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(54) **Reinforcement plate for multiple row heat exchanger**

(57) A heat exchanger includes a pair of manifolds **20** each extending between manifold ends **22** and defining a plurality of slits **30** disposed in a plurality of parallel slit rows **R** and each slit having a center axis **C**. The center axes **C** of the slits in each of the slit rows **R** are aligned in a row plane **P**. Reinforcement members **38** extend between reinforcement ends **40** each of which have at least one tab **48** for connection thereof to one of the manifold ends **22**. Each of the manifolds **20** has at least one retainer **42** for clamping one of the reinforcement members **38** thereto. Each of the tabs **48** include at least one connector **50** extending toward the adjacent manifold end **22**. One of the connectors **50** is centered on each of the row planes **P** to define row isolating openings **52** between adjacent connectors **50** to isolate each of the row planes **P** from differential forces of adjacent row planes **P**.

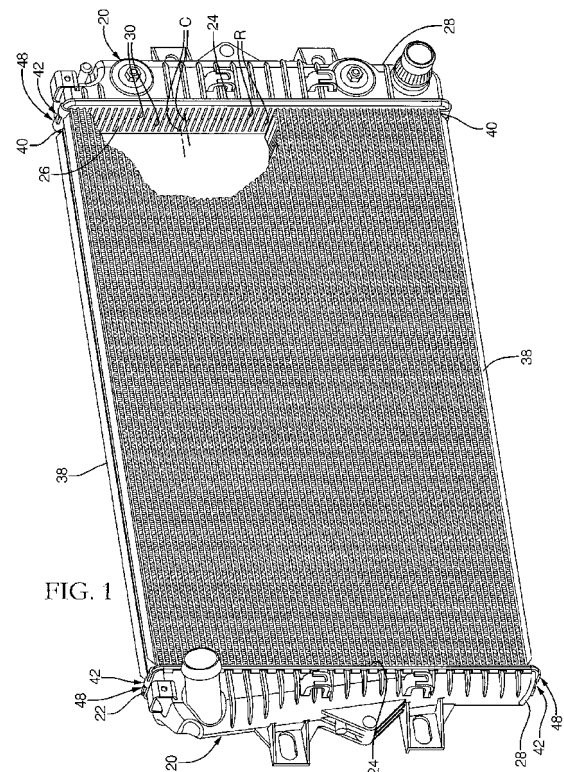


FIG. 1

EP 2 413 082 A2

Description

Technical Field

[0001] A heat exchanger having multiple rows of tubes.

Background of the Invention

[0002] Heat exchangers having multiple rows of tubes are well known in the prior art. US Patent 6,736,193 to Kodumudi, for example, discloses a pair of manifolds in spaced relationship to each other. Each of the manifolds extends between opposite manifold ends. Each of the manifolds define a plurality of slits each having a centrally disposed center axis. At least one reinforcement member interconnects the manifolds and extends between reinforcement ends disposed adjacent the manifolds. Each of the manifolds has at least one retainer for clamping the adjacent one of the reinforcement members thereto. Each of the reinforcement ends defines at least one tab for connection thereof to one of the manifolds ends. The tab includes a lip being clamped by the retainer and at least one connector extending between the reinforcement end and the lip. US Patent Application Publication 2009/0151918 to Hur et al. discloses slits being disposed in a plurality of slit rows disposed in a side by side relationship and each of the slit rows extending between the manifold ends. The center axes of the slits in each of the slit rows are aligned in a row plane. A plurality of tubes are for carrying fluid between the manifolds and each of the tubes extends between the manifolds and has tube ends disposed in the slits.

Summary of the invention

[0003] The invention provides for one of the connectors being centered on each of the row planes to define row isolating openings between adjacent connectors to isolate each of the row planes from differential forces of adjacent row planes.

[0004] The subject invention reduces the torque acting in each of the connectors from the differential forces of the row planes and greatly increases the thermal cycle life of the tubes by reducing thermal strain in the tubes.

[0005] More particularly, the invention is about a heat exchanger having multiple rows of tubes. The heat exchangers comprise a pair of manifolds in spaced relationship to each other. Each manifold extends between opposite manifold ends, each of said manifolds defines a plurality of slits having a centrally disposed center axis. The slits are disposed in a plurality of slit rows disposed side by side, each extending between said manifold ends. The center axes of said slits is aligned in a row plane. A plurality of tubes for carrying fluid between said manifolds and each of said tubes extends between said manifolds and has tube ends disposed in said slits. The tubes create differential forces between said row planes. At least one reinforcement member interconnects said

manifolds and extends between reinforcement ends disposed adjacent manifolds. The manifolds have at least one retainer for clamping the adjacent reinforcement members. The reinforcement ends define at least one tab for connection thereof to at least one of said retainers at the adjacent manifold ends. The tabs include a lip clamped by the adjacent retainers and at least one connector extend between the reinforcement end and the lip. One of the connectors being centered on each of said row planes (P) to define row isolating openings between adjacent of said connectors to isolate each of said row planes (P) from differential forces of adjacent of said row planes (P). Furthermore, a heat exchanger may have two slit rows and two reinforcement members. Each manifold ends has one retainer and each reinforcement ends has one tab and each tab has two connectors. Also, a heat exchanger may have four of slit rows and two reinforcement members. Each manifold ends has one retainer and each reinforcement ends has one tab and each tab has four connectors. Each manifold ends may have two retainers and the retainers being side by side and spaced from each other. Each reinforcement ends include two tabs aligned with a different retainer and has two connectors.

[0006] At least one retainer extends from each manifold ends and each retainers are L-shaped including a first leg extending perpendicularly away from the manifold end and a clamp leg extending from the first leg in a direction parallel the adjacent one of said reinforcement members. The connectors extend outwardly from and between the reinforcement end and the lip thereof. The lips extend arcuately outward from between the adjacent manifold ends and the adjacent clamp legs and over the adjacent manifold ends. Each lip defines a notch in alignment with the adjacent retainers for securing the tab laterally therein. The manifolds have a D-shaped cross-section to define a pair of edges extending between the manifold ends and parallel to each other. A flat wall extends between the edges and a curved wall is arcuate and extends between the edges. A pair of the reinforcement members have a U-shaped cross-section and the reinforcement ends are disposed adjacent the flat walls and inwardly from the manifold ends. The flat walls of each of the manifolds define the slits. The fins extend between the tubes for transferring heat between the tubes and air passing the fins.

[0007] The invention is also about a heat exchanger having multiple rows of tubes and comprising a pair of manifolds in parallel and spaced relationship to each other. Each manifold extends between opposite manifold ends and has a D-shaped cross-section to define a pair of edges extending between the manifold ends and parallel to each other and a flat wall extending between the edges. A curved wall is arcuate and extends between the edges. The flat walls of the manifolds define a plurality of slits each having a centrally disposed center axis. The slits are disposed side by side in a plurality of parallel slit rows. Each slit rows extends between the manifold?. The

center axes of the slits in each rows is aligned in a row plane. A plurality of tubes for carrying fluid between the manifolds and each tubes extends between the manifolds and has tube ends disposed in the slits. The tubes create differential forces between the row planes. The fins extend between the tubes for transferring heat between the tubes and air passing the fins. A pair of reinforcement members having a U-shaped cross-section interconnect the manifolds and extend between reinforcement ends disposed adjacent the flat walls of the manifolds and inwardly from the manifold ends. The manifolds have at least one retainer extending from each of the manifold ends for clamping the adjacent reinforcement members thereto. Each retainer is L-shaped including a first leg extending perpendicularly away from said manifold end and a clamp leg extending from the first leg in a direction parallel the adjacent one of the reinforcement members. The reinforcement ends define one tab for connection thereof to one of the retainers at the adjacent manifold ends. Each tab includes a lip clamped by the adjacent retainer between the adjacent manifold ends and the adjacent clamp legs. It extends arcuately outward there from and over the adjacent manifold ends. At least one connector extends outwardly from and between the reinforcement end and the lip thereof. Each lip defines a notch in alignment with the adjacent retainers for securing the tab laterally therein. One connector is centered on each of the row planes to define row isolating openings between adjacent connectors to isolate each row planes from differential forces of adjacent row planes.

[0008] A heat exchanger may have two, respectively four, of slit rows and each manifold ends one retainer. Each reinforcement ends has one tab and each tab two, respectively four, connectors.

[0009] A heat exchanger may have four of slit rows and each manifold ends two retainers side by side and spaced from each other. Each reinforcement ends has two tabs and each tab is in alignment with a different one of the retainers and has two of the connectors.

Brief description of the drawings

[0010] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Figure 1 is a perspective view of a heat exchanger according to the subject invention;
 Figure 2 is a partial sectional view of a heat exchanger according to the subject invention;
 Figure 3 is a perspective view of a heat exchanger according to the subject invention;
 Figure 4 is a perspective view of a heat exchanger according to the subject invention;
 Figure 5 is a perspective view of a heat exchanger according to the subject invention.

Description of the preferred embodiments

[0011] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a heat exchanger includes a pair of manifolds **20** in parallel and spaced relationship to each other. Each of the manifolds **20** extends between opposite manifold ends **22**. Each manifold **20** has a D-shaped cross-section to define a pair of edges **24** extending between the manifold ends **22** and parallel to each other. A flat wall **26** extends between the edges **24**. A curved wall **28** is arcuate and extends between the edges **24**. The flat wall **26** and the curved wall **28** define a manifold chamber (not shown).

[0012] Each of the flat walls **26** of each of the manifolds **20** defines a plurality of slits **30**. Each of the slits **30** has a centrally disposed center axis **C**. The slits **30** are disposed in a plurality of parallel slit rows **R**. The slit rows **R** are disposed in side by side relationship and each of the slit rows **R** extend between the manifold ends **22**. The center axes **C** of the slits **30** in each of the slit rows **R** are aligned in a row plane **P** (as demonstrated in Figure 2).

[0013] A plurality of tubes **32** are for carrying fluid between the manifolds **20** and each of the tubes **32** extends between the manifolds **20** and has tube ends disposed in the slits **30** (as demonstrated in Figure 3). In each of the tubes **32**, a change in temperature causes relative expansion and contraction. The temperature of each of the tubes **32** changes individually of other of the tubes **32** and the tubes **32** create differential forces between the row planes **P**. Fins **36** extend between the tubes **32** for transferring heat between the tubes **32** and air passing the fins **36**.

[0014] A pair of reinforcement members **38** each have a U-shaped cross-section interconnecting the manifolds **20**. Each of the reinforcement members **38** extend between reinforcement ends **40** disposed adjacent to the flat walls **26** of the manifolds **20** and inwardly from the manifold ends **22**.

[0015] Each of the manifolds **20** has at least one retainer **42** extending from each of the manifold ends **22** for clamping the adjacent one of the reinforcement members **38** thereto. Each of the retainers **42** is L-shaped including a first leg **44** extending perpendicularly away from the manifold end **22** and a clamp leg **46** extending from the first leg **44** in a direction parallel the adjacent one of the reinforcement members **38**.

[0016] Each of the reinforcement ends **40** has at least one tab **48** for connection thereof to at least one of said retainers **42** at the adjacent one of the manifold ends **22**. Each of said tabs **48** include a lip **54** being clamped by the adjacent one of the retainers **42** between the adjacent one of the manifold ends **22** and the adjacent one of the clamp legs **46** and extends arcuately outward therefrom and over the adjacent one of the manifold ends **22**. At least one connector **50** extending outwardly from and between said reinforcement end **40** and said lip **54** there-

of. Each of the lips **54** define a notch **56** in alignment with the adjacent one of the retainers **42** for securing the tab **48** laterally in the retainer **42**.

[0017] The invention is characterized by one of the connectors **50** being centered on each of the row planes **P** to define row isolating openings **52** between adjacent of the connectors **50** to isolate each of the row planes **P** from differential forces of adjacent of the row planes **P**.

[0018] In an embodiment (as demonstrated in Figure 3), the heat exchanger has two of the slit rows **R**. Each of the manifold ends **22** has one of the retainers **42**. Each of the reinforcement ends **40** has one of the tabs **48** and each of the tabs **48** has two of the connectors **50**.

[0019] In an embodiment (as demonstrated in Figure 5), the heat exchanger has four of the slit rows **R**. Each of the manifold ends **22** has one of the retainers **42**. Each of the reinforcement ends **40** has one of the tabs **48** and each of the tabs **48** has four of the connectors **50**.

[0020] In an embodiment (as demonstrated in Figure 4), the heat exchanger has four of the slit rows **R**. Each of the manifold ends **22** has two of the retainers **42** and the retainers **42** are side by side and spaced from each other. Each of the reinforcement ends **40** includes two of the tabs **48** and each of said tabs **48** is in alignment with a different one of the retainers **42** and has two of the connectors **50**.

Claims

1. A heat exchanger having multiple rows of tubes (32) comprising:

a pair of manifolds (20) in spaced relationship to each other,
 each of said manifolds (20) extending between opposite manifold ends (22),
 each of said manifolds (20) defining a plurality of slits (30) each having a centrally disposed center axis (C),
 said slits (30) being disposed in a plurality of slit rows (R) disposed in a side by side relationship and each extending between said manifold ends (22), said center axes (C) of said slits (30) in each of said slit rows (R) being aligned in a row plane (P),
 a plurality of tubes (32) for carrying fluid between said manifolds (20) and each of said tubes (32) extends between said manifolds (20) and has tube ends disposed in said slits (30),
 said tubes (32) creating differential forces between said row planes (P), at least one reinforcement member (38) interconnecting said manifolds (20) and extending between reinforcement ends (40) disposed adjacent said manifolds (20), each of said manifolds (20) having at least one retainer (42) for clamping the adjacent one of said reinforcement members (38) thereto,

each of said reinforcement ends (40) defining at least one tab (48) for connection thereof to at least one of said retainers (42) at the adjacent one of said manifold ends (22),

each of said tabs (48) including a lip (54) being clamped by the adjacent one of said retainers (42) and at least one connector (50) extending between said reinforcement end (40) and said lip (54) thereof, and

characterized by

one of said connectors (50) being centered on each of said row planes (P) to define row isolating openings (52) between adjacent of said connectors (50) to isolate each of said row planes (P) from differential forces of adjacent of said row planes (P).

2. A heat exchanger as set forth in Claim 1 having two of said slit rows (R) and two of said reinforcement members (38) and each of said manifold ends (22) having one of said retainers (42) and each of said reinforcement ends (40) having one of said tabs (48) and each of said tabs (48) having two of said connectors (50).
3. A heat exchanger as set forth in Claim 1 having four of said slit rows (R) and two of said reinforcement members (38) and each of said manifold ends (22) having one of said retainers (42) and each of said reinforcement ends (40) having one of said tabs (48) and each of said tabs (48) having four of said connectors (50).
4. A heat exchanger as set forth in Claim 1 having four of said slit rows (R) and two of said reinforcement members (38) and each of said manifold ends (22) having two of said retainers (42) and said retainers (42) side by side and spaced from each other and each of said reinforcement ends (40) including two of said tabs (48) and each of said tabs (48) being in alignment with a different one of said retainers (42) and having two of said connectors (50).
5. A heat exchanger as set forth in Claim 1 wherein at least one of said retainers (42) extends from each of said manifold ends (22) and each of said retainers (42) are L-shaped including a first leg (44) extending perpendicularly away from said manifold end (22) and a clamp leg (46) extending from said first leg (44) in a direction parallel the adjacent one of said reinforcement members (38).
6. A heat exchanger as set forth in Claim 1 wherein each of said connectors (50) extend outwardly from and between said reinforcement end (40) and said lip (54) thereof.
7. A heat exchanger as set forth in Claim 6 wherein

each of said lips (54) extend arcuately outward from between the adjacent one of said manifold ends (22) and the adjacent one of said clamp legs (46) and over the adjacent one of said manifold ends (22).

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8. A heat exchanger as set forth in Claim 7 wherein each of said lips (54) define a notch (56) in alignment with the adjacent one of said retainers (42) for securing said tab (48) laterally therein.

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9. A heat exchanger as set forth in Claim 1 wherein each of said manifolds (20) have a D-shaped cross-section to define a pair of edges (24) extending between said manifold ends (22) and parallel to each other and a flat wall (26) extending between said edges (24) and a curved wall (28) being arcuate and extending between said edges (24).

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10. A heat exchanger as set forth in Claim 9 wherein a pair of said reinforcement members (38) each have a U-shaped cross-section and said reinforcement ends (40) are disposed adjacent said flat walls (26) and inwardly from said manifold ends (22).

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11. A heat exchanger as set forth in Claim 9 wherein each of said flat walls (26) of each of said manifolds (20) defining said slits (30).

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12. A heat exchanger as set forth in Claim 1 wherein fins (36) extend between said tubes (32) for transferring heat between said tubes (32) and air passing said fins (36).

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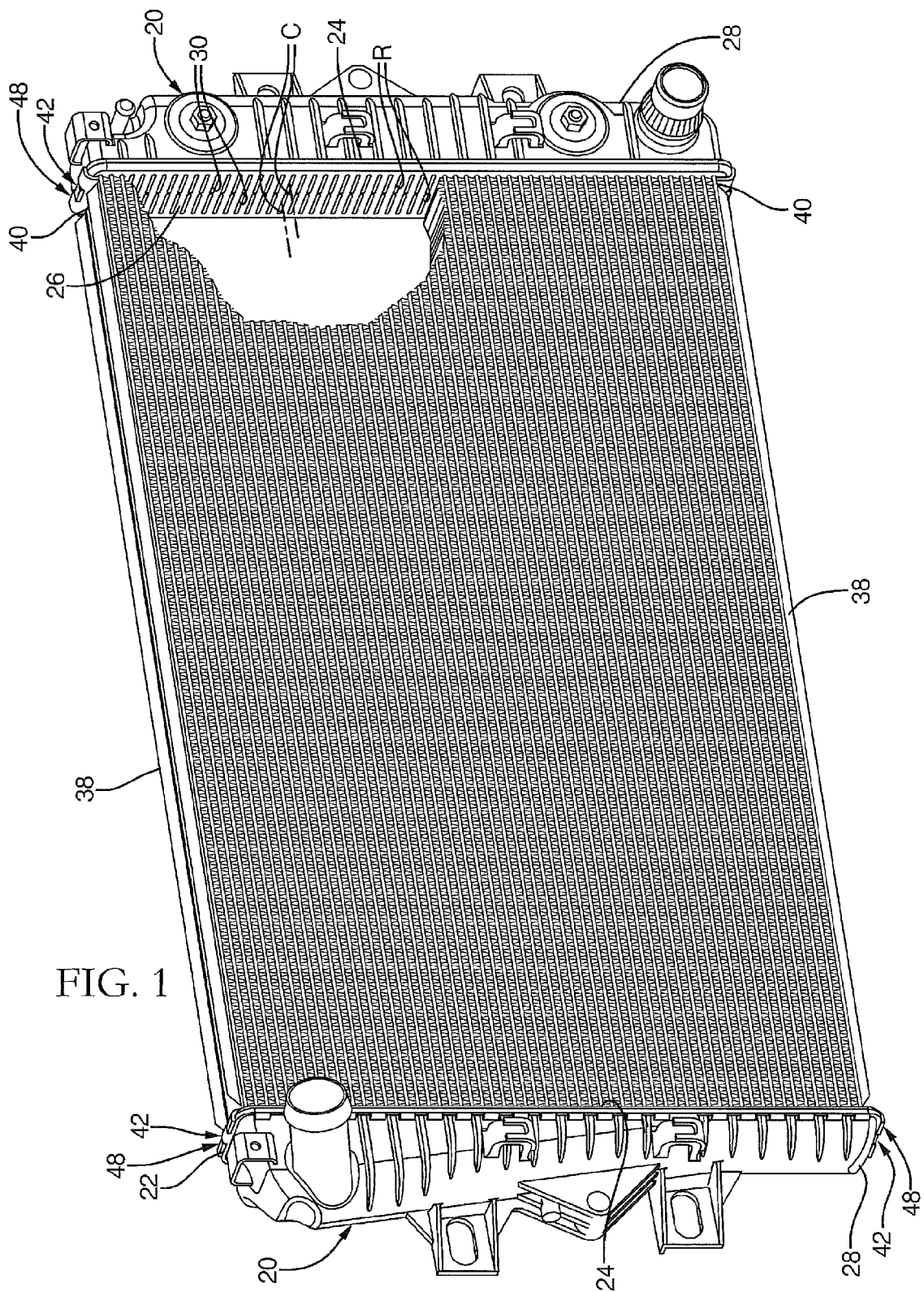


FIG. 1

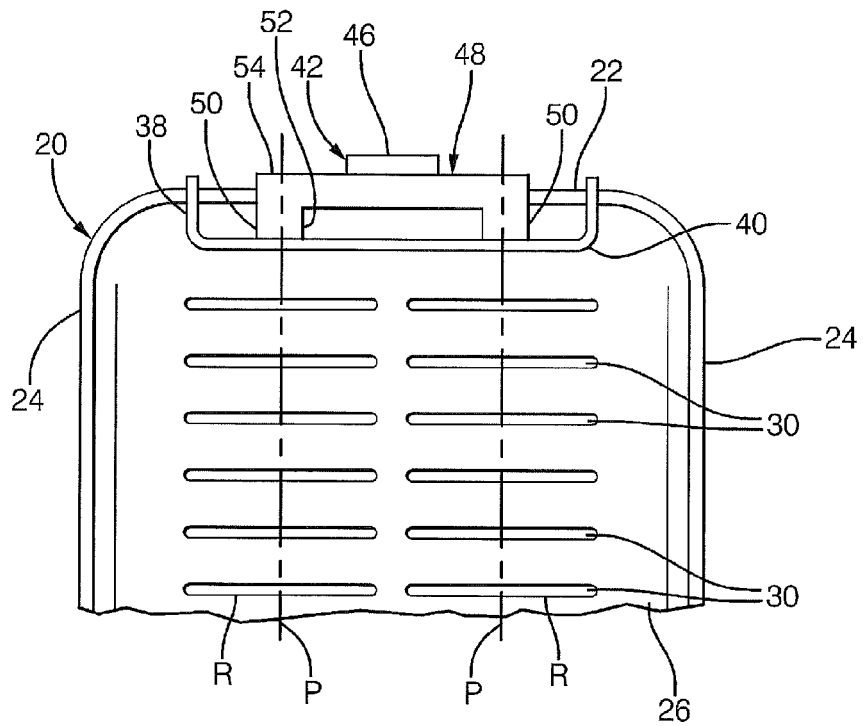


FIG. 2

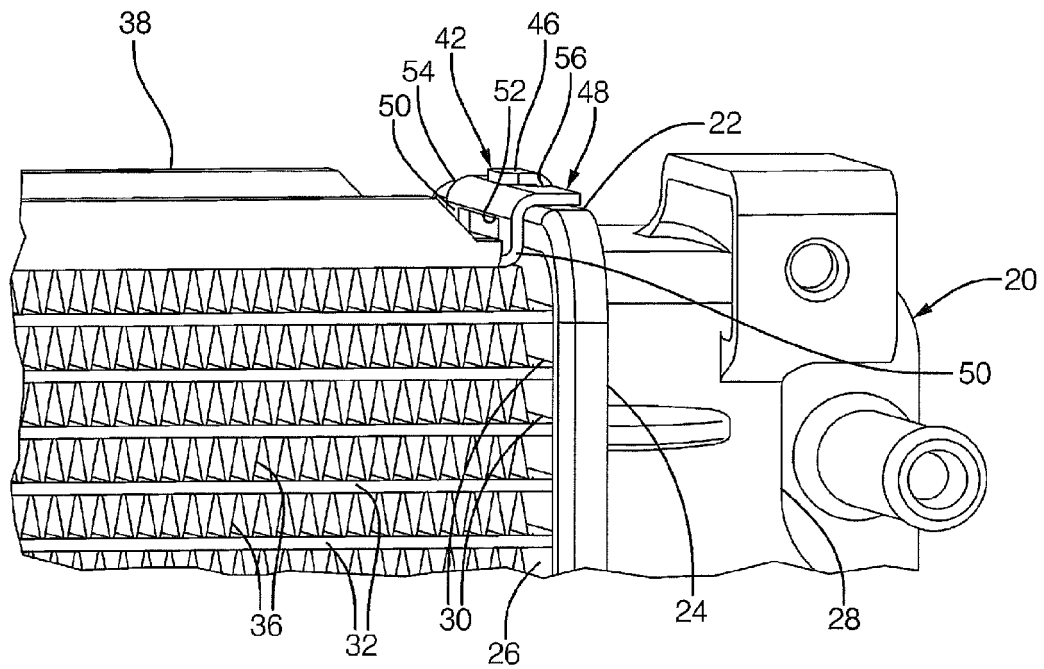


FIG. 3

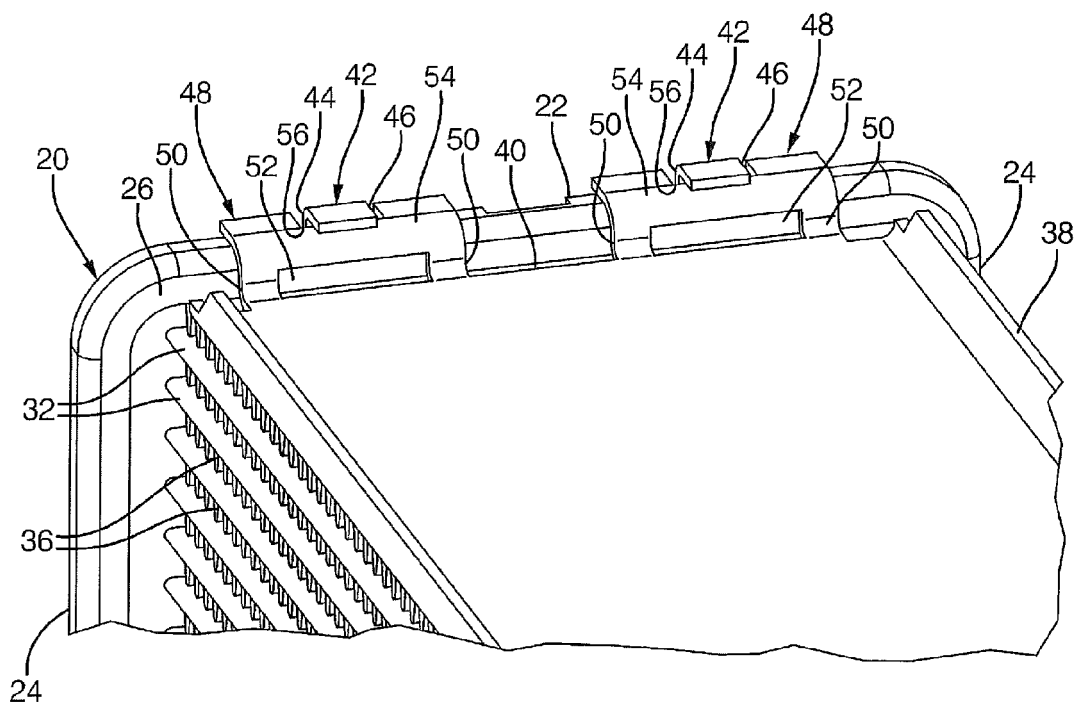


FIG. 4

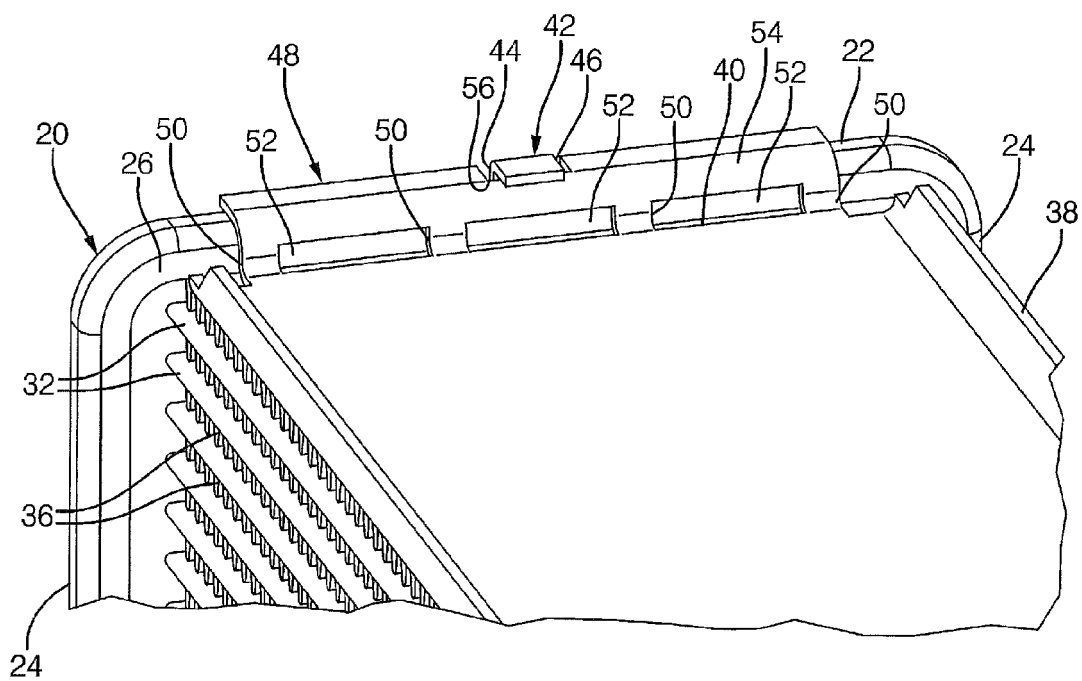


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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