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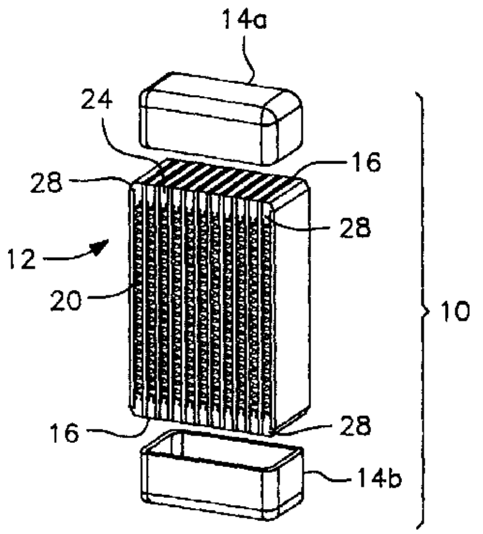
(54)【発明の名称】溝付きスペーサバーを備えたフィン付き管ブロック型熱交換器

(57)【要約】
【課題】押出管に用いられるろう付け特性が向上したフィン付き管ブロック型の熱交換器を提供すること。
【解決手段】フィン（２０）が管（１６）よりも短い全長を有し、フィン（２０）の端部のところには、管（１６）相互間のスペーサバー（２４）として役立つ細長いバー（２４）が設けられているフィン付き管ブロック型熱交換器。スペーサバーの側壁（２４ａ）は好ましくは、互いに向かってテーパしていて、内壁のところのスペーサバーの厚さは、外壁（２４ｂ）のところのスペーサバーの厚さよりも小さくなっている。側壁（２４ａ）は、スペーサバーの長手方向に延びていて、低融点合金（２８）が捕捉的に挿入された１以上の凹部（２６）を有している。ろう付け中、合金は溶融し、毛管作用によりスペーサバーのテーパ側壁（２４ａ）と隣接の管の対向面との間に形成された空間内へ吸い込まれ、完全な継手又は接合部がスペーサバー（２４）と隣接の管（１６）との間に形成される。
【選択図】図１



【特許請求の範囲】
【請求項１】
交互に配置された第１の組をなす流路と第２の組をなす流路を有するろう付けコアを備えた熱交換器に用いられるスペーサバーであって、コアの内部から遠ざかる方向に向いた外壁と、前記外壁と反対側に位置した内壁と、前記外壁と前記内壁との間に延びる互いに反対側に位置した第１の側壁及び第２の側壁とを有し、前記第１の側壁には、少なくとも１つの長手方向凹部が形成され、前記少なくとも１つの凹部は、前記スペーサバーを前記熱交換器のコアの少なくとも一部に結合する結合剤を受け入れるように形作られていることを特徴とするスペーサバー。
【請求項２】
前記第１の側壁は、少なくとも前記内壁に隣接して内方へテーパしていることを特徴とする請求項１記載のスペーサバー。
【請求項３】
前記スペーサバーを前記熱交換器のコアの少なくとも一部に結合する結合剤を受け入れるように形作られた少なくとも１つの長手方向凹部が、前記第２の側壁にも形成されていることを特徴とする請求項１記載のスペーサバー。
【請求項４】
前記第２の側壁は、少なくとも前記内壁に隣接して内方へテーパしていることを特徴とする請求項３記載のスペーサバー。
【請求項５】
前記第２の側壁は、前記外壁に隣接して外方に延びるフランジを有していることを特徴とする請求項１記載のスペーサバー。
【請求項６】
前記第２の側壁は、前記フランジと前記内壁との間で途切れていないことを特徴とする請求項５記載のスペーサバー。
【請求項７】
低融点合金が、前記少なくとも１つの長手方向凹部に挿入されていることを特徴とする請求項１記載のスペーサバー。
【請求項８】
低融点合金が、前記第１及び第２の側壁の各々の前記少なくとも１つの長手方向凹部に挿入されていることを特徴とする請求項３記載のスペーサバー。
【請求項９】
前記第１の側壁には、前記スペーサバーを前記熱交換器のコアの少なくとも一部に結合する結合剤を受け入れるように形作られた少なくとも２つの長手方向凹部が形成されていることを特徴とする請求項１記載のスペーサバー。
【請求項１０】
前記スペーサバーを前記熱交換器のコアの少なくとも一部に結合する結合剤を受け入れるように形作られた少なくとも２つの長手方向凹部が、前記第２の側壁にも形成されていることを特徴とする請求項９記載のスペーサバー。
【請求項１１】
交互に配置された第１及び第２の組をなす流れ通路と、複数の分離壁とを更に有し、前記分離壁は各々、隣り合う第１の組をなす流れ通路と第２の組をなす流れ通路を互いに分離し、スペーサバーは、前記第２の組をなす流れ通路の端部のところで前記分離壁相互間に配置されていることを特徴とする請求項１記載のスペーサバーを有する熱交換器コア。
【請求項１２】
前記スペーサバーの各々の前記第１の側壁には、前記スペーサバーを前記管の少なくとも一部に結合する結合剤を受け入れるように形作られた少なくとも２つの長手方向凹部が形成されていることを特徴とする請求項１１記載の熱交換器コア。
【請求項１３】
前記第２の組をなす流れ通路は、波形フィンで構成され、前記スペーサバーは、前記フィ

ンの端部のところに配置され、前記スペーサバーの各々の前記内壁は、それぞれ対応関係にあるフィンの対向した端部に接触し、前記内壁の縁部が前記分離壁と前記スペーサバーとの間の接合部に入り込むのを阻止するよう構成されていることを特徴とする請求項１１記載の熱交換器コア。

【請求項１４】

フィンによって構成されていて、端部が外側スペーサバーにより、外面がサイドパネルにより、内面が分離壁により境界付けられた最も外側に位置する流れ通路を更に有し、前記外側スペーサバーは各々、外方に向いた側壁と、内方に向いた側壁と、外壁と、内壁と、前記内方に向いた側壁に形成されている少なくとも１つの長手方向凹部とを有し、前記少なくとも１つの凹部は、前記スペーサバーを前記分離壁の少なくとも一部に結合する結合剤を受け入れるように形作られていることを特徴とする請求項１３記載の熱交換器コア。

【請求項１５】

前記外側スペーサバーの各々の前記内壁は、それぞれ対応関係にあるフィンの対向端部に接触し、前記内壁の縁部が前記分離壁と前記外側スペーサバーとの間の接合部に入り込むのを阻止するよう構成されていることを特徴とする請求項１３記載の熱交換器コア。

【請求項１６】

前記第１及び第２の側壁のうちの少なくとも一方は、少なくとも前記内壁に隣接して内方へテーパしていることを特徴とする請求項１１記載の熱交換器コア。

【請求項１７】

前記外側スペーサバーの前記外方に向いた側壁は、上壁に隣接して位置する外方に延びるフランジを有し、前記外方に向いた側壁は、前記フランジと前記内壁との間で途切れていないことを特徴とする請求項１３記載の熱交換器コア。

【請求項１８】

前記外方に向いた側壁は、前記外側スペーサバー内に、前記城壁に隣接して位置する外方に延びるフランジを有し、前記外方に向いた側壁には、前記内壁に隣接して少なくとも１つの長手方向凹部が形成され、前記少なくとも１つの凹部は、前記外側スペーサバーを熱交換器コアの少なくとも１部に結合する結合剤を受け入れるように形作られていることを特徴とする請求項１３記載の熱交換器コア。

【請求項１９】

前記コアは、複数の管から成り、前記管は、前記第１の組をなす流れ通路を形成し、前記分離壁は、前記管の側壁を構成していることを特徴とする請求項１１記載の熱交換器コア。

【請求項２０】

前記管は、押出アルミニウムでできていることを特徴とする請求項１９記載の熱交換器コア。

【請求項２１】

請求項１９記載の熱交換器コアを有する熱交換器であって、前記管の端部のところに第１及び第２のタンクを更に有し、前記管は各々、互いに反対側に位置した端壁及び互いに反対側位置した側壁を有し、前記端壁は、前記タンクをこれに直接取り付けることができるのに十分な厚さのものであることを特徴とする熱交換器。

【請求項２２】

請求項１記載のスペーサバーを有する熱交換器であって、第１及び第２の互いに間隔を置いた互いに平行なタンクと、前記第１及び第２のタンク相互間に延びる第１の組をなす互いに平行な流れ通路を構成する複数の互いに間隔を置いた互いに平行な管とを更に有し、前記管は、互いに反対側に位置した側壁、互いに反対側に位置した端壁、及び側壁相互間に延びて前記第１の組をなす流れ通路を構成するピラーを有し、前記熱交換器は更に、前記管と交互に配置されていて、第２の組をなす互いに平行な流れ通路を構成する波形フィンを有し、前記スペーサバーは、前記管の端部相互間に介在して配置され、前記フィンを受け入れる空間を構成するよう幅が前記管と実質的に同一の広がりをもち、前記フィンは、前記空間内に嵌まるように寸法決めされていることを特徴とする熱交換器。

【請求項２３】
前記スペーサバーは、前記管の側壁に隣接して前記管の端部相互間に介在して設けられ、前記スペーサバーの前記第１の側壁及び第２の側壁は、前記第１及び第２の側壁と隣接の管の側壁との間に隙間を形成するよう少なくとも前記内壁に隣接して内方にテーパしていることを特徴とする請求項２２記載の熱交換器。
【請求項２４】
前記隙間の各々内に融剤及びろう付け材料を更に有していることを特徴とする請求項２３記載の熱交換器。
【請求項２５】
前記スペーサバーの各々の前記内壁は、それぞれ対応関係にあるフィンの対向端部に接触し、前記内壁の縁部が前記管の前記側壁と前記外側スペーサバーとの間の接合部に入り込むのを阻止するよう構成されていることを特徴とする請求項２２記載の熱交換器。
【請求項２６】
フィンによって構成されていて、端部が外側スペーサバーにより、外面がサイドパネルにより、内面が前記管の前記側壁により境界付けられた最も外側に位置する流れ通路を更に有し、前記外側スペーサバーは各々、外方に向いた側壁と、内方に向いた側壁と、外壁と、内壁と、前記内方に向いた側壁に形成されている少なくとも１つの長手方向凹部とを有し、前記少なくとも１つの凹部は、前記スペーサバーを前記分離壁の少なくとも一部に結合する結合剤を受け入れるように形作られていることを特徴とする請求項１３記載の熱交換器。
【請求項２７】
前記外側スペーサバーの前記外方に向いた側壁は、上壁に隣接して位置する外方に延びるフランジを有し、前記外方に向いた側壁は、前記フランジと前記内壁との間で途切れていないことを特徴とする請求項１３記載の熱交換器
【請求項２８】
前記内方に向いた側壁は、前記内方に向いた側壁と隣接の管の側壁との間に形成されていて、融剤及びろう付け材料を受け入れる隙間を形成するよう少なくとも前記内壁に隣接して内方にテーパしていることを特徴とする請求項２６記載の熱交換器。
【請求項２９】
前記外方に向いた側壁には、前記内壁に隣接して少なくとも１つの長手方向凹部が形成され、前記外方に向いた側壁は、前記外方に向いた側壁をそれぞれ対応関係をなすサイドパネルに結合する結合剤を受け入れるように構成されていることを特徴とする請求項２６記載の熱交換器。
【請求項３０】
前記外側スペーサバーの各々の前記内方に向いた側壁及び外方に向いた側壁には、前記スペーサバーを熱交換器コアの少なくとも一部に結合する結合剤を受け入れるよう形作られた少なくとも２つの長手方向凹部が形成されていることを特徴とする請求項２６記載の熱交換器。
【請求項３１】
前記スペーサバーの各々の前記第１の側壁には、前記スペーサバーを前記管の少なくとも一部に結合する結合剤を受け入れるように形作られた少なくとも２つの長手方向凹部が形成されていることを特徴とする請求項２２記載の熱交換器。
【請求項３２】
前記スペーサバーを前記熱交換器のコアの少なくとも一部に結合する結合剤を受け入れるように形作られた少なくとも２つの長手方向凹部が、前記第２の側壁にも形成されていることを特徴とする請求項３１記載のスペーサバー。
【発明の詳細な説明】
【０００１】
〔発明の分野〕
本発明は、熱交換システムの分野に関し、特に、押出管に用いられるろう付け特性が向上

したフィン付き管ブロック型の熱交換器に関する。
【０００２】
〔関連技術〕
従来型プレートフィン型熱交換器は、とりわけ米国特許第４，２７６，９２７号、第４，４７３，１１１号及び第４，７２９，４２８号から知られている。かかる熱交換器は、一方向に延びる第１の組をなす互いに平行な流れ通路と第２の全体として垂直に差し向けられた流れ通路の構造とを交互に配置したものであることを特徴とし、流れ通路の第１及び第２の組は、プレートによって分離され、構成部品の順序は、多層サンドイッチコアを形成するよう繰り返されている。第１の流体は、第１の組をなす流れ通路に差し向けられ、第２の流体は、第２の組をなす流れ通路を通り、これらの間で熱交換が行われる。一般に、対をなす平らなプレート相互間に設けられたスペーサによって形成される第１の組をなす流れ通路の形状、間隔及び向きは、プレートスペーサ層相互間に設けられた波形の又は曲がりくねったフィンによって全体が構成される第２の組をなす流れ通路のものとは幾分異なっている。
【０００３】
上記２組の流れ通路の構成に応じて、サンドイッチ型のコアを形成するのに必要な部品相互間の結合を行う際に問題が生じる。一方向に配列された流れ通路は、他の方向に延びる流れ通路又はフィンに結合されなければならない。これは、米国特許第４，４７３，１１１号及び第６，０１９，１６９号に示されているようなヘッダーバー及びエンドピースを用いることにより達成できる。結合面の表面積が制限されているために問題が生じる場合が多い。結合面を広くすると共に強度を増大させることは、米国特許第４，７２９，４２８号に教示されているように肉盛り端部又は側壁により可能になる。
【０００４】
従来技術のプレートフィン型熱交換器は、多くの個々の部品を必要とするので、潜在的に多くの漏れ経路がある。この問題は、米国特許第６，０１９，１６９号に教示されているようにプレートスペーサ層に代えて押出管を用いることにより解決できる。しかしながら、押出品を用いる場合、特に、熱交換器コア部品がアルミニウムで作られている場合には別の問題が生じる。
【０００５】
従来型プレートフィン型熱交換器では、ろう付けされたアルミニウムコアが、ろう付け作業中、組立体を互いに結合するために低融点合金を構成部品のうち１以上の材料上に被覆する。押出品は、金属被覆には向かない。したがって、管をフィンに結合するろう付け材料は、粉末状ろう付け材料を結合剤に入れた状態で管に塗布するか、あるいは、低融点合金をフィン材料に被覆することによって行うのがよい。しかしながら、粉末状ろう付け材料を結合剤に入れた状態で管に塗布する手法では、ろう付け材料の量は、首尾一貫して管をヘッダーバーに結合するほど十分ではない。
したがって、押出管を対応のヘッダーバーに効率的且つ首尾一貫して結合することができるフィン付き管ブロック型熱交換器構造が要望されている。
【０００６】
〔発明の概要〕
上記のことに鑑みて、本発明の一目的は、ろう付け工程中、押出し加工された熱交換管をスペーサバーに結合する際に生じる問題を解決することにある。
【０００７】
本発明の別の目的は、管とバーとの間の接合部中への融剤及びろう付け材料の毛管作用による流れを促進し、それによりこれら相互間に完全な接合部を形成するよう構成されたスペーサバーを有するフィン付き管ブロック型熱交換器を提供することにある。
【０００８】
本発明の別の目的は、簡単に製造できるが、従来型押出管熱交換システムと比べて優れた結合性能を生じさせることができる押出管構造を提供することにある。
【０００９】

上記目的及び他の目的を考慮して、本発明は、押出し管が波形フィンと交互に配置されているフィン付き管ブロック型熱交換器であって、フィンが管よりも短い全長を有し、フィンの端部のところには、管相互間のスペーサバーとして役立つ細長いバーが設けられているフィン付き管ブロック型熱交換器に関する。スペーサバーは、これらの外壁に隣接して管の側壁に当接する互いに反対側に位置した側壁を有する。一実施形態では、スペーサバーの側壁は、互いに実質的に平行であり、これらの内壁に隣接して管の側壁に当接する。別の実施形態では、スペーサバーの側壁は、管の側壁から間隔を置いて位置し、スペーサバーの側壁は、互いに向かってテーパしていて、内壁のところでのスペーサバーの厚さは、外壁のところのスペーサバーの厚さよりも小さくなっている。

【００１０】

スペーサバーの側壁は、スペーサバーの長手方向に延びていて、低融点合金が捕捉的に挿入される１以上の凹部又は溝を有する。スペーサバーの側壁が互いに平行な実施形態では、ろう付けは、溝の局部領域でのみ生じるが、コアの構造的健全性をもたらすには十分である。スペーサバーの側壁が互いに向かってテーパしている実施形態では、ろう付け中、合金は溶融し、毛管作用によりスペーサバーのテーパ側壁と隣接の管の対向面との間に形成された空間内へ吸い込まれ、完全な接合部又は継手がスペーサバーと隣接の管との間に形成されるようになっている。

【００１１】

本発明の他の目的、特徴及び利点は、当業者であれば、添付の図面を参照して以下の詳細な説明を読むと明らかになろう。

本発明の内容は、添付の図面を参照して好ましい実施形態についての以下の詳細な説明を読むと一層よく理解されよう。なお、図中、同一の符号は、同一の要素を示している。

【００１２】

〔好ましい実施形態の詳細な説明〕

図面に示した本発明の好ましい実施形態の説明を行なうにあたり、分かりやすくするために特定の用語を用いる。しかしながら、本発明は、選択された特定の用語には限定されず、各特定の用語は、同一の目的を達成するよう同一の仕方で動作する全ての技術的均等物を含むことは理解されるべきである。

【００１３】

次に図１及び図２を参照すると、フィン付き管ブロックタイプ熱交換器１０の第１の実施形態が示されている。熱交換器１０は、コア１２と、コア１２の各端に設けられた第１のタンク１４ａ及び第２のタンク１４ｂとで構成されている。タンク１４ａ，１４ｂは、従来通り流体入口及び出口（図示せず）を備えている。

【００１４】

コア１２は、タンク１４ａ，１４ｂ相互間に延びる第１の組をなす互いに平行な流れ通路１８を構成する複数の互いに平行な管１６と、管１６と交互に配列されていて、全体として第１の組をなす流れ通路に対して垂直に差し向けられた第２の組をなす互いに平行な流れ通路２２を構成する波形フィン２０とを有している。

【００１５】

各管１６は好ましくは、押出し加工されていて、アルミニウム製であり、各管は、第１の組をなす流れ通路１８を構成するために反対側の側壁１６ａ、互いに反対側の端壁１６ｂ及び側壁１６ａ相互間に延びるピラー１６ｃを有している。管１６は好ましくは押出し加工されるので、側壁１６ａ，端壁１６ｂ及びピラー１６ｃは一体成形される。第１の組をなす流路１８を構成することに加えて、ピラー１６ｃは又、ろう付け中及び熱交換器１０の動作中、側壁１６ａの内面を支持する。端壁１６ｂは、タンク１４ａ，１４ｂ（図１に示す）又は従来型ボルト止めフランジ５０（これは、図１４に示すようにコア１２と従来型タンク５２及び従来型密封バスケット５４との間のインタフェースを形成する）を管１６の縁部に直接溶接できるほどの厚さのものである。

【００１６】

参照符号３で示した領域は、図３に詳細に示されている。図示のように、ピラー１６ｃは

、側壁１６ａに実質的に垂直に差し向けられている。しかしながら、当業者には理解されるように、ピラーの他の形態を用いてもよく、従って、流路１８は、断面が正方形又は矩形ではなく、円形又は三角形、或いは他の形状のものであってよく、かかるピラーの他の形態としては、強化処理型、ディンプル付き型、詰め物入り型が挙げられる。
【００１７】
細長いスペーサバー２４が、管１６の端部相互間に設けられていて、これらスペーサバーは、管１６と幅が実質的に同一の広がりをもっていて、フィン２０を受け入れる空間を構成しており、これらフィンは、かかる空間に嵌入するように寸法決めされている。各スペーサバー２４は、互いに反対側の側壁２４ａ、外壁２４ｂ及び内壁２４ｃを有している（図５に示されている）。管の側壁１６ａは、スペーサバー２４の側壁２４ａ及びフィン２０にろう付けにより接合されている。
【００１８】
上述したように、従来型プレートフィン付きタイプ熱交換器では、ろう付けされたアルミニウムコアは、低融点合金を構成部品の１以上の材料上に被覆する。その目的は、ろう付け中、組立体を互いに結合することにある。押出成形は被覆加工には向いていない。さらに、粉末状ろう付け材料を結合剤に入れた状態で管１６に塗布しても、管をスペーサバー２４に首尾一貫して接合するのに十分なろう付け材料は得られないであろう。本発明によれば、凹部２６をスペーサバー２４の側壁２４ａに形成することにより、管１６とスペーサバー２４との間の隙間を増大させないで、低融点合金２８をスペーサバー２４内に捕捉的に挿入することが可能である。管１６をスペーサバー２４に結合するのに必要な合金材料２８の量は、凹部２６の寸法形状及び用いられる結合材料の種類を特定することによって決定できる。本発明の一実施形態では、合金材料２８は、凹部２６の長さにわたって延びるワイヤの形態をしているのがよい。ワイヤが溶融すると、ワイヤは、漏れのない継手又は接合部を形成し、液体クラッドは、バーと管との間の境界面領域内へ流入し、冷却時にここで凝固する。
【００１９】
図示のようなワイヤは断面が円形であるが、ワイヤは、他の断面形状をしていてもよく、また凹部２６の形態をそれに応じて変えてもよいことは理解されよう。
【００２０】
スペーサバー２４の外壁２４ｂは、実質的に平らであり、管１６の端部と面一をなしている。好ましい実施形態では、内壁２４ｃに隣接した側壁２４ａは、互いに向かって内方に僅かにテーパしている。このテーパは、側壁２４ａの長さ全体にわたって延びるのがよい。このテーパの目的は、管とバーの接合部（以下、「管－バー接合部」又は「バー－管接合部」という場合がある）内への毛管作用による融剤及びろう付け材料の流れを促進し、完全な接合部が形成されるようにすることにある。テーパの角度は、かかる機能に関して重要ではないが、最良の結果は、側壁２４ａと凹部２６に隣接した管１６の互いに向かい合った面相互間の隙間３０が最高約０．０１５インチ（０．３８１ｍｍ）、好ましくは、隙間３０が約０．００３インチ（０．０７６２ｍｍ）の場合に得られる。テーパがあるために、凹部２６は、互いに反対側に位置したスペーサバー２４の各対相互間に形成された空間と連通状態にある。かくして、融剤及びろう付け材料は又、スペーサバーの内壁２４ｃとフィン２０の端部の間の接合部まで流れることができる。
【００２１】
図５に示すような内壁２４ｃは、断面が山形をしている。この山形の形状は、ピーク部３２を提供し、その目的は、フィン２０の対向した端部に接触し、内壁２４ｃの縁部がバー－管接合部に入ってろう付け材料を引き出すのを防止することにある。内壁２４ｃは、これまたピーク部をもたらす他の断面形状のものであってもよく、かかる断面形状としては、三角形又は突起を備えた平面が挙げられるが、これらには限定されないことは理解されよう。
【００２２】
図１及び図２で示すように、最も外側の流路は、フィン２０、フィン２０の端部のところ

に設けられた外側スペーサバー４０及びサイドパネル４２によって構成されている。参照符号４で示された領域が図４に詳細に示されており、図１１に最もよく示されている。
【００２３】
これらの図に示すように、外側スペーサバー４０は、管１６相互間に設けられたスペーサバー２４と異なる形態をしている。各外側スペーサバー４０は、外方に向いた側壁４０ａ、内方に向いた側壁４０ｂ、外壁４０ｃ及び内壁４０ｄを有している。管１６と外側スペーサバー４０との間の隙間を増大させないで、低融点合金を外側スペーサバー４０内で捕捉的に挿入するために凹部４４が内向きの側壁４０ｂに形成されている。これら凹部４４は、ろう付け材料を保持することができる任意の形状のものであってよい。
【００２４】
スペーサバー４０の外壁４０ｃは、実質的に平らであり、管１６の端部と面一をなしている。好ましい実施形態では、管１６に隣接した内向きの側壁４０ｂは、パネルとバーの接合部（以下、「パネルーバー接合部」又は「バーーパネル接合部」という場合がある）内への毛管作用による融剤及びろう付け材料の流れを促進し、完全な接合部が形成されるようにするために内方に僅かにテーパしている。かくして、テーパをそれに応じて寸法決めする必要がある。サイドパネル４２に隣接して位置する外方に向いた側壁４０ａは、実質的に平らであり、ストリップ状のろう付け材料によりサイドパネル４２の対向面に取り付けられており、このストリップ状ろう付け材料は、接合されるべき表面を覆っている。好ましい実施形態では、このストリップは厚さが０．００５インチ（０．１２７ｍｍ）である。側壁４０ａは接合されるべき表面を覆うストリップによって取り付けられているので、バーーパネル接合部のところのテーパは不要である。変形例として、外方に向いた側壁４０ａを溶接ワイヤによってサイドパネル４２の対向面に取り付けてもよい。内壁４０ｄは、外方に向いた側壁４０ａと内方に向いた側壁４０ｂの両方からテーパしていてフィン２０の対向端部に接触するピーク部２９を形成している。
【００２５】
好ましい実施形態では、外側スペーサバー４０の外方に向いた側壁４０ａは、外方に延びるフランジ部分４６を有している。サイドパネル４２は、熱交換器１０の各側に設けられた互いに反対側に位置したフランジ部分４６相互間に嵌まるように寸法決めされている。好ましくは、外側スペーサバー４０の側壁４０ａ，４０ｂは両方とも、内側スペーサバー２４の側壁２４ａよりも長い。このように長さが長いことにより、フランジ部分４６によって占められた領域を補償する一層広い表面積がバーーパネル接合部について得られる。
【００２６】
本発明は、各側壁に凹部が１つだけ設けられたスペーサバーには限定されない。スペーサバーは、スペーサバーと管との間に漏れのない接合部を構成することが望ましい状況では各側壁に２以上の凹部を有するのがよい。次に図６を参照すると、本発明の別の実施形態、具体的にはスペーサバー１２４が示されており、このスペーサバー１２４では、内壁１２４ｃに隣接して各側壁１２４ａに２つの凹部１２６が形成されている。各凹部１２６は、充填材１２８が入れられた状態で示されている。充填材１２８は、スペーサバーの幅全体にわたって延びるワイヤとして具体化されたものであるのがよい。図６に示すように、多数の凹部１２６を、側壁１２４ａを互いに向かって内方にテーパさせること、最高約０．０１５インチの矢印で示した隙間１３０及び好ましくは約０．００３インチの隙間と組み合わせてもよい。
【００２７】
図７及び図８に示す変形実施形態では、スペーサバー１２４，３２４のそれぞれの側壁２２４ａ，３２４ａは、これらの長さ全体にわたって互いに実質的に平行であり、スペーサバー２２４，３２４のそれぞれの内壁２２４ｃ，３２４ｃと外壁２２４ｂ，３２４ｂの両方に隣接して位置する管１６の側壁に当接するようになっている。これら実施形態では、ろう付けは、凹部２２６，３２６の局部領域でのみ起こり、かかるろう付けは、コア１２の構造的健全性を得るのに十分である。これら実施形態は、例えば管１６の端部から管ーバー接合部までのろう付け材料の流れが必要ではなく、或いは望ましくない場合に用いら

れる。図７に示すように各側には１つの凹部２２６、図８に示すように各側には２つの凹部３２６、さらに、特定の用途に合うように各側に任意の個数の凹部を設けるのがよい。
【００２８】
スペーサバーの側壁のテーパは、クラッドの流れを一層広い表面積にわたってもたらすので優れた結合結果が得られる。しかしながら、漏れのないようにするには、管－バー接合部は、内部環境と外部環境との間に例えば溶接ワイヤがもたらすことができる薄いバリヤを必要とするに過ぎない。
【００２９】
次に図９及び図１０を参照すると、管１６の側壁とスペーサバー４２４，５２４のそれぞれの側壁４２４ａ，５２４ａとの間に種々の構成を有する本発明の更に別の実施形態が示されている。図９は、各凹部４２６が側壁４２４ａの各々に設けられ、空間４３０が側壁４２４ａと管１６の側壁との間に維持される内壁４２４ｃにすぐ隣接した部分を除き、側壁４２４ａが管１６の側壁に当接するよう互いに実質的に平行であるスペーサバー４２４を示している。充填材４２８は、断面が変形のワイヤの形態をしており、凹部４２６が、凹部４２６と管１６の側壁の境界面領域のところに非常に細い毛管領域４６０を構成するよう形状が充填材４２８と実質的に相補している。図１０は、隣接の側壁５２４ａについて別の輪郭を備えたスペーサバー５２４を示している。図１０の実施形態では、側壁５２４ａは又、互いに実質的に平行であり、２つの凹部５２６を有しているが、これら凹部５２６は、凹部５２６と管１６の側壁の境界面領域のところにクラッド流のための広い毛管作用領域５５０をもたらすように形作られている。特に、充填材５２８は、断面が円形のワイヤであり、凹部５２６は、フレア状側部を有している。
【００３０】
図６～図１０に示すような内壁１２４ｃ，２２４ｃ，３２４ｃ，４２４ｃ，５２４ｃは、図５に示す内壁２４ｃの断面と類似した山形の断面を有している。図５に示す内壁２４ｃの場合と同様、この山形の形状は、それぞれ符号１４６，２４６，３４６，４４６，５４６で示したピーク部を備えており、その目的は、フィン２０の対向端部に接触し、内壁１２４ｃ，２２４ｃ，３２４ｃ，４２４ｃ，５２４ｃの縁部がバー－管接合部に入ってろう付け材料を引き出すのを阻止することにある。
【００３１】
次に図１２を参照すると、内側スペーサバー１２４と関連してコア内に用いられる外側スペーサバー１４０の実施形態が示されている。この実施形態では、外側スペーサバー１４０の内方に向いた側壁１４０ｂは、内方にテーパしていて、充填材１２８が入った多数の凹部１４４を有している。外方に向いた側壁１４０ａは、テーパしていないが、これ又、非充填材１２８の入った多数の凹部１４４を有している。内壁１４０ｃは、スペーサバー１２４の内壁１２４ｃと類似した山形の形状をしている。凹部２６を用いる側壁２４と管１６との間の接合部の場合と同様、外方に向いた側壁１４０ａを、溶接ワイヤを凹部１４４に挿入し、その後、溶解させて凝固させることによりサイドパネル１４２に接合するのがよい。
【００３２】
本発明の更に別の実施形態、特に、内側スペーサバー３２４と連携してコア内に用いられる外側スペーサバー３４０の実施形態が図１３に示されている。外側スペーサバー３４０では、内壁３４０ｄに隣接して内方に向いた側壁３４０ｂに凹部３４４が形成されている。追加の凹部を同様な方法で内方に向いた側壁３４０ｂに設けるのがよい。スペーサバー３２４の場合と同様、外側スペーサバー３４０と管１６の側壁との間に漏れのない接合部を構成するために場合によっては多数の凹部３４４が場合によっては内方に向いた側壁３４０ｂに必要である。外方に向いた側壁３４０ａには凹部が設けられていない。この実施形態も又、外方に向いた側壁３４０ａ及び内方に向いた側壁３４０ｂが互いに実質的に平行であり、内方に向いた側壁３４０ｂが内方にテーパしていない形態を示している。この実施形態では、ろう付けは、凹部３４４の局部領域でのみ生じるが、コアの構造的健全性をもたらすには十分である。

【００３３】
上記説明より図面は、本発明の原理の例示に過ぎないものであることは理解されるべきである。本発明は、開示した具体的な実施形態及び図示して説明した構造及び作用そのものに限定されない。当業者であれば上述の教示に照らして本発明の上記実施形態の改造例及び変形例を想到できる。例えば、スペーサバー２４を、第１の組をなす流体通路が一体成形された管によってではなく、対をなす隣り合うプレート相互間に設けられたスペーサによって構成されるプレート－フィン型熱交換器に用いることができることは理解されよう。したがって、特許請求の範囲に記載された本発明の範囲及びその均等範囲内で本発明は具体的に記載した形態以外の形態で実施できる。

【図面の簡単な説明】

【図１】
本発明の第１の実施形態としての上方タンク及び下方タンクを備えたフィン付き管ブロック型熱交換器の斜視図である。

【図２】
図１のフィン付き管ブロック型熱交換器の斜視図である。

【図３】
図２に破線で囲んだ円形領域３の拡大図である。

【図４】
図２に破線で囲んだ円形領域４の拡大図である。

【図５】
図１に示す熱交換器の内側スペーサバーの端面図である。

【図６】
図１に示す熱交換器の内側スペーサバーの変形実施形態の端面図である。

【図７】
図１に示す熱交換器の内側スペーサバーの変形実施形態の端面図である。

【図８】
図１に示す熱交換器の内側スペーサバーの変形実施形態の端面図である。

【図９】
図１に示す熱交換器の内側スペーサバーの変形実施形態の端面図である。

【図１０】
図１に示す熱交換器の内側スペーサバーの変形実施形態の端面図である。

【図１１】
図１に示す熱交換器の外側スペーサバーの端面図である。

【図１２】
図１に示す熱交換器の外側スペーサバーの端面図である。

【図１３】
図１に示す熱交換器の外側スペーサバーの端面図である。

【図１４】
図１の熱交換器の外はスペーサバーの変形実施形態の端面図である。

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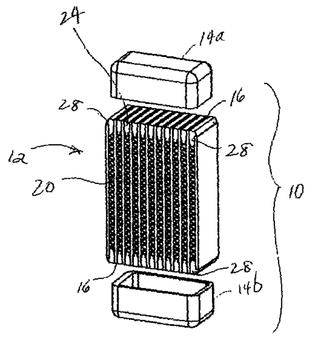
(54) Title: FIN-TUBE BLOCK TYPE HEAT EXCHANGER WITH GROOVED SPACER BARS



(57) Abstract: A fin-tube block type heat exchanger (10) in which extruded tubes (16) are alternatingly arranged with corrugated fins (20), the fins (20) being shorter in overall length than the tubes (16) and having elongated bars (24) at their ends serving as spacer bars (24) between the tubes (16). The side walls (24a) of the spacer bar preferably taper towards each other such that the thickness of the spacer bar at the inner wall is less than the thickness of the spacer bar at the outer wall (24b). The side walls (24a) include one or more recesses (26) or grooves extending lengthwise with the spacer bar into which low temperature melting alloy (28) is captively inserted. During brazing, the alloy melts and is drawn by capillary action into the space created between the tapered side walls (24a) of the spacer bar and the facing surfaces of the adjacent tubes so that a complete joint is formed between the spacer bar (24) and the adjacent tubes (16).

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FIN-TUBE BLOCK TYPE HEAT EXCHANGER WITH GROOVED SPACER BARS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to the field of heat exchanger systems and, more particularly, to a heat exchanger of the fin-tube block type, and having improved brazing characteristics for use with extruded tubes.

2. Related Art

Prior art plate-finned style heat exchangers are known from U.S. Patent Nos. 4,276,927, 4,473,111 and 4,729,428, among others. Such heat exchangers are characterized by a first set of parallel flow passages extending in one direction and alternating with a second, generally perpendicularly-oriented, arrangement of flow passages, the first and second sets being separated by a plate and the sequence of components being repeated to form a multi-layer sandwich core. A first fluid is directed through the first set of flow passages, while a second fluid passes through the second set of flow passages, with heat being exchanged therebetween. Generally the shape, spacing, and orientation of the first set of flow passages, which are defined by spacers interposed between pairs of flat plates, differs somewhat from that of the second set of flow passages, which are generally defined by corrugated or serpentine fins interposed between the plate-spacer layers.

Depending on the construction of the two sets of flow passages, difficulties arise when effecting the necessary bonding of the components to create the sandwich-type core. The flow passages arranged in one direction must be bonded to the flow passages or fins extending in the other. This may be accomplished through the use of header bars and end pieces as is shown in U.S. Patent Nos. 4,473,111 and 6,019,169. Problems are often encountered due to the limited surface area of the bonding surfaces. Increased bonding surface, as well as increased strength, may be provided through thickened end or side walls, as taught in U.S. Patent No. 4,729,428.

The prior art plate-finned type heat exchangers require numerous individual components, and therefore present numerous potential leak paths. This problem can be alleviated through the use of extruded tubes in place of the plate-spacer layers, as taught by

U.S. Patent No. 6,019,169. However, the use of extrusions presents other problems, particularly when the heat exchanger core components are made of aluminum.

In the prior art plate-finned type heat exchangers, brazed aluminum cores clad a low temperature-melting alloy onto the material of one or more of the components in order to bond the assembly together during the brazing process. Extrusions do not lend themselves to cladding. Therefore the braze material for bonding the tube to the fin can be provided by either applying powdered braze material in a binder to the tubes, or by cladding a low temperature melting alloy to the fin material. However, the application of powdered braze material in a binder to the tube does not provide enough braze material to consistently bond the tube to the header bar.

Accordingly, a need exists for a fin-tube block type heat exchanger construction capable of effectively and consistently bonding extruded tubes to corresponding header bars.

SUMMARY OF THE INVENTION

In view of the foregoing, one object of the present invention is to overcome the difficulties encountered when bonding extruded heat exchanger tubes to spacer bars during a brazing process.

Another object of the invention is to provide a fin-tube block type heat exchanger having spacer bars configured to promote the capillary flow of flux and braze material into the joint between the tube and the bar in order to form a complete joint therebetween.

A further object of the invention is an extruded tube construction that may be manufactured simply and yet yield enhanced bonding performance over conventional extruded tube heat exchange systems.

In accordance with these and other objects, the present invention is directed to a fin-tube block type heat exchanger in which extruded tubes are alternatingly arranged with corrugated fins, the fins being shorter in overall length than the tubes and having elongated bars at their ends serving as spacer bars between the tubes. The spacer bars have opposed side walls that, adjacent their outer walls, abut the side walls of the tubes. In one embodiment, the side walls of the spacer bars are substantially parallel to each other and adjacent their inner walls abut the side walls of the tubes. In another embodiment, the side walls of the spacer bars are spaced from the side walls of the tubes, with the side walls of the spacer bar tapering towards each other such that the thickness of the spacer bar at the inner wall is less than the thickness of the spacer bar at the outer wall.

The side walls of the spacer bars include one or more recesses or grooves extending lengthwise with the spacer bar into which low temperature melting alloy is captively inserted. In the embodiment in which the side walls of the spacer bars are parallel, brazing occurs only in the local area of the grooves, yet is sufficient to afford structural integrity of the core. In the embodiment in which the side walls of the spacer bars taper towards each other, during brazing, the alloy melts and is drawn by capillary action into the space created between the tapered side walls of the spacer bar and the facing surfaces of the adjacent tubes so that a complete joint is formed between the spacer bar and the adjacent tubes.

Other objects, features and advantages of the present invention will be apparent to those skilled in the art upon a reading of this specification including the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is better understood by reading the following Detailed Description of the Preferred Embodiments with reference to the accompanying drawing figures, in which like reference numerals refer to like elements throughout, and in which:

Figure 1 is a perspective view of a fin-tube block type heat exchanger with upper and lower tanks in accordance with a first embodiment of the present invention;

Figure 2 is a perspective view of the fin-tube block type heat exchanger of Figure 1;

Figure 3 is an enlarged view of the circular area 3 enclosed by a broken line in Figure 2;

Figure 4 is an enlarged view of the circular area 4 enclosed by a broken line in Figure 2;

Figure 5 is an end elevational view of an inner spacer bar of the heat exchanger of Figure 1;

Figure 6 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 7 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 8 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 9 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 10 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 11 is an end elevational view of an outer spacer bar of the heat exchanger of Figure 1;

Figure 12 is an end elevational view of an alternative embodiment of an outer spacer bar of the heat exchanger of Figure 1;

Figure 13 is an end elevational view of an alternative embodiment of an outer spacer bar of the heat exchanger of Figure 1; and

Figure 14 is an exploded perspective view of another embodiment of a heat exchanger in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing a preferred embodiment of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

Turning now to Figures 1 and 2, there is shown a first embodiment of a fin-tube block type heat exchanger 10. The heat exchanger 10 is comprised of a core 12 and first and second tanks 14a and 14b at either end of the core 12. The tanks 14a and 14b are provided with fluid inlets and outlets (not shown) in a conventional manner.

The core 12 includes a plurality of parallel tubes 16 defining a first set of parallel flow passages 18 extending between the tanks 14a and 14b, and corrugated fins 20 alternatingly arranged with the tubes 16 and defining a second set of parallel flow passages 22 oriented generally perpendicularly relative to the first set of flow passages.

Each tube 16 preferably is extruded, is made of aluminum, and includes opposed side walls 16a, opposed end walls 16b, and pillars 16c extending between the side walls 16a to define the first set of flow paths 18. Inasmuch as the tubes 16 preferably are extruded, the side walls 16a, end walls 16b, and pillars 16c are unitarily formed. In addition to defining the first set of flow paths 18, the pillars 16c also support the inner surfaces of the side walls 16a during brazing, as well as during operation of the heat exchanger 10. The end walls 16b are of sufficient thickness to allow the tanks 14a and 14b (as shown in Figure 1) or a conventional bolting flange 50 (which provides an interface between the core 12, a conventional tank 52, and a conventional sealing gasket 54, as shown in Figure 14), to be directly welded to the edges of the tubes 16.

The area designated by reference numeral 3 is shown in greater detail in Figure 3. As shown, the pillars 16c are oriented substantially perpendicular to the side walls 16a. However, as will be appreciated by those of skill in the art, other configurations of the pillars are possible, so that the flow paths 18, instead of having square or rectangular cross-sections, have circular or triangular or other cross-sections, including extrusions that are enhanced, dimpled, stuffed, etc.

Elongated spacer bars 24 are interposed between the ends of the tubes 16 and are substantially coextensive in width with the tubes 16 so as to define spaces for receiving the fins 20, which are sized to fit within the spaces. Each spacer bar 24 has opposed side walls 24a, an outer wall 24b, and an inner wall 24c (as shown in Figure 5). The side walls 16a of the tubes are joined to the side walls 24a of the spacer bars 24 and to the fins 20 by brazing.

As discussed above, in the prior art plate-finned type heat exchangers, brazed aluminum cores clad a low temperature-melting alloy onto the material of one or more of the components in order to bond the assembly together during the brazing process. Extrusions do not lend themselves to cladding. Further, the application of powdered braze material in a binder to the tubes 16 will not provide enough braze material to consistently bond the tubes to the spacer bars 24. In accordance with the invention, by forming a recess 26 into the side walls 24a of the spacer bars 24, it is possible to captively insert low temperature melting alloy 28 into the spacer bars 24 without increasing the clearance between the tubes 16 and the spacer bars 24. The amount of alloy material 28 necessary for bonding the tubes 16 to the spacer bars 24 can be determined by specifying the size and shape of the recesses 26 and the type of bonding material used. In one embodiment of the invention, the alloy material 28 can be in the form of a wire extending the length of the recesses 26. As the wire melts, it forms a leak-free joint, the liquid clad flowing into the interfacial region between the bar and the tube and solidifying there upon cooling.

Although the wire as shown in the Figures is circular in cross-section, it will be appreciated that it can have other cross-sectional shapes, and that the configuration of the recesses 26 can be adjusted accordingly.

The outer walls 24b of the spacer bars 24 are substantially flat and coplanar with the ends of the tubes 16. In a preferred embodiment, the side walls 24a adjacent the inner walls 24c taper slightly inwardly towards each other. This taper may extend the full length of the side walls 24a. The purpose of this taper is to promote the capillary flow of flux and braze material into the tube-to-bar joint so that a complete joint is formed. The angle of the taper is not important to this function, but the best results are achieved with a clearance 30 of up to about 0.015 inch, and preferably with a clearance 30 of about 0.003 inch, between the side walls 24a and the facing surfaces of the tubes 16 adjacent the recesses 26. It will be appreciated that because of the taper, the recesses 26 are in communication with the spaces defined between each pair of opposed spacer bars 24. Thus, flux and braze can also flow to the joint between the inner walls 24c of the spacer bars and the ends of the fins 20.

The inner wall 24c as shown in Figure 5 has a chevron-shaped cross-section. This chevron shape provides a peak 32, the purpose of which is to contact the facing end of the fin 20 and prevent the edges of the inner walls 24c from getting into the bar-to-tube joint and drawing out the braze material. It will be appreciated that the inner wall 24c can have other cross-sectional shapes, including but not limited to triangular, or planar with a projection, that also will provide a peak.

As shown in Figures 1 and 2, the outermost flow paths are defined by fins 20, outer spacer bars 40 positioned at the ends of the fins 20, and side panels 42. The area designated by reference numeral 4 is shown in greater detail in Figure 4, and best shown in Figure 11.

As illustrated in these figures, the outer spacer bars 40 have a different configuration than the spacer bars 24 positioned between the tubes 16. Each outer spacer bar 40 has an outwardly-facing side wall 40a, an inwardly-facing side wall 40b, an outer wall 40c, and an inner wall 40d. A recess 44 is formed in the inwardly-facing side wall 40b to captively insert low temperature melting alloy into the outer spacer bars 40 without increasing the clearance between the tubes 16 and the outer spacer bars 40. The recess 44 can be of any shape capable of retaining the braze material.

The outer walls 40c of the outer spacer bars 40 are substantially flat and coplanar with the ends of the tubes 16. In a preferred embodiment, the inwardly-facing side walls 40b adjacent the tubes 16 taper slightly inwardly to promote the capillary flow of flux and braze material into the panel-to-bar joint so that a complete joint is formed. The taper should thus be dimensioned accordingly. The outwardly-facing side walls 40a adjacent the side panels 42 are substantially planar, and are attached to the facing surfaces of the side panels 42 by a strip of braze material that covers the surface to be bonded. In a preferred embodiment, this strip is 0.005 inch thick. Because the side walls 40a are attached by a strip that covers the surface to be bonded, a taper at the bar-to-panel joint is not necessary. Alternatively, the outwardly-facing side walls 40a can be attached to the facing surfaces of the side panels 42 by a filler wire. The inner walls 40d taper from both the outwardly-facing side walls 40a and the inwardly-facing side walls 40b so as to form a peak 29 that contacts the facing ends of the fins 20.

In a preferred embodiment, the outwardly-facing side walls 40a of the outer spacer bars 40 include an outwardly-extending flange portion 46. The side panels 42 are dimensioned to fit between opposing flange portions 46 on each side of the heat exchanger 10. Preferably, both the side walls 40a and 40b of the outer spacer bars 40 are longer than the side walls 24a of the inner spacer bars 24. This longer length provides more surface area for the bar-to-panel joint, to compensate for the area taken up by the flange portions 46.

The invention is not limited to a spacer bar having only a single recess in each side wall. The spacer bar can have more than one recess in each side wall in those situations where it is desirable to achieve a leak-free joint between the spacer bars and the tubes. Referring now to Figure 6, there is shown another embodiment of the invention and, more particularly, a spacer bar 124 in which two recesses 126 are formed in each side wall 124a adjacent the inner wall 124c. Each recess 126 is shown with filler 128. The filler 128 may be embodied as a wire that runs the entire width of the spacer bar. As shown in Figure 6, multiple recesses 126 may be combined with the inward tapering of the side walls 124a toward each other, with an indicated clearance 130 of up to about 0.015 inch, and preferably with a clearance of about 0.003 inch.

In alternative embodiments shown in Figures 7 and 8, the side walls 224a and 324a of the respective spacer bars 224 and 324 are substantially parallel to each other throughout their length so as to abut against the side walls of the tubes 16 adjacent both the inner walls 224c and 324c and the outer walls 224b and 324b of the spacer bars 224 and 324. In these embodiments, brazing occurs only in the local area of the recesses 226 and 326, yet is sufficient to afford structural integrity of the core 12. These embodiments are used where the flow of braze material, for example from the end of the tube 16 to the tube-to-bar joint, either is not needed or wanted. There may be one recess 226 on each side, as shown in Figure 7, two recesses 326 on each side, as shown in Figure 8, or any number of recesses on either side as may be appropriate to the particular application.

The tapering of the spacer bar side walls provides superior bonding because it induces clad flow over a greater surface area. However, to be leak free, the tube-to-bar joint only requires a thin barrier, such as filler wire can provide, between the interior and exterior environments.

Referring now to Figures 9 and 10, there are shown still further embodiments of the invention with various configurations between the side walls of the tubes 16 and the side walls 424a and 524a of the spacer bars 424 and 524, respectively. Figure 9 shows a spacer bar 424 in which two recesses 426 are provided in each of the side walls 424a, and in which the side walls 424a are substantially parallel to each other so as to abut against the side walls of the tubes 16, except for that portion immediately adjacent the inner wall 424c, where a space 430 is maintained between the side walls 424a and the side walls of the tubes 16. The filler 428 is in the form of a wire of circular cross-section, and the recesses 426 are substantially complementary in shape to the filler 428, so as to provide very small capillary regions 460 at the interfacial region of the recesses 426 with the side walls of the tubes 16. Figure 10 shows a spacer bar 524 with an alternative contour of the side walls 524a adjacent. In the embodiment of Figure 10, the side walls 524a also are substantially parallel to each other and have two recesses 526, but the recesses 526 are configured to provide larger capillary regions 550 for clad flow at the interfacial region of the recesses 526 with the side walls of the tubes 16. In particular, the filler 528 is a wire of circular cross-section and the recesses 526 have flared sides.

The inner walls 124c, 224c, 324c, 424c, and 524c as shown in Figures 6-10 have a chevron-shaped cross-section, similar to that of the inner wall 24c shown in Figure 5.

As with the inner wall 24c shown in Figure 5, this chevron shape provides a peak, respectively designated 146, 246, 346, 446, and 546, the purpose of which is to contact the facing end of the fin 20 and prevent the edges of the inner walls 124c, 224c, 324c, 424c, and 524c from getting into the bar-to-tube joint and drawing out the braze material.

Referring now to Figure 12, there is shown an embodiment of an outer spacer bar 140 for use in a core in conjunction with inner spacer bars 124. In this embodiment, the inwardly-facing side wall 140b of the outer spacer bar 140 tapers inwardly and includes multiple recesses 144 with filler 128. The outwardly-facing side wall 140a does not taper but also includes multiple recesses 144, with filler 128. The inner wall 140c is chevron-shaped, similar to the inner wall 124c of the spacer bar 124. As with the joints between the side walls 24 and the tubes 16 using recesses 26, the outwardly-facing side wall 140a can be bonded to the side panel 142 using filler wire inserted into recesses 144 and subsequently melted and allowed to solidify.

A still further embodiment of the invention is shown in Figure 13, and in particular, an embodiment of an outer spacer bar 340 for use in a core in conjunction with inner spacer bars 324. In the outer spacer bar 340, two recesses 344 are formed in the inwardly-facing side wall 340b adjacent the inner wall 340d. Additional recesses can be added to the inwardly-facing side wall 340b in a similar manner. As with the spacer bars 324, multiple recesses 344 may be needed in the inwardly-facing side wall 340b in some situations to achieve a leak-free joint between the outer spacer bars 340 and the side walls of the tubes 16. No recesses are provided in the outwardly-facing side wall 340a. This embodiment also demonstrates a configuration in which the outwardly-facing side wall 340a and the inwardly-facing side wall 340b are substantially parallel to each other; the inwardly-facing side wall 340b does not taper inwardly. In this embodiment, brazing occurs only in the local area of the recesses 344, yet is sufficient to afford structural integrity of the core 12.

The foregoing descriptions and drawings should be considered as illustrative only of the principles of the invention. It is not desired to limit the invention to the specific examples disclosed or the exact construction and operation shown and described. Modifications and variations of the above-described embodiments of the present invention are possible, as appreciated by those skilled in the art in light of the above teachings. For example, it will be appreciated that the spacer bars 24 can be used in a plate-fin style heat exchanger wherein the first set of fluid passages are defined by spacers interposed between pairs of adjacent plates, rather than by unitarily-formed tubes. It is therefore to be understood that, within the scope of the appended claims and their equivalents, the invention may be practiced otherwise than as specifically described.

WHAT IS CLAIMED IS:

1. A spacer bar for use in a heat exchanger having a brazed core comprising alternating first and second sets of flow paths, said spacer bar having an outer wall facing away from the interior of the core, an inner wall opposite said outer wall, and opposed first and second side walls extending between said outer and inner walls, said first side wall having at least one lengthwise recess formed therein, and said at least one recess being configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

2. The spacer bar as set forth in claim 1, wherein said first side wall is inwardly tapered at least adjacent said inner wall.

3. The spacer bar as set forth in claim 1, wherein said second side wall also has at least one lengthwise recess formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

4. The spacer bar as set forth in claim 3, wherein said second side wall is inwardly tapered at least adjacent said inner wall.

5. The spacer bar as set forth in claim 1, wherein said second side wall includes an outwardly extending flange adjacent said outer wall.

6. The spacer bar as set forth in claim 5, wherein said second side wall is uninterrupted between said flange and said inner wall.

7. The spacer bar as set forth in claim 1, wherein low temperature melting alloy is inserted into said at least one lengthwise recess.

8. The spacer bar as set forth in claim 3, wherein low temperature melting alloy is inserted into said at least one lengthwise recess in each of said first and second side walls.

9. The spacer bar as set forth in claim 1, wherein said first side wall has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

10. The spacer bar as set forth in claim 9, wherein said second side wall also has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

11. A heat exchanger core comprising spacer bars as set forth in claim 1 and further comprising:

alternating first and second sets of flow passages; and

a plurality of separator walls, each said separator wall separating adjacent first and second sets of flow passages from each other;

wherein the spacer bars are positioned between said separator walls at the ends of said second sets of flow passages.

12. The heat exchanger core as set forth in claim 11, wherein said first side wall of each of said spacer bars has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bars to at least a portion of said tubes.

13. The heat exchanger core as set forth in claim 11, wherein said second sets of flow passages are defined by corrugated fins, said spacer bars being positioned at the ends of said fins; and

wherein said inner wall of each said spacer bar is configured to contact the facing end of its respective fin and prevent the edges of said inner wall from getting into the joint between said separator wall and said spacer bar.

14. The heat exchanger core as set forth in claim 13, further comprising outermost flow passages defined by fins bounded at their ends by outer spacer bars, at their outer faces by side panels, and at their inner faces by separator walls; and

wherein said outer spacer bars each have an outwardly-facing side wall, an inwardly-facing side wall, an outer wall, an inner wall, and at least one lengthwise recess formed in said inwardly-facing side wall, said at least one recess being configured to receive a bonding material for bonding said spacer bar to at least a portion of said separator walls.

15. The heat exchanger core as set forth in claim 13, wherein said inner wall of each said outer spacer bar is configured to contact the facing end of its respective fin and prevent the edges of said inner wall from getting into the joint between said separator wall and said outer spacer bar.

16. The heat exchanger core as set forth in claim 11, wherein at least one of said first and second side walls is inwardly tapered at least adjacent said inner wall.

17. The heat exchanger core as set forth in claim 13, wherein in said outer spacer bars, said outwardly-facing side wall includes an outwardly extending flange adjacent said upper wall, and said outwardly-facing side wall is uninterrupted between said flange and said inner wall.

18. The heat exchanger core as set forth in claim 13, wherein in said outer spacer bars, said outwardly-facing side wall includes an outwardly extending flange adjacent said upper wall, and at least one lengthwise recess formed therein adjacent said inner wall, said at least one recess being configured to receive a bonding material for bonding said outer spacer bar to at least a portion of the heat exchanger core.

19. The heat exchanger core as set forth in claim 11, wherein said core comprises a plurality of tubes, said tubes defining said first sets of flow passages, and wherein said separator walls define the side walls of said tubes.

20. The heat exchanger core as set forth in claim 19, wherein said tubes are made of extruded aluminum.

21. A heat exchanger comprising the heat exchanger core as set forth in claim 19, and further comprising first and second tanks at the ends of said tubes;

wherein each of said tubes has opposed end walls and opposed side walls; and

wherein said end walls are of sufficient thickness to allow said tanks to be directly affixed thereto.

22. A heat exchanger including spacer bars as set forth in claim 1 and further comprising:

first and second spaced parallel tanks;

a plurality of spaced parallel tubes defining a first set of parallel flow passages extending between said first and second tanks, said tubes including opposed side walls, opposed end walls, and pillars extending between the side walls to define said first set of flow passages; and

corrugated fins alternatingly arranged with said tubes and defining a second set of parallel flow passages;

wherein said spacer bars are interposed between the ends of said tubes and are substantially coextensive in width with said tubes to define spaces for receiving said fins, said fins being sized to fit within said spaces.

23. A heat exchanger as set forth in claim 22, wherein said spacer bars are interposed between the ends of said tubes adjacent said tube side walls and wherein said first and second side walls of said spacer bars are inwardly tapered at least adjacent said inner wall to define a gap between said first and second side walls and the adjacent tube side walls.

24. The heat exchanger as set forth in claim 23, further comprising flux and braze material in each said gap.

25. The heat exchanger as set forth in claim 22, wherein said inner wall of each said spacer bar is configured to contact the facing end of its respective fin and prevent the edges of said inner wall from getting into the joint between said side wall of said tube and said spacer bar.

26. The heat exchanger as set forth in claim 22, further comprising outermost flow passages defined by fins bounded at their ends by outer spacer bars, at their outer faces by side panels, and at their inner faces by side walls of said tubes; and

wherein each of said outer spacer bars each has an outwardly-facing side wall, an inwardly-facing side wall, an outer wall, an inner wall, and at least one lengthwise recess formed in said inwardly-facing side wall, said at least one recess being configured to receive a bonding material for bonding said outer spacer bar to at least a portion of said tubes.

27. The heat exchanger as set forth in claim 26, wherein in said outer spacer bars, said outwardly-facing side wall includes an outwardly extending flange adjacent said upper wall, and said outwardly-facing side wall is uninterrupted between said flange and said inner wall.

28. The heat exchanger as set forth in claim 26, wherein said inwardly-facing side wall is inwardly tapered at least adjacent said inner wall to define a gap between said inwardly-facing side wall and the adjacent tube side walls for receiving flux and braze material.

29. The heat exchanger as set forth in claim 26, wherein said outwardly-facing side wall includes at least one lengthwise recess formed therein adjacent said inner wall, said outwardly-facing side wall being configured to receive a bonding material for bonding said outwardly-facing side wall to a respective side panel.

30. The heat exchanger as set forth in claim 26, wherein said inwardly-facing and outwardly-facing side walls of each of said outer spacer bars has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

31. The heat exchanger as set forth in claim 22, wherein said first side wall of each of said spacer bars has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bars to at least a portion of said tubes.

32. The spacer bar as set forth in claim 31, wherein said second side wall also has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

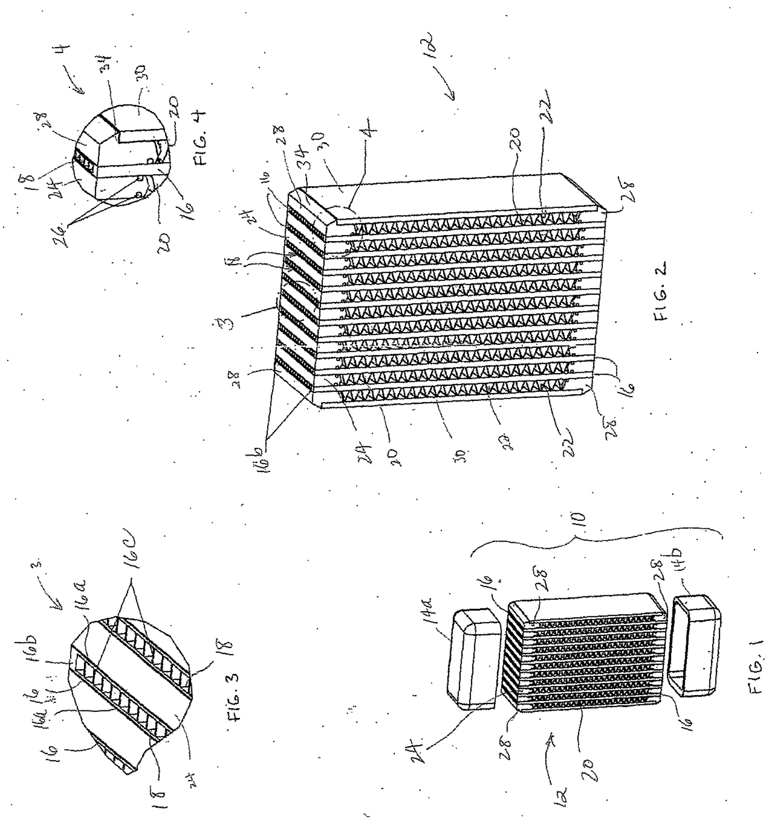
FIG. 4
FIG. 2
FIG. 3
FIG. 1

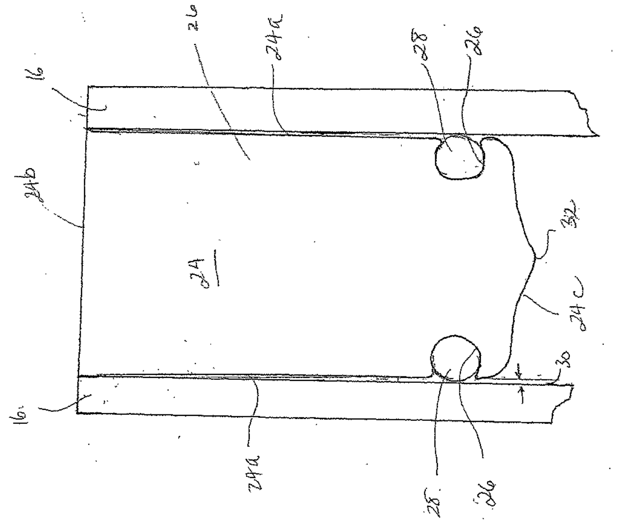

FIG. 5

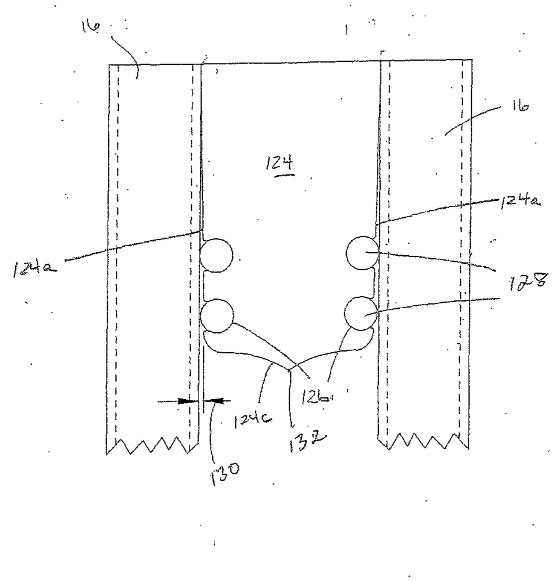

FIG. 6

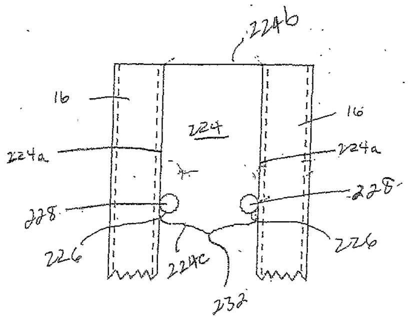
224b
16
224
16
224a
224a
228
228
226
226
224c
232

FIG. 7

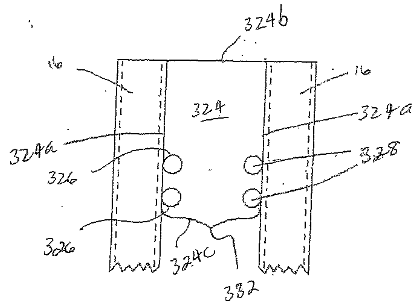
324b
16
16
324
324a
324a
326
328
326
324c
332

FIG. 8

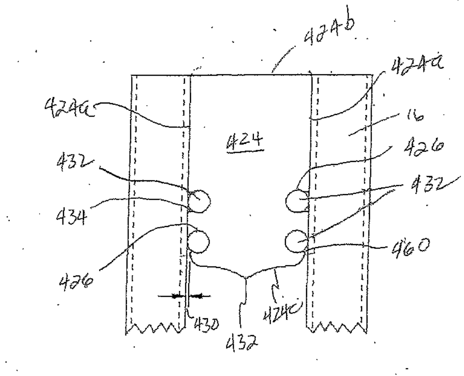
424b
424a
424a
16
424
426
432
432
434
460
426
430
424c
432

FIG. 9

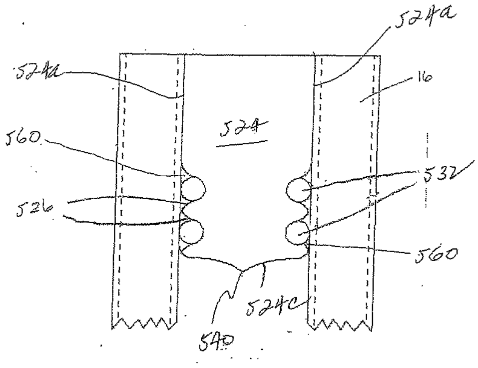
524a
524a
16
524
560
532
526
560
524c
540

FIG. 10

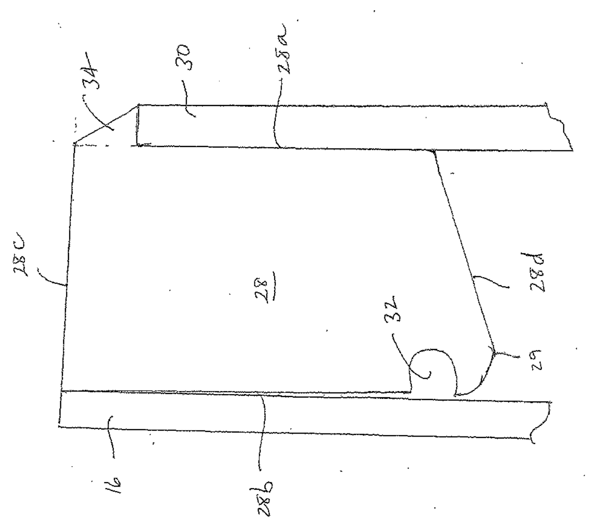

FIG. 11

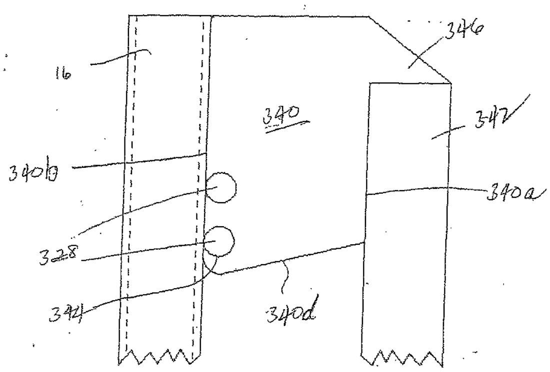
16
346
340
342
340b
340a
328
344
340d

FIG. 13

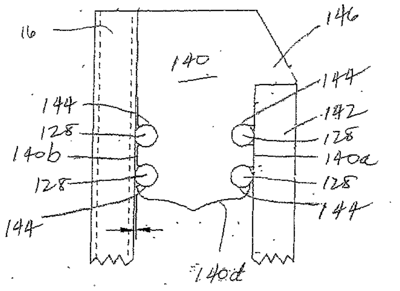
16
146
140
144
142
128
140b
140a
140d

FIG. 12

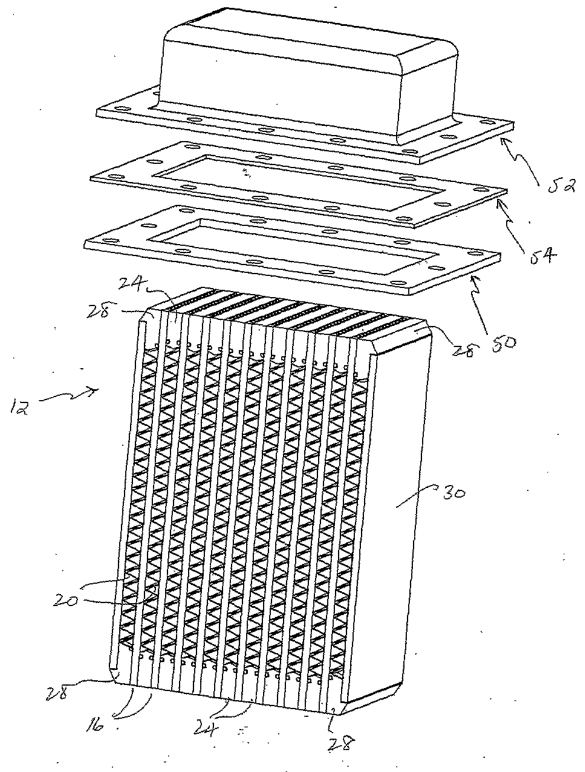

Fig. 14

【国際公開パンフレット（コレクトバージョン）】

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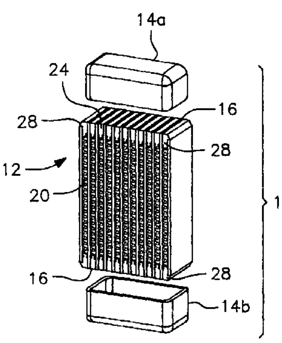
(54) Title: FIN-TUBE BLOCK TYPE HEAT EXCHANGER WITH GROOVED SPACER BARS



(57) Abstract: A fin-tube block type heat exchanger (10) in which extruded tubes (16) are alternatingly arranged with corrugated fins (20), the fins (20) being shorter in overall length than the tubes (16) and having elongated bars (24) at their ends serving as spacer bars (24) between the tubes (16). The side walls (24a) of the spacer bar preferably taper towards each other such that the thickness of the spacer bar at the inner wall is less than the thickness of the spacer bar at the outer wall (24b). The side walls (24a) include one or more recesses (26) or grooves extending lengthwise with the spacer bar into which low temperature melting alloy (28) is captively inserted. During brazing, the alloy melts and is drawn by capillary action into the space created between the tapered side walls (24a) of the spacer bar and the facing surfaces of the adjacent tubes so that a complete joint is formed between the spacer bar (24) and the adjacent tubes (16).

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FIN-TUBE BLOCK TYPE HEAT EXCHANGER WITH GROOVED SPACER BARS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to the field of heat exchanger systems and, more particularly, to a heat exchanger of the fin-tube block type, and having improved brazing characteristics for use with extruded tubes.

2. Related Art

Prior art plate-finned style heat exchangers are known from U.S. Patent Nos. 4,276,927, 4,473,111 and 4,729,428, among others. Such heat exchangers are characterized by a first set of parallel flow passages extending in one direction and alternating with a second, generally perpendicularly-oriented, arrangement of flow passages, the first and second sets being separated by a plate and the sequence of components being repeated to form a multi-layer sandwich core. A first fluid is directed through the first set of flow passages, while a second fluid passes through the second set of flow passages, with heat being exchanged therebetween. Generally the shape, spacing, and orientation of the first set of flow passages, which are defined by spacers interposed between pairs of flat plates, differs somewhat from that of the second set of flow passages, which are generally defined by corrugated or serpentine fins interposed between the plate-spacer layers.

Depending on the construction of the two sets of flow passages, difficulties arise when effecting the necessary bonding of the components to create the sandwich-type core. The flow passages arranged in one direction must be bonded to the flow passages or fins extending in the other. This may be accomplished through the use of header bars and end pieces as is shown in U.S. Patent Nos. 4,473,111 and 6,019,169. Problems are often encountered due to the limited surface area of the bonding surfaces. Increased bonding surface, as well as increased strength, may be provided through thickened end or side walls, as taught in U.S. Patent No. 4,729,428.

The prior art plate-finned type heat exchangers require numerous individual components, and therefore present numerous potential leak paths. This problem can be alleviated through the use of extruded tubes in place of the plate-spacer layers, as taught by

U.S. Patent No. 6,019,169. However, the use of extrusions presents other problems, particularly when the heat exchanger core components are made of aluminum.

In the prior art plate-finned type heat exchangers, brazed aluminum cores clad a low temperature-melting alloy onto the material of one or more of the components in order to bond the assembly together during the brazing process. Extrusions do not lend themselves to cladding. Therefore the braze material for bonding the tube to the fin can be provided by either applying powdered braze material in a binder to the tubes, or by cladding a low temperature melting alloy to the fin material. However, the application of powdered braze material in a binder to the tube does not provide enough braze material to consistently bond the tube to the header bar.

Accordingly, a need exists for a fin-tube block type heat exchanger construction capable of effectively and consistently bonding extruded tubes to corresponding header bars.

SUMMARY OF THE INVENTION

In view of the foregoing, one object of the present invention is to overcome the difficulties encountered when bonding extruded heat exchanger tubes to spacer bars during a brazing process.

Another object of the invention is to provide a fin-tube block type heat exchanger having spacer bars configured to promote the capillary flow of flux and braze material into the joint between the tube and the bar in order to form a complete joint therebetween.

A further object of the invention is an extruded tube construction that may be manufactured simply and yet yield enhanced bonding performance over conventional extruded tube heat exchange systems.

In accordance with these and other objects, the present invention is directed to a fin-tube block type heat exchanger in which extruded tubes are alternatingly arranged with corrugated fins, the fins being shorter in overall length than the tubes and having elongated bars at their ends serving as spacer bars between the tubes. The spacer bars have opposed side walls that, adjacent their outer walls, abut the side walls of the tubes. In one embodiment, the side walls of the spacer bars are substantially parallel to each other and adjacent their inner walls abut the side walls of the tubes. In another embodiment, the side walls of the spacer bars are spaced from the side walls of the tubes, with the side walls of the spacer bar tapering towards each other such that the thickness of the spacer bar at the inner wall is less than the thickness of the spacer bar at the outer wall.

The side walls of the spacer bars include one or more recesses or grooves extending lengthwise with the spacer bar into which low temperature melting alloy is captively inserted. In the embodiment in which the side walls of the spacer bars are parallel, brazing occurs only in the local area of the grooves, yet is sufficient to afford structural integrity of the core. In the embodiment in which the side walls of the spacer bars taper towards each other, during brazing, the alloy melts and is drawn by capillary action into the space created between the tapered side walls of the spacer bar and the facing surfaces of the adjacent tubes so that a complete joint is formed between the spacer bar and the adjacent tubes.

Other objects, features and advantages of the present invention will be apparent to those skilled in the art upon a reading of this specification including the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is better understood by reading the following Detailed Description of the Preferred Embodiments with reference to the accompanying drawing figures, in which like reference numerals refer to like elements throughout, and in which:

Figure 1 is a perspective view of a fin-tube block type heat exchanger with upper and lower tanks in accordance with a first embodiment of the present invention;

Figure 2 is a perspective view of the fin-tube block type heat exchanger of Figure 1;

Figure 3 is an enlarged view of the circular area 3 enclosed by a broken line in Figure 2;

Figure 4 is an enlarged view of the circular area 4 enclosed by a broken line in Figure 2;

Figure 5 is an end elevational view of an inner spacer bar of the heat exchanger of Figure 1;

Figure 6 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 7 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 8 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 9 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 10 is an end elevational view of an alternative embodiment of an inner spacer bar of the heat exchanger of Figure 1;

Figure 11 is an end elevational view of an outer spacer bar of the heat exchanger of Figure 1;

Figure 12 is an end elevational view of an alternative embodiment of an outer spacer bar of the heat exchanger of Figure 1;

Figure 13 is an end elevational view of an alternative embodiment of an outer spacer bar of the heat exchanger of Figure 1; and

Figure 14 is an exploded perspective view of another embodiment of a heat exchanger in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing a preferred embodiment of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

Turning now to Figures 1 and 2, there is shown a first embodiment of a fin-tube block type heat exchanger 10. The heat exchanger 10 is comprised of a core 12 and first and second tanks 14a and 14b at either end of the core 12. The tanks 14a and 14b are provided with fluid inlets and outlets (not shown) in a conventional manner.

The core 12 includes a plurality of parallel tubes 16 defining a first set of parallel flow passages 18 extending between the tanks 14a and 14b, and corrugated fins 20 alternatingly arranged with the tubes 16 and defining a second set of parallel flow passages 22 oriented generally perpendicularly relative to the first set of flow passages.

Each tube 16 preferably is extruded, is made of aluminum, and includes opposed side walls 16a, opposed end walls 16b, and pillars 16c extending between the side walls 16a to define the first set of flow paths 18. Inasmuch as the tubes 16 preferably are extruded, the side walls 16a, end walls 16b, and pillars 16c are unitarily formed. In addition to defining the first set of flow paths 18, the pillars 16c also support the inner surfaces of the side walls 16a during brazing, as well as during operation of the heat exchanger 10. The end walls 16b are of sufficient thickness to allow the tanks 14a and 14b (as shown in Figure 1) or a conventional bolting flange 50 (which provides an interface between the core 12, a conventional tank 52, and a conventional sealing gasket 54, as shown in Figure 14), to be directly welded to the edges of the tubes 16.

The area designated by reference numeral 3 is shown in greater detail in Figure 3. As shown, the pillars 16c are oriented substantially perpendicular to the side walls 16a. However, as will be appreciated by those of skill in the art, other configurations of the pillars are possible, so that the flow paths 18, instead of having square or rectangular cross-sections, have circular or triangular or other cross-sections, including extrusions that are enhanced, dimpled, stuffed, etc.

Elongated spacer bars 24 are interposed between the ends of the tubes 16 and are substantially coextensive in width with the tubes 16 so as to define spaces for receiving the fins 20, which are sized to fit within the spaces. Each spacer bar 24 has opposed side walls 24a, an outer wall 24b, and an inner wall 24c (as shown in Figure 5). The side walls 16a of the tubes are joined to the side walls 24a of the spacer bars 24 and to the fins 20 by brazing.

As discussed above, in the prior art plate-finned type heat exchangers, brazed aluminum cores clad a low temperature-melting alloy onto the material of one or more of the components in order to bond the assembly together during the brazing process. Extrusions do not lend themselves to cladding. Further, the application of powdered braze material in a binder to the tubes 16 will not provide enough braze material to consistently bond the tubes to the spacer bars 24. In accordance with the invention, by forming a recess 26 into the side walls 24a of the spacer bars 24, it is possible to captively insert low temperature melting alloy 28 into the spacer bars 24 without increasing the clearance between the tubes 16 and the spacer bars 24. The amount of alloy material 28 necessary for bonding the tubes 16 to the spacer bars 24 can be determined by specifying the size and shape of the recesses 26 and the type of bonding material used. In one embodiment of the invention, the alloy material 28 can be in the form of a wire extending the length of the recesses 26. As the wire melts, it forms a leak-free joint, the liquid clad flowing into the interfacial region between the bar and the tube and solidifying there upon cooling.

Although the wire as shown in the Figures is circular in cross-section, it will be appreciated that it can have other cross-sectional shapes, and that the configuration of the recesses 26 can be adjusted accordingly.

The outer walls 24b of the spacer bars 24 are substantially flat and coplanar with the ends of the tubes 16. In a preferred embodiment, the side walls 24a adjacent the inner walls 24c taper slightly inwardly towards each other. This taper may extend the full length of the side walls 24a. The purpose of this taper is to promote the capillary flow of flux and braze material into the tube-to-bar joint so that a complete joint is formed. The angle of the taper is not important to this function, but the best results are achieved with a clearance 30 of up to about 0.015 inch, and preferably with a clearance 30 of about 0.003 inch, between the side walls 24a and the facing surfaces of the tubes 16 adjacent the recesses 26. It will be appreciated that because of the taper, the recesses 26 are in communication with the spaces defined between each pair of opposed spacer bars 24. Thus, flux and braze can also flow to the joint between the inner walls 24c of the spacer bars and the ends of the fins 20.

The inner wall 24c as shown in Figure 5 has a chevron-shaped cross-section. This chevron shape provides a peak 32, the purpose of which is to contact the facing end of the fin 20 and prevent the edges of the inner walls 24c from getting into the bar-to-tube joint and drawing out the braze material. It will be appreciated that the inner wall 24c can have other cross-sectional shapes, including but not limited to triangular, or planar with a projection, that also will provide a peak.

As shown in Figures 1 and 2, the outermost flow paths are defined by fins 20, outer spacer bars 40 positioned at the ends of the fins 20, and side panels 42. The area designated by reference numeral 4 is shown in greater detail in Figure 4, and best shown in Figure 11.

As illustrated in these figures, the outer spacer bars 40 have a different configuration than the spacer bars 24 positioned between the tubes 16. Each outer spacer bar 40 has an outwardly-facing side wall 40a, an inwardly-facing side wall 40b, an outer wall 40c, and an inner wall 40d. A recess 44 is formed in the inwardly-facing side wall 40b to captively insert low temperature melting alloy into the outer spacer bars 40 without increasing the clearance between the tubes 16 and the outer spacer bars 40. The recess 44 can be of any shape capable of retaining the braze material.

The outer walls 40c of the outer spacer bars 40 are substantially flat and coplanar with the ends of the tubes 16. In a preferred embodiment, the inwardly-facing side walls 40b adjacent the tubes 16 taper slightly inwardly to promote the capillary flow of flux and braze material into the panel-to-bar joint so that a complete joint is formed. The taper should thus be dimensioned accordingly. The outwardly-facing side walls 40a adjacent the side panels 42 are substantially planar, and are attached to the facing surfaces of the side panels 42 by a strip of braze material that covers the surface to be bonded. In a preferred embodiment, this strip is 0.005 inch thick. Because the side walls 40a are attached by a strip that covers the surface to be bonded, a taper at the bar-to-panel joint is not necessary. Alternatively, the outwardly-facing side walls 40a can be attached to the facing surfaces of the side panels 42 by a filler wire. The inner walls 40d taper from both the outwardly-facing side walls 40a and the inwardly-facing side walls 40b so as to form a peak 29 that contacts the facing ends of the fins 20.

In a preferred embodiment, the outwardly-facing side walls 40a of the outer spacer bars 40 include an outwardly-extending flange portion 46. The side panels 42 are dimensioned to fit between opposing flange portions 46 on each side of the heat exchanger 10. Preferably, both the side walls 40a and 40b of the outer spacer bars 40 are longer than the side walls 24a of the inner spacer bars 24. This longer length provides more surface area for the bar-to-panel joint, to compensate for the area taken up by the flange portions 46.

The invention is not limited to a spacer bar having only a single recess in each side wall. The spacer bar can have more than one recess in each side wall in those situations where it is desirable to achieve a leak-free joint between the spacer bars and the tubes. Referring now to Figure 6, there is shown another embodiment of the invention and, more particularly, a spacer bar 124 in which two recesses 126 are formed in each side wall 124a adjacent the inner wall 124c. Each recess 126 is shown with filler 128. The filler 128 may be embodied as a wire that runs the entire width of the spacer bar. As shown in Figure 6, multiple recesses 126 may be combined with the inward tapering of the side walls 124a toward each other, with an indicated clearance 130 of up to about 0.015 inch, and preferably with a clearance of about 0.003 inch.

In alternative embodiments shown in Figures 7 and 8, the side walls 224a and 324a of the respective spacer bars 224 and 324 are substantially parallel to each other throughout their length so as to abut against the side walls of the tubes 16 adjacent both the inner walls 224c and 324c and the outer walls 224b and 324b of the spacer bars 224 and 324. In these embodiments, brazing occurs only in the local area of the recesses 226 and 326, yet is sufficient to afford structural integrity of the core 12. These embodiments are used where the flow of braze material, for example from the end of the tube 16 to the tube-to-bar joint, either is not needed or wanted. There may be one recess 226 on each side, as shown in Figure 7, two recesses 326 on each side, as shown in Figure 8, or any number of recesses on either side as may be appropriate to the particular application.

The tapering of the spacer bar side walls provides superior bonding because it induces clad flow over a greater surface area. However, to be leak free, the tube-to-bar joint only requires a thin barrier, such as filler wire can provide, between the interior and exterior environments.

Referring now to Figures 9 and 10, there are shown still further embodiments of the invention with various configurations between the side walls of the tubes 16 and the side walls 424a and 524a of the spacer bars 424 and 524, respectively. Figure 9 shows a spacer bar 424 in which two recesses 426 are provided in each of the side walls 424a, and in which the side walls 424a are substantially parallel to each other so as to abut against the side walls of the tubes 16, except for that portion immediately adjacent the inner wall 424c, where a space 430 is maintained between the side walls 424a and the side walls of the tubes 16. The filler 428 is in the form of a wire of circular cross-section, and the recesses 426 are substantially complementary in shape to the filler 428, so as to provide very small capillary regions 460 at the interfacial region of the recesses 426 with the side walls of the tubes 16. Figure 10 shows a spacer bar 524 with an alternative contour of the side walls 524a adjacent. In the embodiment of Figure 10, the side walls 524a also are substantially parallel to each other and have two recesses 526, but the recesses 526 are configured to provide larger capillary regions 550 for clad flow at the interfacial region of the recesses 526 with the side walls of the tubes 16. In particular, the filler 528 is a wire of circular cross-section and the recesses 526 have flared sides.

The inner walls 124c, 224c, 324c, 424c, and 524c as shown in Figures 6-10 have a chevron-shaped cross-section, similar to that of the inner wall 24c shown in Figure 5.

As with the inner wall 24c shown in Figure 5, this chevron shape provides a peak, respectively designated 146, 246, 346, 446, and 546, the purpose of which is to contact the facing end of the fin 20 and prevent the edges of the inner walls 124c, 224c, 324c, 424c, and 524c from getting into the bar-to-tube joint and drawing out the braze material.

Referring now to Figure 12, there is shown an embodiment of an outer spacer bar 140 for use in a core in conjunction with inner spacer bars 124. In this embodiment, the inwardly-facing side wall 140b of the outer spacer bar 140 tapers inwardly and includes multiple recesses 144 with filler 128. The outwardly-facing side wall 140a does not taper but also includes multiple recesses 144, with filler 128. The inner wall 140c is chevron-shaped, similar to the inner wall 124c of the spacer bar 124. As with the joints between the side walls 24 and the tubes 16 using recesses 26, the outwardly-facing side wall 140a can be bonded to the side panel 142 using filler wire inserted into recesses 144 and subsequently melted and allowed to solidify.

A still further embodiment of the invention is shown in Figure 13, and in particular, an embodiment of an outer spacer bar 340 for use in a core in conjunction with inner spacer bars 324. In the outer spacer bar 340, two recesses 344 are formed in the inwardly-facing side wall 340b adjacent the inner wall 340d. Additional recesses can be added to the inwardly-facing side wall 340b in a similar manner. As with the spacer bars 324, multiple recesses 344 may be needed in the inwardly-facing side wall 340b in some situations to achieve a leak-free joint between the outer spacer bars 340 and the side walls of the tubes 16. No recesses are provided in the outwardly-facing side wall 340a. This embodiment also demonstrates a configuration in which the outwardly-facing side wall 340a and the inwardly-facing side wall 340b are substantially parallel to each other; the inwardly-facing side wall 340b does not taper inwardly. In this embodiment, brazing occurs only in the local area of the recesses 344, yet is sufficient to afford structural integrity of the core 12.

The foregoing descriptions and drawings should be considered as illustrative only of the principles of the invention. It is not desired to limit the invention to the specific examples disclosed or the exact construction and operation shown and described. Modifications and variations of the above-described embodiments of the present invention are possible, as appreciated by those skilled in the art in light of the above teachings. For example, it will be appreciated that the spacer bars 24 can be used in a plate-fin style heat exchanger wherein the first set of fluid passages are defined by spacers interposed between pairs of adjacent plates, rather than by unitarily-formed tubes. It is therefore to be understood that, within the scope of the appended claims and their equivalents, the invention may be practiced otherwise than as specifically described.

WHAT IS CLAIMED IS:

1. A spacer bar for use in a heat exchanger having a brazed core comprising alternating first and second sets of flow paths, said spacer bar having an outer wall facing away from the interior of the core, an inner wall opposite said outer wall, and opposed first and second side walls extending between said outer and inner walls, said first side wall having at least one lengthwise recess formed therein, and said at least one recess being configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

2. The spacer bar as set forth in claim 1, wherein said first side wall is inwardly tapered at least adjacent said inner wall.

3. The spacer bar as set forth in claim 1, wherein said second side wall also has at least one lengthwise recess formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

4. The spacer bar as set forth in claim 3, wherein said second side wall is inwardly tapered at least adjacent said inner wall.

5. The spacer bar as set forth in claim 1, wherein said second side wall includes an outwardly extending flange adjacent said outer wall.

6. The spacer bar as set forth in claim 5, wherein said second side wall is uninterrupted between said flange and said inner wall.

7. The spacer bar as set forth in claim 1, wherein low temperature melting alloy is inserted into said at least one lengthwise recess.

8. The spacer bar as set forth in claim 3, wherein low temperature melting alloy is inserted into said at least one lengthwise recess in each of said first and second side walls.

9. The spacer bar as set forth in claim 1, wherein said first side wall has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

10. The spacer bar as set forth in claim 9, wherein said second side wall also has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

11. A heat exchanger core comprising spacer bars as set forth in claim 1 and further comprising:

alternating first and second sets of flow passages; and

a plurality of separator walls, each said separator wall separating adjacent first and second sets of flow passages from each other;

wherein the spacer bars are positioned between said separator walls at the ends of said second sets of flow passages.

12. The heat exchanger core as set forth in claim 11, wherein said first side wall of each of said spacer bars has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bars to at least a portion of said tubes.

13. The heat exchanger core as set forth in claim 11, wherein said second sets of flow passages are defined by corrugated fins, said spacer bars being positioned at the ends of said fins; and

wherein said inner wall of each said spacer bar is configured to contact the facing end of its respective fin and prevent the edges of said inner wall from getting into the joint between said separator wall and said spacer bar.

14. The heat exchanger core as set forth in claim 13, further comprising outermost flow passages defined by fins bounded at their ends by outer spacer bars, at their outer faces by side panels, and at their inner faces by separator walls; and

wherein said outer spacer bars each have an outwardly-facing side wall, an inwardly-facing side wall, an outer wall, an inner wall, and at least one lengthwise recess formed in said inwardly-facing side wall, said at least one recess being configured to receive a bonding material for bonding said spacer bar to at least a portion of said separator walls.

15. The heat exchanger core as set forth in claim 13, wherein said inner wall of each said outer spacer bar is configured to contact the facing end of its respective fin and prevent the edges of said inner wall from getting into the joint between said separator wall and said outer spacer bar.

16. The heat exchanger core as set forth in claim 11, wherein at least one of said first and second side walls is inwardly tapered at least adjacent said inner wall.

17. The heat exchanger core as set forth in claim 13, wherein in said outer spacer bars, said outwardly-facing side wall includes an outwardly extending flange adjacent said upper wall, and said outwardly-facing side wall is uninterrupted between said flange and said inner wall.

18. The heat exchanger core as set forth in claim 13, wherein in said outer spacer bars, said outwardly-facing side wall includes an outwardly extending flange adjacent said upper wall, and at least one lengthwise recess formed therein adjacent said inner wall, said at least one recess being configured to receive a bonding material for bonding said outer spacer bar to at least a portion of the heat exchanger core.

19. The heat exchanger core as set forth in claim 11, wherein said core comprises a plurality of tubes, said tubes defining said first sets of flow passages, and wherein said separator walls define the side walls of said tubes.

20. The heat exchanger core as set forth in claim 19, wherein said tubes are made of extruded aluminum.

21. A heat exchanger comprising the heat exchanger core as set forth in claim 19, and further comprising first and second tanks at the ends of said tubes;

wherein each of said tubes has opposed end walls and opposed side walls; and

wherein said end walls are of sufficient thickness to allow said tanks to be directly affixed thereto.

22. A heat exchanger including spacer bars as set forth in claim 1 and further comprising:

first and second spaced parallel tanks;

a plurality of spaced parallel tubes defining a first set of parallel flow passages extending between said first and second tanks, said tubes including opposed side walls, opposed end walls, and pillars extending between the side walls to define said first set of flow passages; and

corrugated fins alternatingly arranged with said tubes and defining a second set of parallel flow passages;

wherein said spacer bars are interposed between the ends of said tubes and are substantially coextensive in width with said tubes to define spaces for receiving said fins, said fins being sized to fit within said spaces.

23. A heat exchanger as set forth in claim 22, wherein said spacer bars are interposed between the ends of said tubes adjacent said tube side walls and wherein said first and second side walls of said spacer bars are inwardly tapered at least adjacent said inner wall to define a gap between said first and second side walls and the adjacent tube side walls.

24. The heat exchanger as set forth in claim 23, further comprising flux and braze material in each said gap.

25. The heat exchanger as set forth in claim 22, wherein said inner wall of each said spacer bar is configured to contact the facing end of its respective fin and prevent the edges of said inner wall from getting into the joint between said side wall of said tube and said spacer bar.

26. The heat exchanger as set forth in claim 22, further comprising outermost flow passages defined by fins bounded at their ends by outer spacer bars, at their outer faces by side panels, and at their inner faces by side walls of said tubes; and

wherein each of said outer spacer bars each has an outwardly-facing side wall, an inwardly-facing side wall, an outer wall, an inner wall, and at least one lengthwise recess formed in said inwardly-facing side wall, said at least one recess being configured to receive a bonding material for bonding said outer spacer bar to at least a portion of said tubes.

27. The heat exchanger as set forth in claim 26, wherein in said outer spacer bars, said outwardly-facing side wall includes an outwardly extending flange adjacent said upper wall, and said outwardly-facing side wall is uninterrupted between said flange and said inner wall.

28. The heat exchanger as set forth in claim 26, wherein said inwardly-facing side wall is inwardly tapered at least adjacent said inner wall to define a gap between said inwardly-facing side wall and the adjacent tube side walls for receiving flux and braze material.

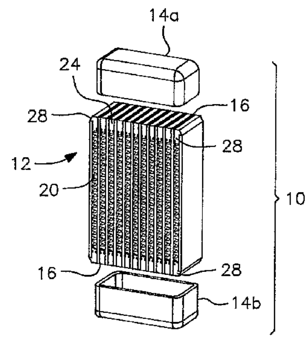
29. The heat exchanger as set forth in claim 26, wherein said outwardly-facing side wall includes at least one lengthwise recess formed therein adjacent said inner wall, said outwardly-facing side wall being configured to receive a bonding material for bonding said outwardly-facing side wall to a respective side panel.

30. The heat exchanger as set forth in claim 26, wherein said inwardly-facing and outwardly-facing side walls of each of said outer spacer bars has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

31. The heat exchanger as set forth in claim 22, wherein said first side wall of each of said spacer bars has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bars to at least a portion of said tubes.

32. The spacer bar as set forth in claim 31, wherein said second side wall also has at least two lengthwise recesses formed therein configured to receive a bonding material for bonding said spacer bar to at least a portion of the heat exchanger core.

FIG. 1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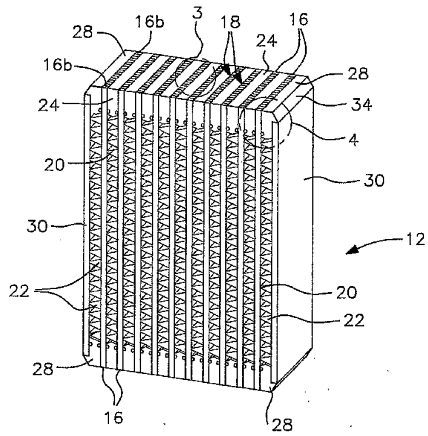
24
16
28
28
12
20
10
16
28
14b

FIG. 2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16b
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4
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22
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16
28

FIG. 3

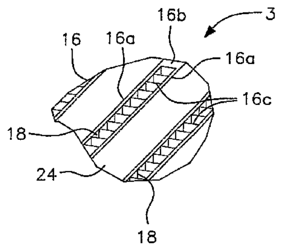


FIG. 4

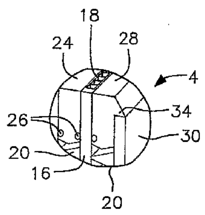


FIG. 5

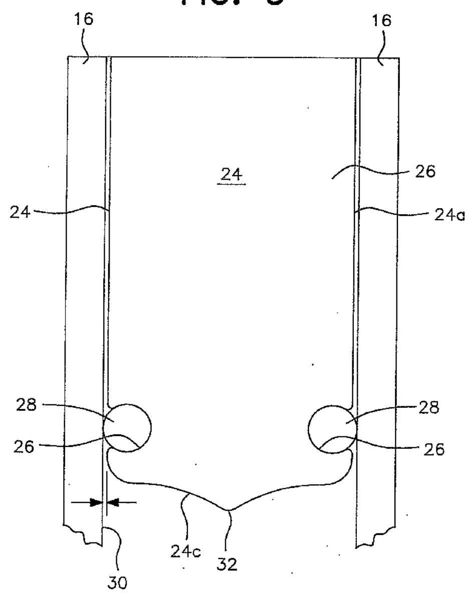


FIG. 5

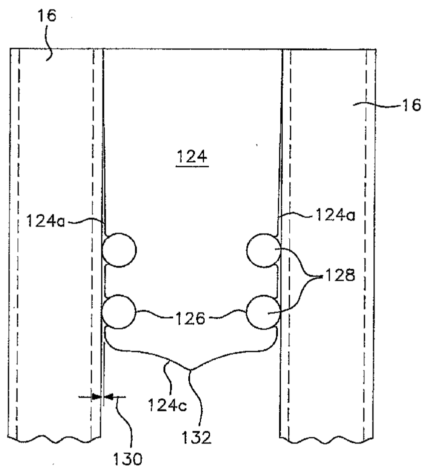
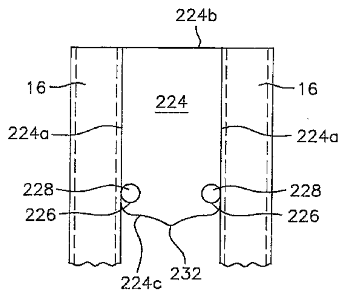


FIG. 7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224a
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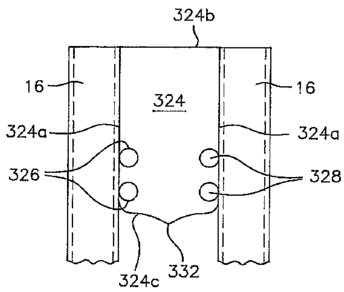
226
224c
232

FIG. 8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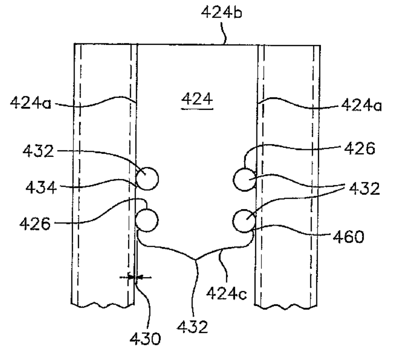
324
16
324a
324a
326
328
324c
332

FIG. 9


424b
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434
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426
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424c
432
430

FIG. 10

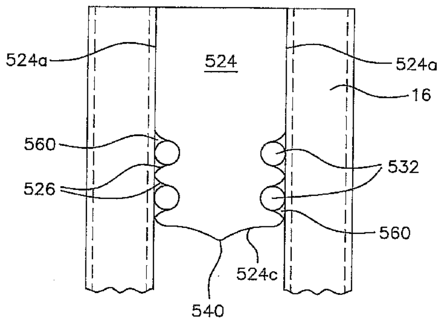

524a
524
524a
16
560
532
526
560
524c
540

FIG. 11

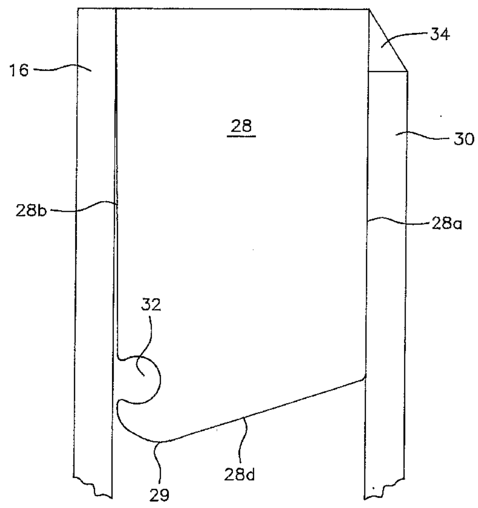
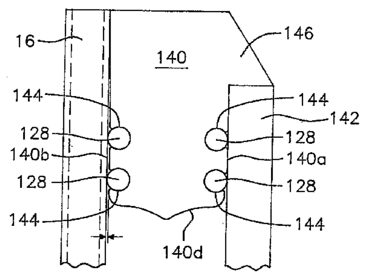
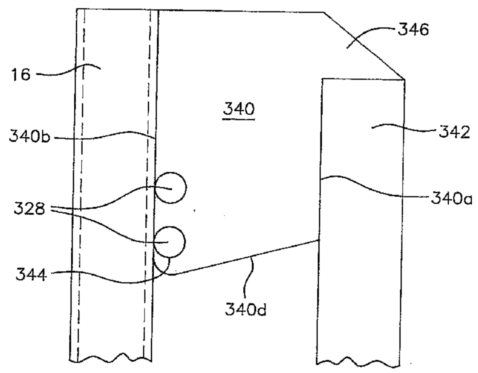


FIG. 12



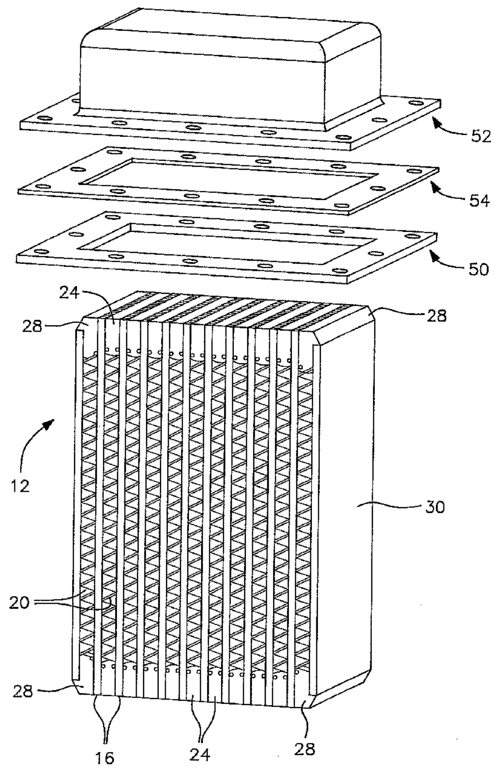
16
146
140
144
142
128
140b
140a
128
144
140d

FIG. 13



346
16
340
340b
342
328
340a
344
340d

FIG. 14



【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/47686

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : F28D 1/02; F28F 3/00, 9/02; B23K 1/20, 31/02
US CL : 165/152,153,166,173,dig.505,dig.486; 228/223,224,209,183,189,190
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 165/152,153,166,173,dig.505,dig.486; 228/223,224,209,183,189,190

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,699,856 A (MERLE) 23 December 1997 (23.12.1997), figure 2.	1-9,11, 12, 19 and 20
A	US 4,934,455 A (HASEGAWA) 19 June 1990 (19.06.1990), figure 1.	1, 22-32
A	US 4,183,402 A (COTTER) 15 JANUARY 1980 (15.01.1980), figures 7 and 8.	1-32
A	US 4,332,291 A (MULOCK-BENTLEY) 01 June 1982 (01.06.1982), figure 1	21
A	US 5,931,224 A (CHEVALLIER) 03 August 1999 (03.08.1999), figures 1 and 3	1-32
A	US 4,473,111 A (STEEB) 25 September 1984 (25.09.1984), figure 1.	1-32

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 April 2002 (15.04.2002)	14 MAY 2002

Name and mailing address of the ISA/US	Authorized officer
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(81)指定国 AP(GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DZ,EC,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NO,NZ,PH,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW

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Ｆターム(参考) 3L103 AA01 BB50 CC40 DD08 DD34 DD42 DD45