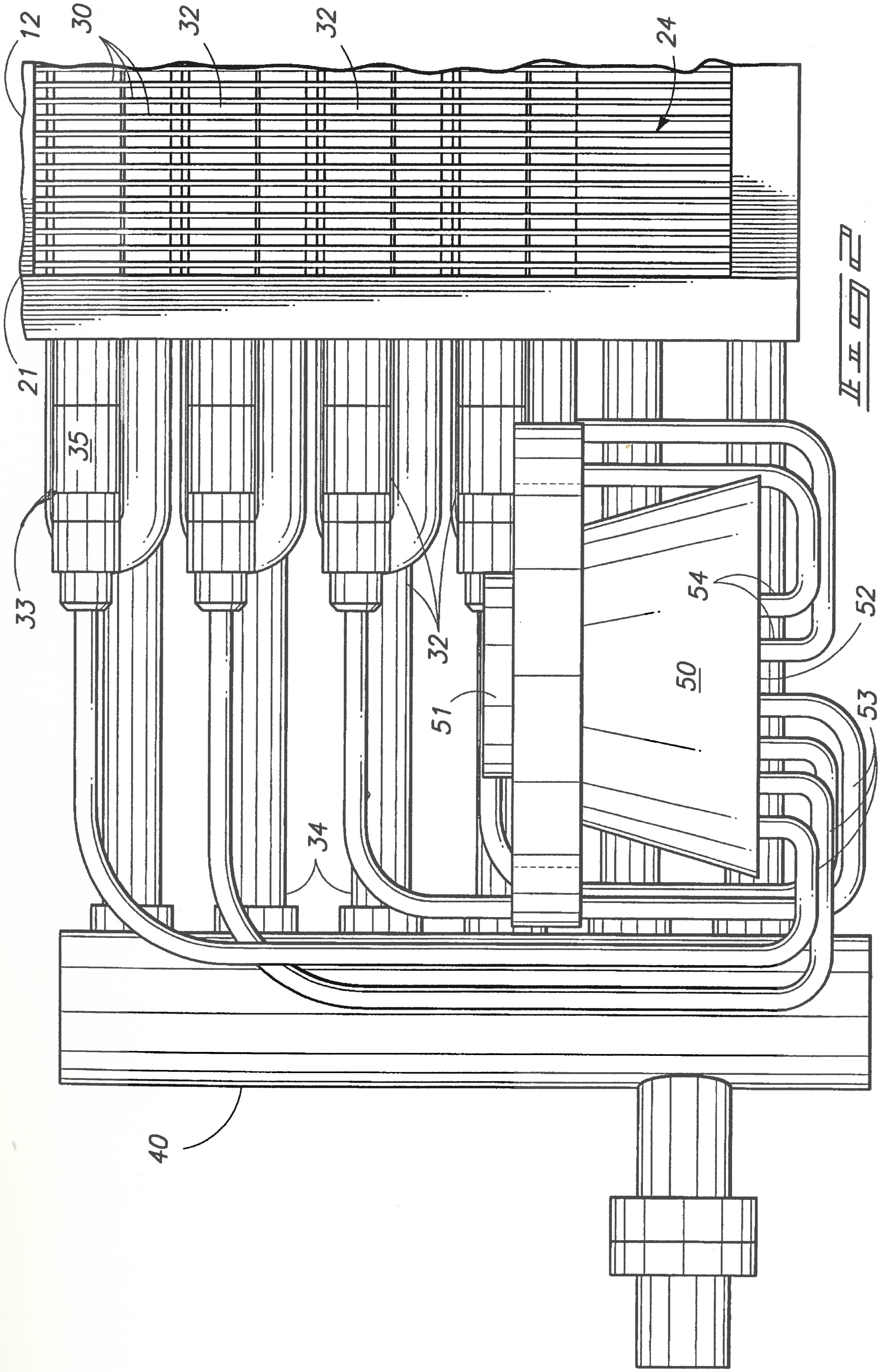


Fig. 2

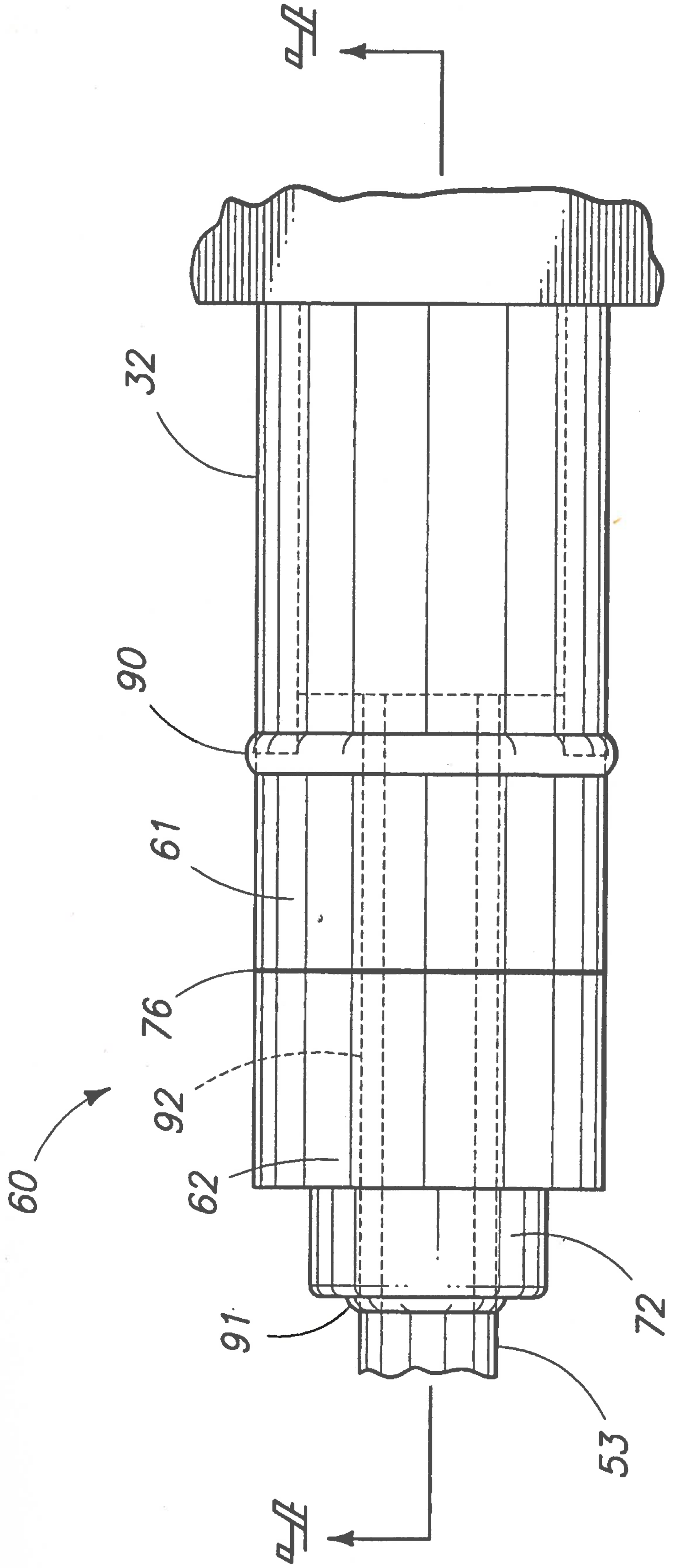


FIG. 3

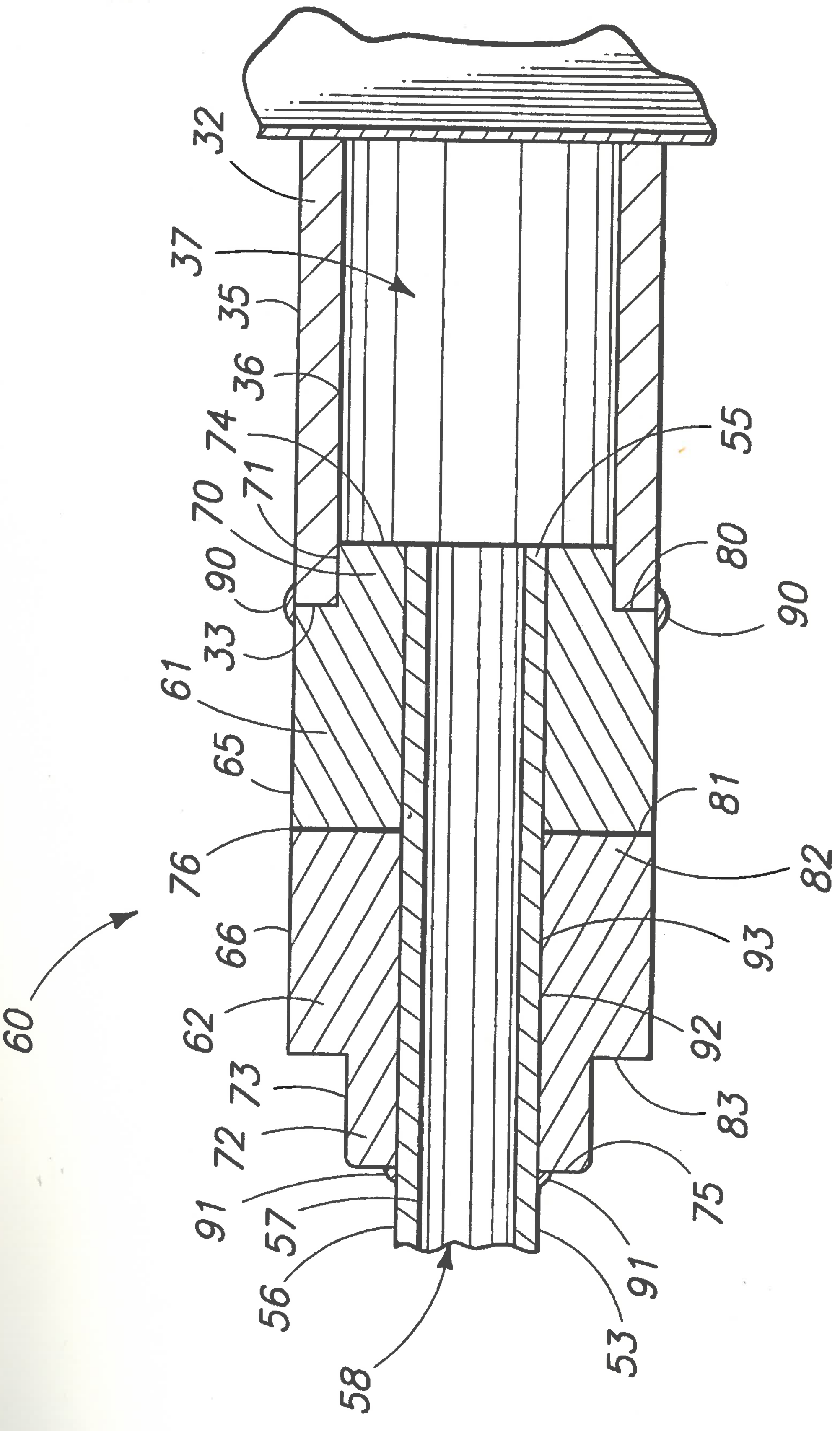

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FIG. 4

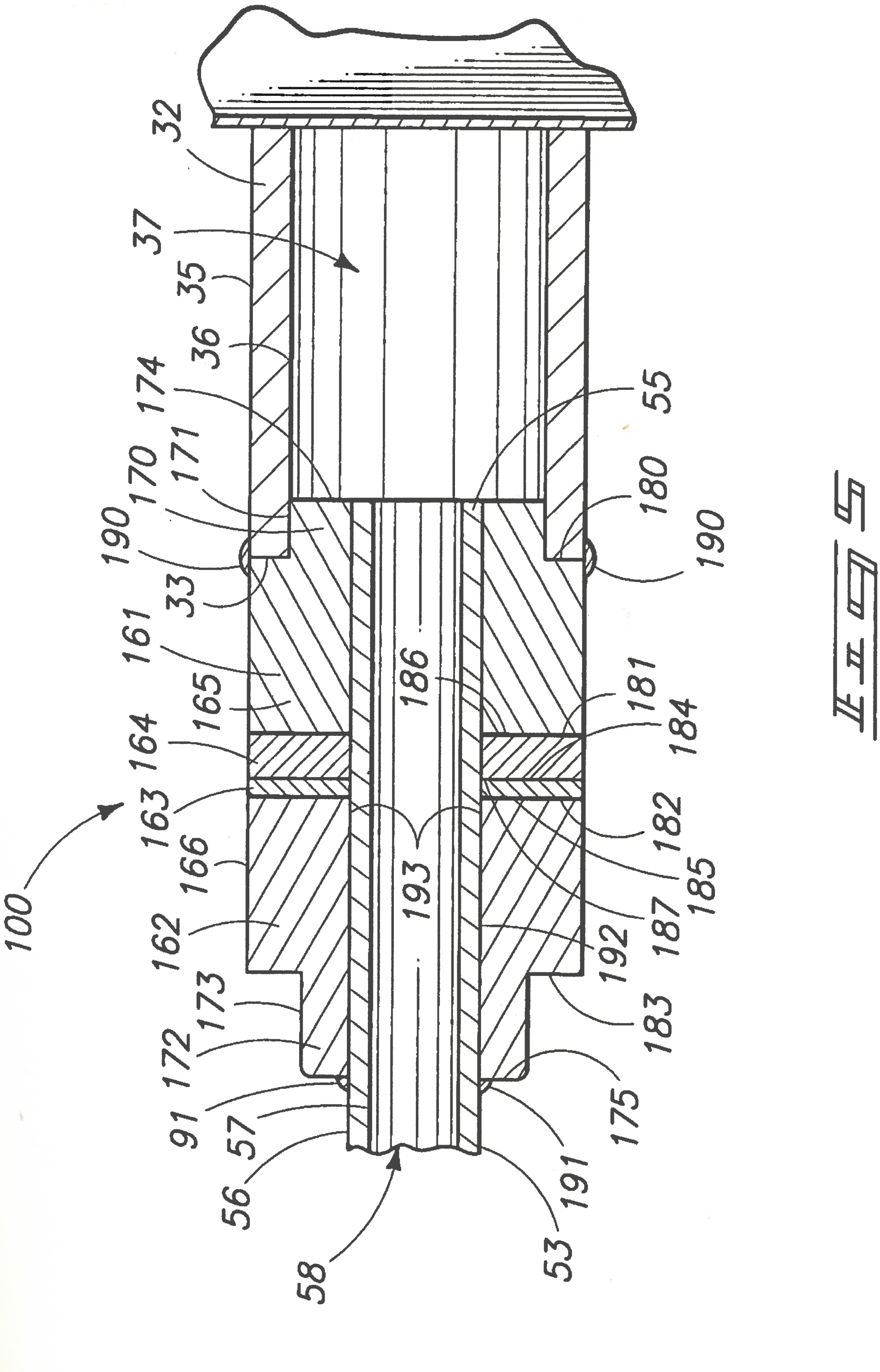
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Fig 5

HEAT EXCHANGER SYSTEM

TECHNICAL FIELD

The present invention relates to a heat exchanger system, and more specifically, to a metal tubular heat exchanger connected to a fluid distributor assembly fabricated from a dissimilar metal.

BACKGROUND OF THE INVENTION

Heat exchanger systems are used in a large variety of industrial, commercial, and consumer applications. Aluminum has been used successfully for many years in the construction of many types of heat exchanger systems due to its physical properties. Aluminum is lightweight, has high thermal conductivity, good corrosion resistance, and further has a relatively low cost. Aluminum is also widely used in industrial heat exchanger systems because of its compatibility with ammonia and halocarbons, which are commonly used with same.

Evaporator heat exchangers, such as those used in industrial refrigeration systems, are fed with refrigerants in a number of different ways. One popular method for controlling the flow of refrigerant to the evaporator is by direct, or "dry," expansion. This method employs an automatic expansion valve which modulates so as to maintain a preset, constant amount of heat at the exit of the heat exchanger. Larger direct expansion evaporators will generally be constructed with two or more parallel refrigerant circuits. Each of these multiple parallel circuits must be supplied with equal amounts of refrigerant from the exit of the expansion valve. To do this, a refrigerant distributor is used to deliver equal mass flow to each of the refrigerant circuits. The refrigerant distributor assembly includes a conical body with an inlet at one end of the conical body and multiple outlet ports which are equally spaced around the perimeter of the base of the body. A small diameter conduit, called a distributor "lead" or conduit, fluidly connects each port in the distributor to each refrigerant circuit in the heat exchanger.

Traditionally, aluminum tube, direct expansion heat exchangers have necessarily utilized aluminum distributor bodies and distributor leads. Because of the difficulties associated with welding small diameter aluminum tubing, these aluminum distributor assemblies and leads have been inherently prone to cracking and leaks, especially in the region surrounding the welding zone located at either end of the respective leads. Ammonia refrigerant leaks, of course, present risks of fire and explosions and immediate health risks to persons nearby. Halocarbon refrigerant leaks present serious environmental problems that may lead to civil liabilities for the user thereof.

In view of the problems associated with the prior art devices and practices utilized heretofore, there has been a long felt need for an improved aluminum heat exchanger system. The prior art is replete with numerous examples of couplers for coupling conduits fabricated from different metals. For example, U.S. Pat. No. 6,886,629 teaches the use of a steel header applied to an aluminum plate heat exchanger. However, the welding method disclosed in that patent does not appear to be useful for a refrigerant distributor assembly having multiple small-diameter tubular leads, such as those used in a direct expansion evaporator heat exchanger. Additionally, mating dissimilar metal tubes using explosion welding or roll bonding is well known in the art. For example, U.S. Pat. No. 6,843,509, which is incorporated by reference herein, teaches an explosively welded coupler for joining a

steel or stainless steel conduit to an aluminum conduit when those conduits have similar outer diameter dimensions. The particular teachings of that patent, however, do not appear to be useful for solving the several problems identified above, and more specifically where a small diameter stainless steel distributor lead must be mated with a larger diameter aluminum heat exchanger tube.

A metal tubular heat exchanger system connected to a fluid distributor fabricated from a dissimilar metal, and which avoids the shortcomings attendant with the prior art devices and practices utilized heretofore, is the subject matter of the present application.

SUMMARY OF THE INVENTION

A first aspect of the invention relates to a heat exchanger system that includes a metal tubular heat exchanger; a fluid distributor conduit fabricated from a metal dissimilar to that of the heat exchanger, and wherein the fluid distributor conduit is connected in fluid flowing relation relative to the metal tubular heat exchanger; and a fluid distributor made of a metal that is similar to that of the fluid distributor conduit, and which is connected in fluid flowing relation relative to the fluid distributor.

Another aspect of the invention relates to a heat exchanger system that includes a plurality of aluminum heat exchanger tubes; a plurality of fluid distributor conduits fabricated from steel or stainless steel; a fluid distributor fabricated from steel or stainless steel, and wherein each of the plurality of fluid distributor conduits is coupled in fluid flowing relation relative to the fluid distributor; and a plurality of couplers for joining each of the plurality of aluminum heat exchanger tubes in fluid flowing relation relative to each of the plurality of fluid distributor conduits.

Yet another aspect of the invention relates to a heat exchanger system that includes a plurality of aluminum heat exchanger tubes; a plurality of fluid distributor conduits fabricated from steel or stainless steel; a fluid distributor fabricated from steel or stainless steel and wherein each of the plurality of fluid distributor conduits is coupled in fluid flowing relation relative to the fluid distributor; and a plurality of couplers for joining each of the of the plurality of aluminum heat exchanger tubes in fluid flowing relation relative to each of the plurality of fluid distributor conduits, and wherein each coupler has a main body which has a first layer of aluminum, and a second layer of steel or stainless steel, and wherein a third layer of chromium is located therebetween the first and second layers, and wherein the first, second, and third layers are roll bonded together, and wherein each of the first, second, and third layers define a passageway which extends therethrough the main body, and wherein the respective aluminum heat exchanger tubes are individually welded to the first aluminum layer of one of the couplers, and the respective fluid distributor conduits are individually welded to the second steel or stainless steel layer of one of the couplers.

Yet another aspect of the invention relates to a heat exchanger system that includes a plurality of aluminum heat exchanger tubes; a plurality of refrigerant distributor conduits fabricated from steel or an stainless steel alloy; a refrigerant distributor fabricated from steel or an stainless steel alloy, and wherein each of the plurality of refrigerant distributor conduits are coupled in fluid flowing relation relative to the refrigerant distributor; and a plurality of couplers for individually joining in fluid flowing relation each of the plurality of aluminum heat exchanger tubes to each of the plurality of refrigerant distributor conduits, and wherein each of the plurality of couplers comprises a substantially annular shaped first aluminum layer which has a first hardness; a substantially annular shaped second aluminum layer which has a second hardness that is less than the first hardness; a substantially annular shaped third titanium layer juxtaposed relative to the second aluminum layer; a substantially annular shaped fourth steel or an stainless steel alloy layer juxtaposed relative to the third titanium layer, and wherein the respective layers are explosively welded together to form a ring shaped main body, and wherein the respective aluminum heat exchanger tubes are welded to the outside facing surface of the first aluminum layer of one of the couplers, and wherein the respective refrigerant distributor conduits are welded to the outside facing surface of the fourth steel or stainless steel alloy layer of one of the couplers.

Still another aspect of the invention relates to a heat exchanger system that includes a plurality of aluminum heat exchanger tubes which have an outside diameter dimension and an inner diameter dimension; a plurality of fluid distributor conduits fabricated from steel or stainless steel; a fluid distributor fabricated from steel or stainless steel and wherein each of the plurality of fluid distributor conduits is coupled in fluid flowing relation relative to the fluid distributor; a plurality of couplers for joining each of the of the plurality of aluminum tubular heat exchanger tubes in fluid flowing relation relative to each of the plurality of fluid distributor conduits, and wherein each coupler has a substantially ring-shaped first layer of aluminum with a first hardness; a substantially ring shaped second layer of aluminum with a second hardness juxtaposed relative to the first layer, and wherein the second hardness is less than the first hardness; a substantially ring-shaped third layer of titanium juxtaposed relative to the second layer; and a substantially ring-shaped fourth layer of steel or stainless steel juxtaposed relative to the third layer, and wherein the first, second, third, and fourth layers circumscribe the fluid distributor conduit and are explosively welded together.

These and other aspects of the present invention will be described in greater detail hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

FIG. 1 is a perspective view of a heat exchanger system utilizing the present invention.

FIG. 2 is a fragmentary, side elevation view of a heat exchanger system utilizing the present invention.

FIG. 3 is a side elevation view of a coupler which forms a feature of the present invention.

FIG. 4 is a longitudinal cross sectional view of a first form of a coupler which forms a feature of the present invention.

FIG. 5 is a longitudinal cross sectional view of an alternative second form of the coupler which forms a feature of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

Referring now to FIG. 1, the present invention is generally designated by the numeral 10. An aluminum tube evaporator heat exchanger 11 is shown, which might be installed in any of a number of industrial, commercial, or consumer applications. The heat exchanger 11 comprises a housing 12, and which is defined by a top surface 13, a bottom surface 14, a front end wall 21, and a back end wall 22. In the aluminum evaporator heat exchanger 11, these components of the housing 12 are typically fabricated from aluminum or an alloy thereof, however, other structural materials such as steel or stainless steel may also be used. The top surface 13, bottom surface 14, front end wall 21, and back end wall 22 together define the housing cavity 24.

Referring still to FIG. 1, the front end wall 21 of the heat exchanger housing 12 further defines a plurality of apertures 23. A plurality of heat exchanger fins or plates 30 are mounted within the housing cavity 24. Most typically, these fins 30 are fabricated of aluminum or other metal with a high degree of heat conductivity, and are substantially equidistantly spaced in order to maximize their ability to transfer heat to the surrounding air. Each of the plurality of fins 30 also define a plurality of substantially co-aligned fin apertures 31 that are also substantially co-aligned with the front wall apertures 23. A plurality of fluid conducting tubes 32, which are also typically fabricated from aluminum or other metal with a high degree of heat conductivity, extend through the fin apertures 30 and the front wall apertures 23. Each of the plurality of fluid conducting tubes 32 in the heat exchanger 11 has a first intake end 33 and a second output end 34. The fluid conducting tubes 32 may include one or more tube bends 38 to allow the tubes to pass through the heat exchanger cavity 24 multiple times between the intake end 33 and the output end 34. The fluid conducting tubes 32 and the fins 30 are mounted in thermal conducting relation one relative to the other in order to facilitate the transfer of heat from one to the other.

Referring now to FIG. 1 and FIG. 2, the evaporator heat exchanger 11 as shown typically has a plurality of aluminum fluid conducting tubes 32 that conduct a refrigerant fluid from a refrigerant fluid distributor 50, through the heat exchanger cavity 24, and then to a suction manifold 40. The refrigerant fluid distributor 50 includes a first fluid intake end 51, and a second fluid discharge end 52. Refrigerant fluid is discharged from the distributor discharge end 52 using a plurality of fluid distributor conduits 53, commonly referred to in the art as distributor "leads." These distributor conduits or leads 53 are typically fabricated from steel, or more preferably, from stainless steel, which provides a higher degree of corrosion resistance. Moreover, the distributor conduits 53 typically have a smaller outside diameter dimension, relatively speaking, than the inside diameter dimension of the aluminum tubes 32 of the heat exchanger. The outside diameter of the distributor conduits 53 typically range in size from about 3/16 to 3/8 inch, while the outside diameter of the aluminum fluid tubes 32 typically range in size from about 3/8 to about 1 inch. The first end 54 of each of the distributor conduits 53 are connected in fluid flowing relation relative to the discharge end 52 of the fluid distributor 50. The second ends 55 of each the distributor conduits 53 are connected to a coupler which is generally indicated by the numeral 60, and which is further discussed in greater detail, below (FIGS. 4 and 5). The coupler 60 connects each of the respective fluid distributor conduits 53 to the respective first end 33 of each of the plurality of aluminum fluid tubes 32. The second end 34 of each of the plurality of aluminum fluid tubes 32 are then connected in fluid flowing relation relative to the expansion valve 40, as shown on FIG. 1. One skilled in the art will recognize that the number, length, and size of the respective refrigerant fluid distributors 50, distributor conduits 53, couplers 60, and aluminum tubes 32 can be varied depending upon the requirements of the application. It will also be recognized that one salient feature of the invention is the ability to utilize a fluid distributor **50** and distributor conduits **53** that are fabricated from steel or stainless steel in conjunction with an aluminum tube evaporator heat exchanger **11** that utilizes aluminum fluid tubes **32**.

Referring now to FIGS. **3-5**, the respective couplers **60** that couple the individual distributor conduits **53** to the aluminum tubes **32** are now discussed in greater detail. Two embodiments of the coupler **60** are shown those being, the first embodiment as shown in FIGS. **3** and **4**; and the second embodiment as illustrated in FIG. **5**. One skilled in the art will recognize that other means for coupling a stainless steel tube to an aluminum tube are possible, and that several variations of the two forms of the couplers as described hereinafter are possible. Also, it will be recognized that the distributor conduits **53** each have an outside facing surface **56**, and an opposite inside facing surface **57**, which defines an internal passageway **58**. Likewise, the aluminum tubes **32** have an outside facing surface **35**, and an opposite inside facing surface **36**, which defines an internal passageway **37**. In the present invention as shown in FIGS. **1-5**, the outside diameter dimension of the distributor conduits **53** is less than the inside diameter dimension of the aluminum tubes **32**.

FIGS. **3** and **4** illustrate the first embodiment of the coupler **60**. In this first embodiment, the coupler **60** includes a first, annular or substantially ring-shaped, aluminum layer **61**, and a second, annular or substantially ring-shaped stainless steel layer **62**. The first aluminum layer **61** has a thickness that is greater than about 0.25 inches, but typically ranges in thickness from about 0.5 to about 0.75 inches. The first aluminum layer **61** further has a main body **65**, which has a first end **80**, and an opposite second end **81**. Extending coaxially outwardly from the first end **80** is a substantially ring shaped coupling or alignment member **70** that extends coaxially outwardly from the main body **65**, and in the direction of the aluminum tube **32**. The coupling member **70** is telescopingly received substantially completely within the aluminum tube **32**. Further, the coupling member is further defined by an outside facing surface **71** and a distal end **74**. The outside diameter dimension of the coupling member **70** is slightly less than about the inside diameter of the aluminum tube **32**, so that the outside facing surface **71** of the coupling member **70** is closely juxtaposed relative to the inside facing surface **36** of the aluminum tube **32** along the circumference thereof. The first end **80** of the main body **65** of the first aluminum layer **61** is abutted against the first end **33** of the aluminum fluid tube **32**

Referring still to FIGS. **3** and **4**, which illustrates the first embodiment of the coupler **60**, the second stainless steel layer **62** of the coupler has a main body **66**, a first end **82**, and an opposite second end **83**. The second stainless steel layer **62** typically has a thickness dimension that ranges from about 0.5 inches to about 0.75 inches. The first end **82** of the second stainless steel layer **62** abuts substantially directly against and is juxtaposed relative to the second end **81** of the first aluminum layer **61**. Extending substantially coaxially outwardly from the second end **83** is a substantially ring shaped member **72** which has an outside facing surface **73**, and a distal end **75**. The first aluminum layer **61**, and the second stainless steel layer **62** are roll bonded together in this embodiment of the coupler **60**. Roll bonding is a technique for bonding two dissimilar metals that is well known in the prior art. Prior to roll bonding, a thin layer of chromium **76** is deposited between the first and second layers **61** and **62**, respectively. The resulting coupler **60** has an outside diameter dimension that is substantially the same as the outside diameter dimension of the aluminum tube **32**, which typically ranges in size from about ⅜ to about 1 inch. The overall length of the coupler ranges from about 0.5 to about 1.0 inch, and is typically about 0.75 inches long. As earlier discussed, the outside diameter of the coupler **60** is substantially the same as that of the aluminum tube, and the first aluminum layer **61** of the coupler **60** is welded directly to the aluminum tube **32** as seen in FIG. **3**. A welding bead **90** can be formed along the outside circumference of the joint between the aluminum conduit **32**, and the coupler **60**. Likewise, a welding bead **91** is formed along the intersection of the distal end **75** of the member **72** and the distributor conduit **53**.

Referring still to FIG. **4**, the first aluminum layer **61**, and the second stainless steel layer **62** each have an interior facing surface **92** which defines a passageway **93**. As seen in FIGS. **3** and **4**, the stainless steel distributor conduit **53** extends substantially through the entire length of the interior passageway **93**, such that the second end **55** of the stainless steel distributor conduit **53** is positioned adjacent to the distal end **74** of the coupling member **70** of the first aluminum layer **61**. Therefore, the coupler **60** thus provides a convenient means of coupling the stainless steel distributor conduit **53** with the aluminum fluid tube **32** of the heat exchanger **11**.

Referring now to FIG. **5**, a second embodiment of the coupler **100** is shown. In this embodiment of the invention, the coupler **100** includes a first, annular or substantially ring-shaped, aluminum layer **161**, which has a main body **165**. The main body has a first end **180**, and an opposite second end **181**. The first aluminum layer **161** further has a thickness dimension that is greater than about 0.25 inches, but typically ranges in thickness from about 0.5 to about 0.75 inches. Extending from the first end **180** is a substantially ring shaped coupling or alignment member **170** that extends substantially coaxially from the main body **165**, and in the direction of, and is received within the aluminum tube or conduit **32**. The coupling member **170** is telescopingly received substantially wholly within the aluminum tube **32**. Further, the coupling member has an outside facing surface **171**. The outside diameter dimension of the coupling member **170** is slightly less than the inside diameter of the aluminum tube **32**, so that the outside facing surface **171** of the coupling member **180** is juxtaposed relative to the inside facing surface **36** of the aluminum tube **32** and along the circumference thereof. The first end **180** of the main body **165** of the first Aluminum layer **161** is abutted against the first end **33** of the aluminum fluid tube **32**.

Referring still to FIG. **5**, the second embodiment of the coupler **100** also includes a second, annular or substantially ring-shaped aluminum layer **164**. The aluminum layer **164** has a first end **186**, and a second end **187**. The second end **181** of the first aluminum layer **161** directly abuts and is juxtaposed relative to the first end **186** of the second aluminum layer **164**. The aluminum that is used to fabricate the first aluminum layer **161** has a hardness (typically that of T4 aluminum) that is greater than that of the second aluminum layer **164**. The second aluminum layer **161** has a thickness that typically ranges from about 0.04 to about 0.10 inches, and it has an outer diameter dimension substantially equal to that of the first aluminum layer. The second embodiment of the coupler **100** also includes a third, annular or substantially ring-shaped titanium layer **163**, which has a first end **184**, and a second end **185**. The second end **187** of the second aluminum layer **164** directly abuts and is juxtaposed relative to the first end **184** of the third titanium layer **163**. The third titanium layer **163** has a thickness dimension that typically ranges from about 0.01 to about 0.03 inches, and it has an outer diameter dimension which is substantially equal to that of the first and second aluminum layers. Finally, the second embodiment of the coupler **100** also includes a fourth, annular or substantially ring-shaped steel or stainless steel layer **162**, which has a main body **166**, and which includes a first end **182**, and an opposite, second end **183**. The second end **185** of the third titanium layer **163** directly abuts, and is juxtaposed relative to, the first end **182** of the fourth steel or stainless steel layer. The fourth steel or stainless steel layer **162** typically has a thickness dimension that ranges from about 0.5 inches to about 0.75 inches, and the main body **166** has an outer diameter dimension substantially equal to that of the first, second, and third layers. Protruding from the second end **183** is a substantially ring shaped member **172** that extends substantially coaxially outwardly from the main body **166**, and in the direction of the distributor conduit **53**. This member **172** has an outer diameter dimension which is typically less than the outer diameter dimension of the main body **166**, and the outside diameter dimension of the coupling member **170**.

Still referring to FIG. **5**, the first aluminum layer **161**, the second aluminum layer **164**, the third titanium layer **163** and the fourth steel or stainless steel layer **162** are explosively welded together to form the second embodiment **100**. Explosion welding is a technique for bonding two dissimilar metals that is well known in the prior art. It will be recognized that roll bonding or explosive welding could be used in either the first or second embodiment of the coupler **60**. As earlier noted, the resulting coupler **60** has an outside diameter dimension that is substantially the same as the outside diameter dimension of the aluminum tube **32**, and which typically ranges from about ⅜ to about 1 inch. The overall length of the coupler ranges from about 0.5 to about 1.0 inch, and is typically about 0.75 inches long. The first aluminum layer **16** of the coupler **60** is welded to the aluminum tube **32**. A welding bead **190** can be formed along the outside circumference of the joint between the aluminum fluid tube **32** and the coupler **60**. Likewise, a welding bead **191** is formed along the intersection of the end **175** of the protruding member **12** of the fourth steel or stainless steel layer **162** and the steel or stainless steel distributor conduit **53**. Further, the first aluminum layer **161**, the second aluminum layer **164**, the third titanium layer **163**, and the fourth steel or stainless steel layer **162** each have an inside surface **192** which defines a passageway **193**. As seen in FIG. **5**, the steel or stainless steel distributor conduit **53** extends substantially through the entire length of the interior passageway **193**, such that the second end **55** of the stainless steel distributor conduit **53** is positioned adjacent to the distal end **174** of the coupling member **170**. Thus, the coupler **100** provides a convenient means of coupling the stainless steel distributor conduit **53** with the aluminum fluid tube or coupler **32** of the heat exchanger **11**.

Operation

The operation of the described embodiment of the present invention is believed to be readily apparent and is briefly summarized at this point.

In its broadest aspect, the present invention relates to a heat exchanger system **10** which includes a metal tubular heat exchanger **11**; a fluid distributor conduit **53** fabricated from a metal dissimilar to that of the heat exchanger **11**, and wherein the fluid distributor conduit is connected in fluid flowing relation relative to the metal tubular heat exchanger **11**; and a fluid distributor **50** made of a metal that is similar to that of the fluid distributor conduit **53**, and which is connected in fluid flowing relation relative to the fluid distributor. In the invention as seen FIG. **1** and following, it should be understood that the metal tubular heat exchanger **11** is fabricated from aluminum and the dissimilar metal comprises steel or stainless steel. Still further, the fluid distributor **50** comprises a refrigerant distributor, and wherein the fluid distributor conduit comprises a plurality refrigerant distributor conduits **53** which are located in a predetermined pattern. In the present invention, the fluid distributor conduit **53** has an outside diameter dimension, and wherein the aluminum tubular heat exchanger **11** includes an aluminum heat exchanger tube **32** with an inside diameter dimension and an outside diameter dimension, and wherein the outside diameter dimension of the fluid distributor conduit **53** is less than the inside diameter dimension of the aluminum heat exchanger tube **32**. In the arrangement as seen in the drawings, the fluid distributor conduit **53** has a first end **54** which is coupled in fluid flowing relation relative to the fluid distributor **50**, and an opposite second end **55** which is coupled in fluid flowing relation relative to the aluminum heat exchanger tube **32**. The second end **55** is circumscribed by an aluminum layer **61/161** which is joined to the aluminum heat exchanger tube **32** by means of welding and the like. In the two forms of the invention as shown in FIGS. **4** and **5**, it will be appreciated that the aluminum layer **61/161**, depending upon the form of the invention, has an outside diameter dimension substantially similar to the outside diameter dimension of the aluminum heat exchanger tube **32** with which it is coupled. Still further, it will be recognized by studying both FIGS. **4** and **5**, that the second end **55** is telescopingly received, at least in part, within the aluminum heat exchanger tube **32**. In one form of the invention, as seen in FIG. **5**, it will be appreciated that the aluminum layer **161** is explosion welded to the steel or stainless steel layer **162**. Still further, in another form of the invention as seen in FIG. **4**, the aluminum layer **61** is roll bonded to the steel or stainless steel layer **62**. In both forms of the invention as seen in FIGS. **4** and **5**, it will be appreciated that a plurality of heat exchanger tubes **32** are provided, and the fluid distributor conduit **53** comprises a plurality of fluid distributor conduits which are individually coupled in fluid flowing relation relative to each of the respective heat exchanger tubes **32**.

Another aspect of the present invention relates to a heat exchanger system **10** which includes a plurality of aluminum heat exchanger tubes **32**; and a plurality of fluid distributor conduits **53** fabricated from steel or stainless steel. The heat exchanger system **10** further includes a fluid distributor **50** fabricated from steel or stainless steel, and wherein each of the plurality of fluid distributor conduits **53** is coupled in fluid flowing relation relative to the fluid distributor **50**. Still further, the heat exchanger system **10** further includes a plurality of couplers **60/100** for joining each of the plurality of aluminum heat exchanger tubes **32** in fluid flowing relation relative to each of the plurality of fluid distributor conduits **53**. In one form of the invention, as seen in FIG. **4**, each of the plurality of couplers **60** has a main body which is formed from a first layer of aluminum **61**, and a second layer of steel or stainless steel **62**, which are roll bonded together, and which further define a passageway **93** therethrough. The main body has a first aluminum end **80**, and an opposite, second, steel or stainless steel end **75**, and wherein each of the plurality of aluminum heat exchanger tubes **32** are individually welded to the first aluminum end **80** of the couplers **60**, and each of the plurality of fluid distributor conduits **53** is welded to the second steel or stainless steel end or surface **75** of one of the couplers. In the arrangement as seen in FIGS. **4** and **5**, and as earlier discussed, the fluid distributor conduits **53** extend substantially through the coupler passageway **93**, and are oriented, at least in part, within the adjoining aluminum heat exchanger tube **32**. Still further, in the arrangements as seen in FIGS. **4** and **5**, the outside diameter dimension of the coupler **60/100** is substantially equal to the outside diameter of the respective aluminum heat exchanger tubes **32**.

In the form of the invention as seen in FIG. **5**, each of the plurality of couplers **100** include a first aluminum layer **161** having a hardness of at least about T4; a second aluminum layer **164** juxtaposed relative to the first aluminum layer **161**, and having a hardness less than that of the first aluminum layer **161**; a third titanium layer **163** juxtaposed relative to the second aluminum layer **164**; and a fourth steel or stainless steel layer **162** juxtaposed relative to the titanium layer **163**, and wherein the first, second, third, and fourth layers **161**, **164**, **163** and **162**, respectively, are explosively welded together. In the arrangement as discussed above, the first aluminum layer **161** has a thickness dimension of at least about 0.25 inches; the second aluminum layer **164** has a thickness dimension of at least about 0.04 inches; the third titanium layer **163** has a thickness dimension of at least about 0.010 inches; and the fourth steel or stainless steel layer **162** has a thickness dimension of at least about 0.5 inches; and wherein the outside diameter dimension of the respective couplers **100** is about equal to the outside diameter dimension of the respective aluminum heat exchanger tubes **32**. In the second form of the invention as seen in FIG. **5**, the coupler **100** further defines a passageway **193** therethrough, and wherein the fluid distributor conduit **53** extends substantially through the coupler passageway **193**. Still further, a portion of the first aluminum layers **161** is received within the respective aluminum heat exchanger tubes **32**.

More specifically relative to the form of the invention as seen in FIG. **4**, a heat exchanger system **10** of the present invention includes a plurality of aluminum heat exchanger tubes **32**; and a plurality of fluid distributor conduits **53** fabricated from steel or stainless steel. Still further, the heat exchanger system **10** as seen in FIG. **4** includes a fluid distributor **50** fabricated from steel or stainless steel and wherein each of the plurality of fluid distributor conduits **53** is coupled in fluid flowing relation relative to the fluid distributor **50**; and a plurality of couplers **60** are provided for joining each of the of the plurality of aluminum heat exchanger tubes **32** in fluid flowing relation relative to each of the plurality of fluid distributor conduits **53**. Each coupler **60** has a main body which has a first layer of aluminum **61**, and a second layer of steel or stainless steel **62**. A third layer of chromium **76** is provided and is located therebetween the first and second layers **61** and **62**, respectively. The first, second, and third layers **61**, **62** and **76**, respectively, are roll bonded together. Each of the first, second, and third layers define a passageway **93** which extends therethrough the main body **66**, and wherein the aluminum heat exchanger tubes **32** are individually welded to the first aluminum layer **61** of one of the couplers **60**. The respective fluid distributor conduits **53** are individually welded to the second steel or stainless steel layer **62** of one of the couplers **60**. As earlier discussed, the fluid distributor conduit **53** extends substantially through the coupler passageway **93** and are positioned, at least in part, within the aluminum heat exchanger tubes **53**. In the arrangement as seen in FIG. **4**, the first and second layers **61** and **62** have substantially the same thickness dimension and the third layer has a thickness dimension which is less than about 5% the thickness dimension of the first and second layers. In the arrangement as seen in FIG. **4**, it is understood that the respective aluminum heat exchanger tubes **32** have an inside diameter dimension, and wherein the first layer of the coupler **61** defines a male member **70** which extends concentrically, outwardly therefrom, and which has an outside diameter dimension which is less than about the inside diameter dimension of the respective aluminum heat exchanger tubes **32**. The male member **70** of the first aluminum layer **61** is received within one of the aluminum tubular heat exchanger tubes **32** as best seen by reference to FIG. **4**.

With respect to the form of the invention as seen in FIG. **5**, a heat exchanger system **10** includes, in one aspect of the invention, a plurality of aluminum heat exchanger tubes **32**; and a plurality of refrigerant distributor conduits **53** fabricated from steel or an stainless steel alloy. Still further, the invention includes a refrigerant distributor **50** fabricated from steel or an stainless steel alloy, and wherein each of the plurality of refrigerant distributor conduits **53** are coupled in fluid flowing relation relative to the refrigerant distributor **50**. Still further, the invention includes a plurality of couplers **100** for individually joining in fluid flowing relation each of the plurality of aluminum heat exchanger tubes **32** to each of the plurality of refrigerant distributor conduits **53**. In this form of the invention as seen in FIG. **5**, each of the plurality of couplers **100** comprises a substantially annular shaped first aluminum layer **161** which has a first hardness; a substantially annular shaped second aluminum layer **164** which has a second hardness that is less than the first hardness; a substantially annular shaped third titanium layer **163** juxtaposed relative to the second aluminum layer **164**; and a substantially annular shaped fourth steel or an stainless steel alloy layer **162** juxtaposed relative to the third titanium layer **163**. In this form of the invention, the respective layers are explosively welded together to form a ring shaped main body, and wherein the respective aluminum heat exchanger tubes **32** are welded to the outside facing surface of the first aluminum layer **161** of one of the couplers. Still further, the respective refrigerant distributor conduits **53** are welded to the outside facing surface of the fourth steel or stainless steel alloy layer **162** of one of the couplers **100**. In this form of the invention, it should be understood that the plurality of couplers **100** each have a length dimension of about 0.5 inches to about 1.0 inch; and an outside diameter dimension of about ⅜ of an inch to about 1.0 inch. Still further, the first aluminum layer **161** has a thickness dimension of about 0.5 inches to about 0.75 inches; the second aluminum layer **164** has a thickness dimension of about 0.04 inches to about 0.10 inches; the third titanium layer **163** has a thickness dimension of about 0.01 inches to about 0.03 inches; and the fourth layer of steel or an stainless steel layer **162** has a thickness of about 0.5 inches to about 0.75 inches. As in the previous discussion, the respective couplers **100** further define a passageway **193** therethrough, and the respective fluid distributor conduits **53** extend through each of the coupler passageways **193**.

Therefore, it will be seen that the present invention provides a convenient means whereby a stainless steel conduit providing a refrigerant may be expeditiously coupled to an aluminum conduit **32** of an aluminum tubular heat exchanger which is generally indicated by the numeral **11**. The present couplers also provide a convenient means for avoiding shortcomings attendant with the prior art practices as described earlier in this application.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

We claim:

1. A heat exchanger system, comprising:

a plurality of aluminum heat exchanger tubes which have an outside diametral dimension, an inside diametral dimension, and a distal end;

a stainless steel refrigerant distributor;

a plurality of stainless steel fluid distributor conduits each having a proximal end which is coupled in fluid flowing relation relative to the stainless steel refrigerant distributor and an opposite distal end, and wherein the respective stainless steel fluid distributor conduits further have an outside diametral dimension, and an inside diametral dimension defining a passageway which extends therethrough, and wherein the outside diametral dimension of the respective stainless steel fluid distributor conduits is less than the inside diametral dimension of the respective aluminum heat exchanger tubes, and wherein the distal ends of the respective stainless steel fluid distributor conduits are telescopingly received within, and coaxially located relative to, the respective aluminum heat exchanger tubes; and

a plurality of couplers for securing the respective stainless steel fluid distributor conduits in fluid flowing relation relative to each of the aluminum heat exchanger tubes, and wherein the respective couplers have a first, annular shaped aluminum end, and a second, annular shaped stainless steel end, and wherein the respective couplers have an outside diametral dimension which is substantially equal to or less than the outside diametral dimension of the respective aluminum heat exchanger tubes, and wherein the respective couplers define a continuous internal passageway which extends along the length thereof, and between the first annular shaped aluminum end, and the second annular shaped stainless steel end, and wherein first annular shaped aluminum end has a male coupling member which extends coaxially outwardly from first annular shaped aluminum end and which has an outside diametral dimension which is less than the inside diametral dimension of the respective aluminum heat exchanger tubes, and wherein the male coupling member is wholly received within the aluminum heat exchanger tubes, and wherein the distal end of the respective aluminum heat exchanger tubes is welded to the first annular shaped aluminum end at a location which is in spaced relation relative to the distal end thereof, and wherein the respective stainless steel fluid distributor conduits are received in the continuous passageway defined by the respective couplers, and further extends substantially through each of the couplers, and wherein the second annular shaped stainless steel end of the coupler is welded to the respective stainless steel fluid distributor conduits at a location where the stainless steel fluid conduit enters the continuous passageway which is defined by the coupler, and which is spaced from the distal end of the stainless steel fluid distributor conduit.

2. A heat exchanger system, as claimed in claim 1, and wherein the first annular shaped aluminum end, and the second annular shaped stainless steel ends are explosion welded together.

3. A heat exchanger system, as claimed in claim 1, and wherein the first annular shaped aluminum end and the second annular shaped stainless steel end are roll bonded together.

4. A heat exchanger system as claimed in claim 1, and wherein the first annular shaped aluminum end includes a first layer of aluminum having a hardness of at least about T4; and a second aluminum layer having a hardness less than the first layer.

5. A heat exchanger system as claimed in claim 4, and further comprising:

a third titanium layer positioned next to the second aluminum layer; and a fourth stainless steel layer, forming the second annular shaped stainless steel end, and wherein the first, second, third and fourth layers are explosively welded together.

6. A heat exchanger system as claimed in claim 1, and further comprising:

a layer chromium located between the first, annular shaped aluminum end, and the second annular shaped stainless steel end, and wherein the first annular shaped aluminum end; chromium layer, and second annular shaped stainless steel end are roll bonded together.

7. A heat exchanger system as claimed in claim 1, and wherein the first annular shaped aluminum end, and the second annular shaped stainless steel end have substantially the same length and thickness dimensions.

8. A heat exchange system, comprising:

a plurality of aluminum heat exchanger tubes having an outside diameter, and an inside diameter which defines a fluid passageway;

a stainless steel fluid distributor conduit coupled in fluid flowing relation relative to each of the fluid passageways defined by the respective aluminum heat exchanger tubes, and wherein the stainless steel fluid distributor conduit has an outside diameter dimension less than the inside diameter of the aluminum heat exchanger tube, and further has a distal end located telescopingly within the fluid passageway which is defined by the respective aluminum heat exchanger tubes; and

a coupler for securing the distal end of the respective stainless steel fluid distributor conduits in fluid flowing relation relative to the respective aluminum heat exchanger tubes, and wherein each coupler has a first aluminum end which is telescopingly received, at least in part, in the passageway defined by the respective aluminum heat exchanger tubes, and a second stainless steel end, and wherein a passageway extends through the coupler from the first aluminum end, to the second stainless steel end, and wherein the individual stainless steel fluid distributor conduits extend through the passageway defined by the respective couplers so that the distal end of the stainless steel fluid distributor conduit is juxtaposed relative to the first aluminum end of the coupler, and wherein the respective aluminum heat exchanger tubes are welded to the first aluminum end of the coupler, and the second stainless steel end of the coupler is welded to the stainless steel fluid distributor conduit at a location which is spaced from the distal end of the stainless steel fluid distributor conduit.

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