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(54) **FLAT TUBE HEAT EXCHANGER CORE
WITH INTERNAL FLUID SUPPLY AND
SUCTION LINES**

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(57)

ABSTRACT

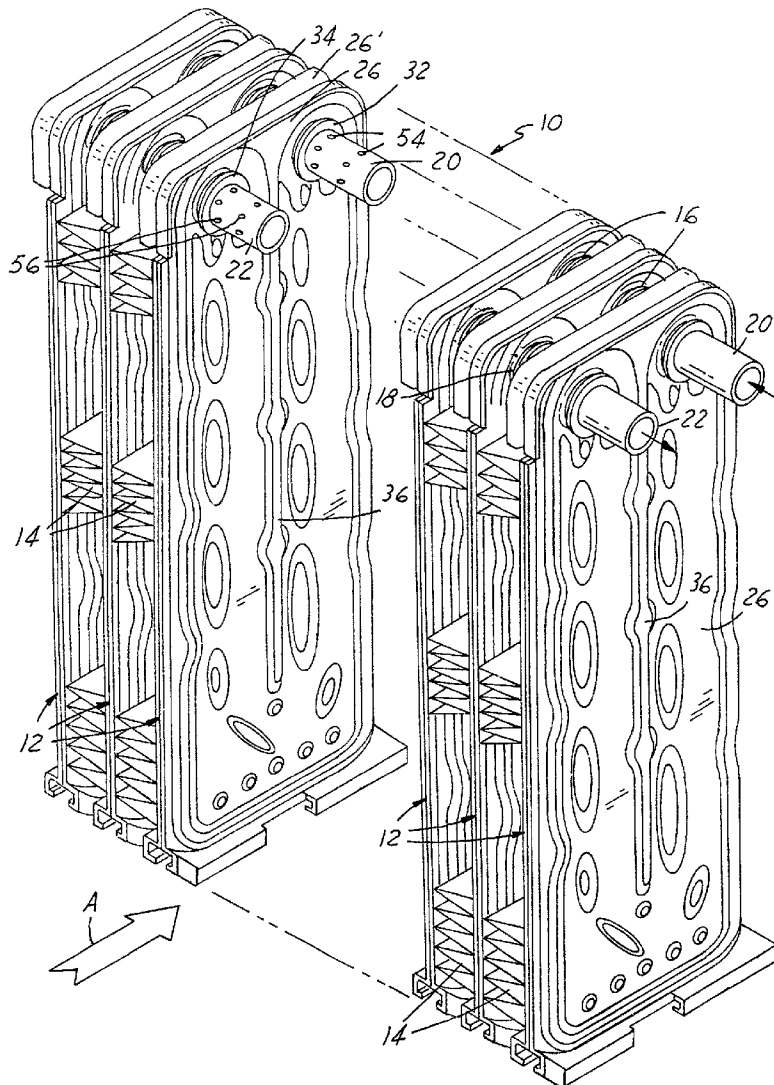
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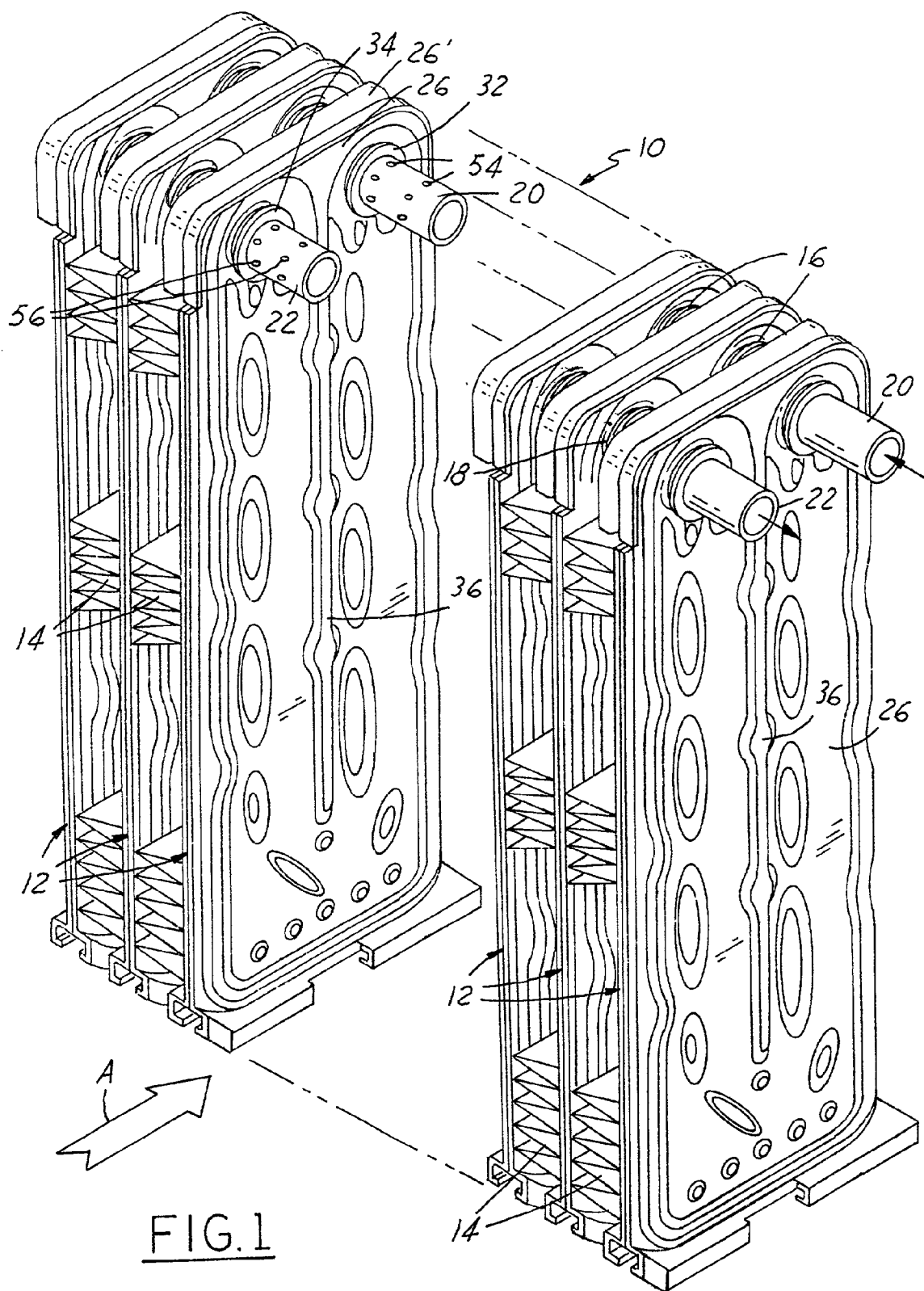
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Heat exchanger core comprising flat plate fluid U flows tubes stacked on one another and operatively connected to one another by discrete fluid supply and suction lines. These lines extending through side-by-side tank portions of the tubes to improve structural integrity of the core and respectively have fluid feed and exhaust openings communicating with the tanks and sized to provide even distribution of the heat exchanger fluid to the tubes. With the supply and suction lines, evenly distributing the heat exchanger fluid, tank size and capacity is optimized and the requirement for large capacity deep draw tanks of prior constructions is eliminated.

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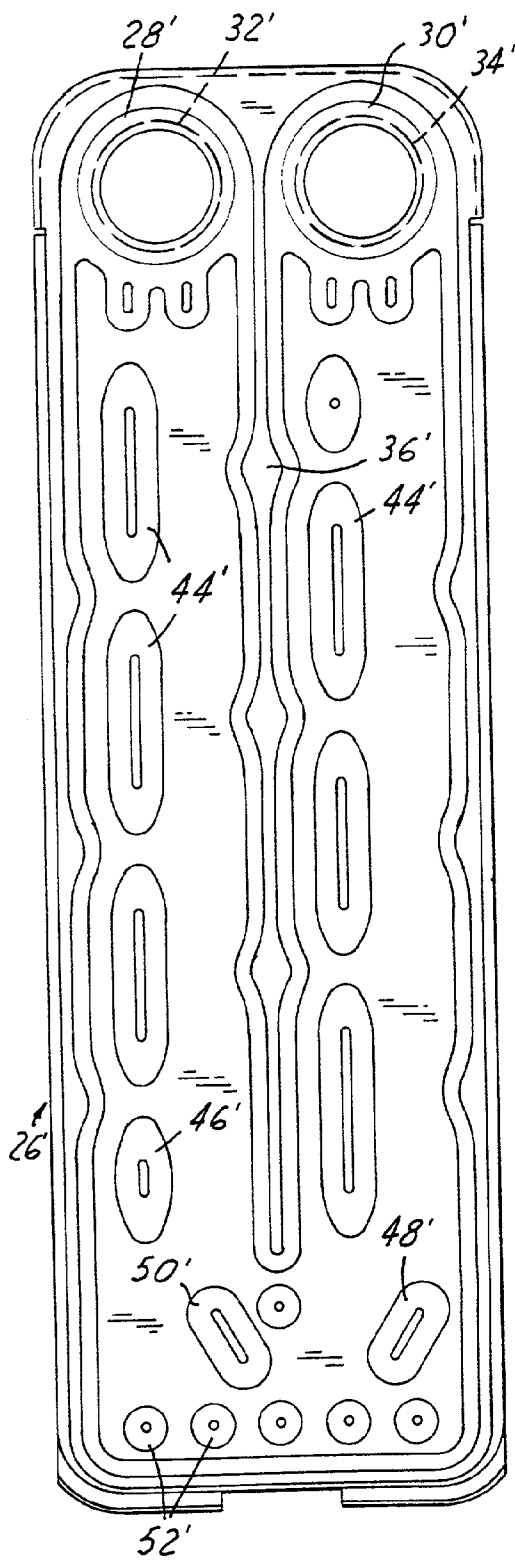


FIG. 2

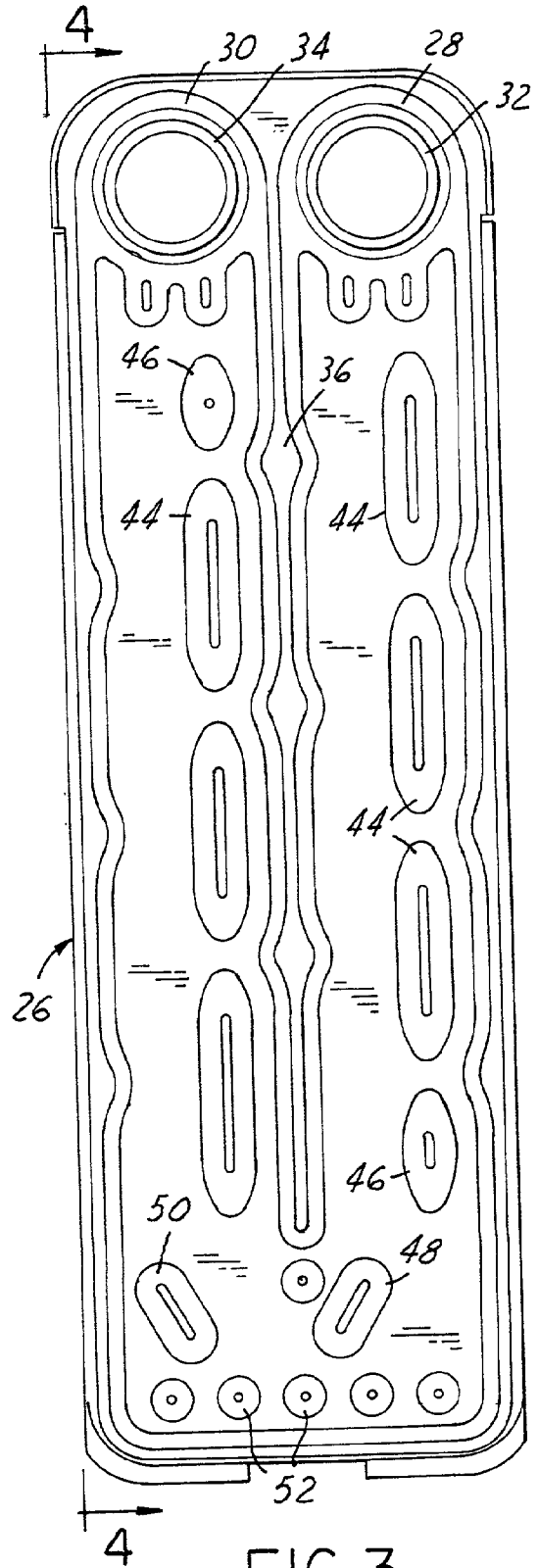


FIG. 3

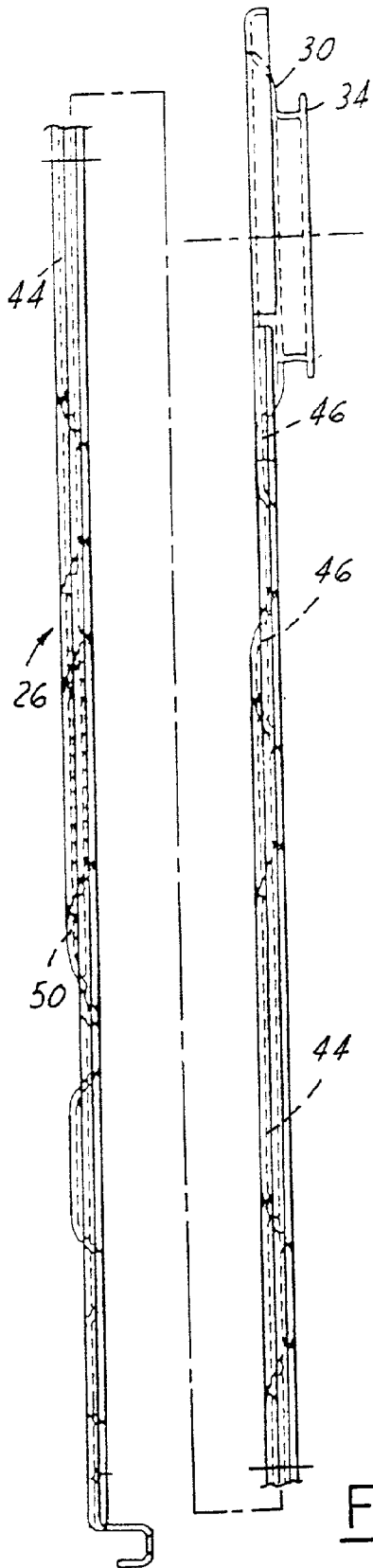


FIG. 4

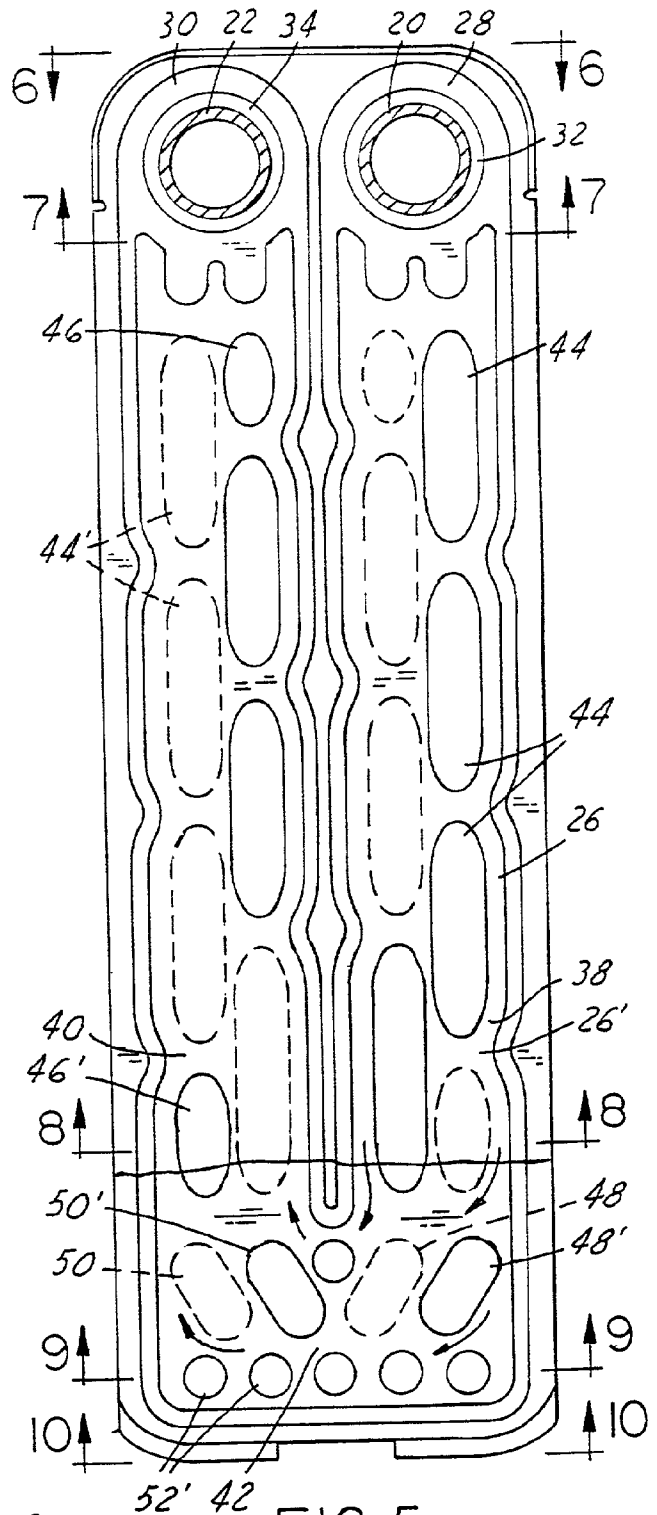


FIG. 5

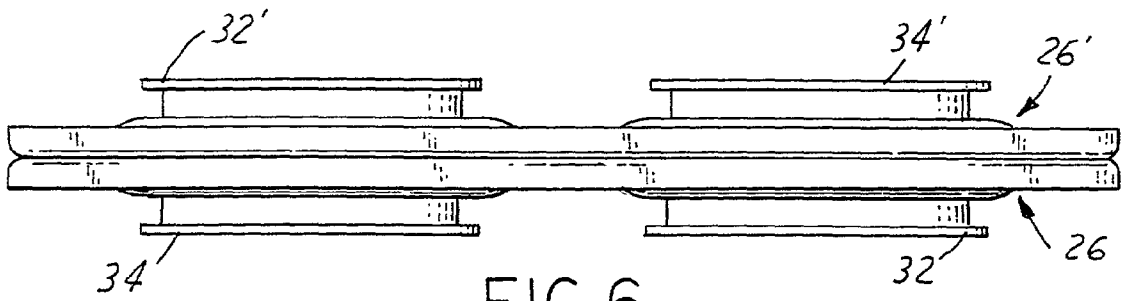


FIG. 6

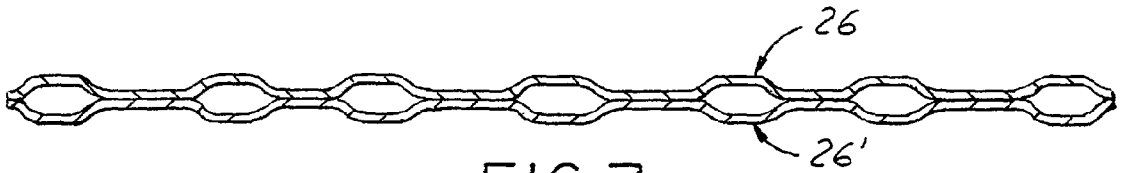


FIG. 7

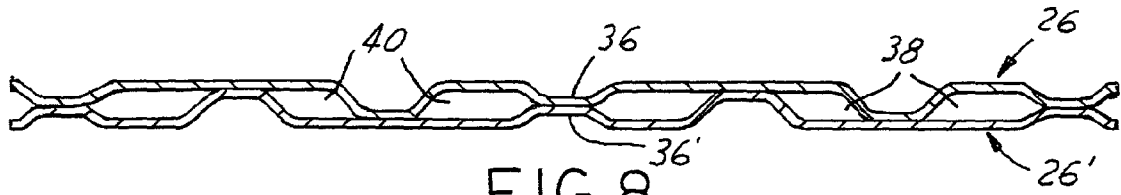


FIG. 8

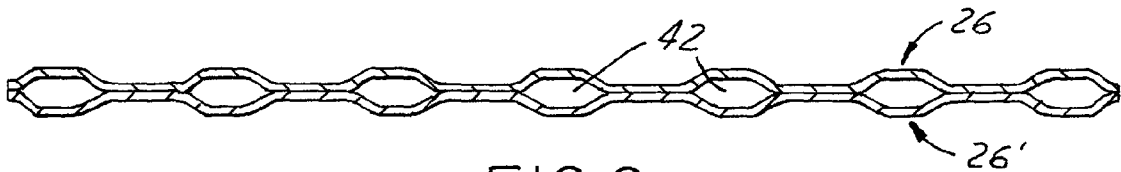


FIG. 9

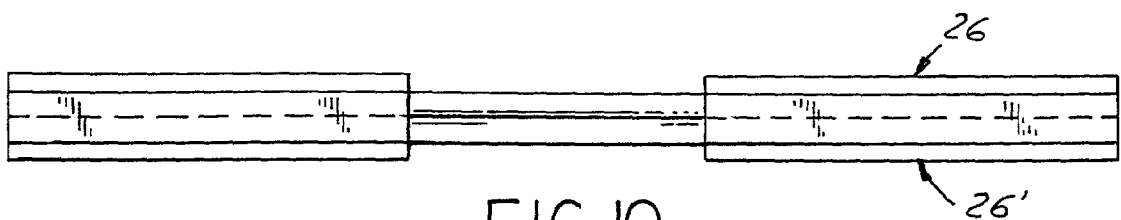


FIG. 10

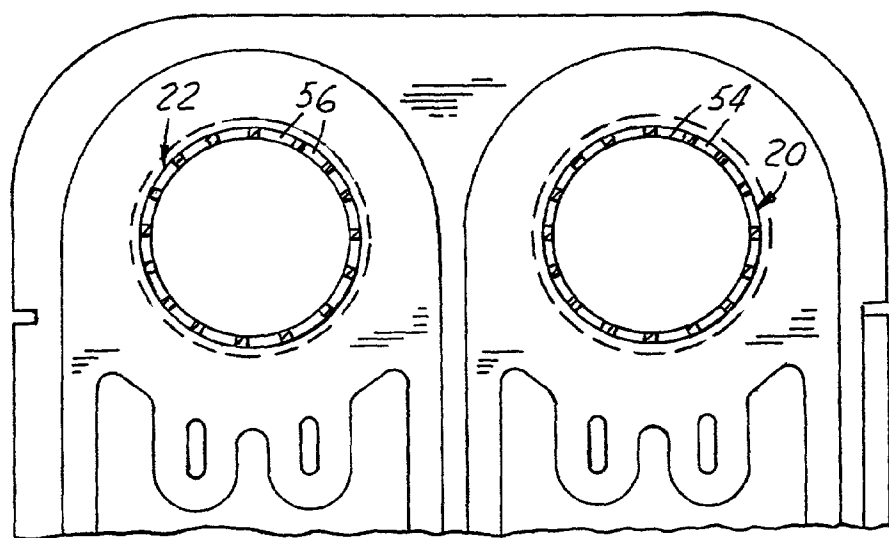
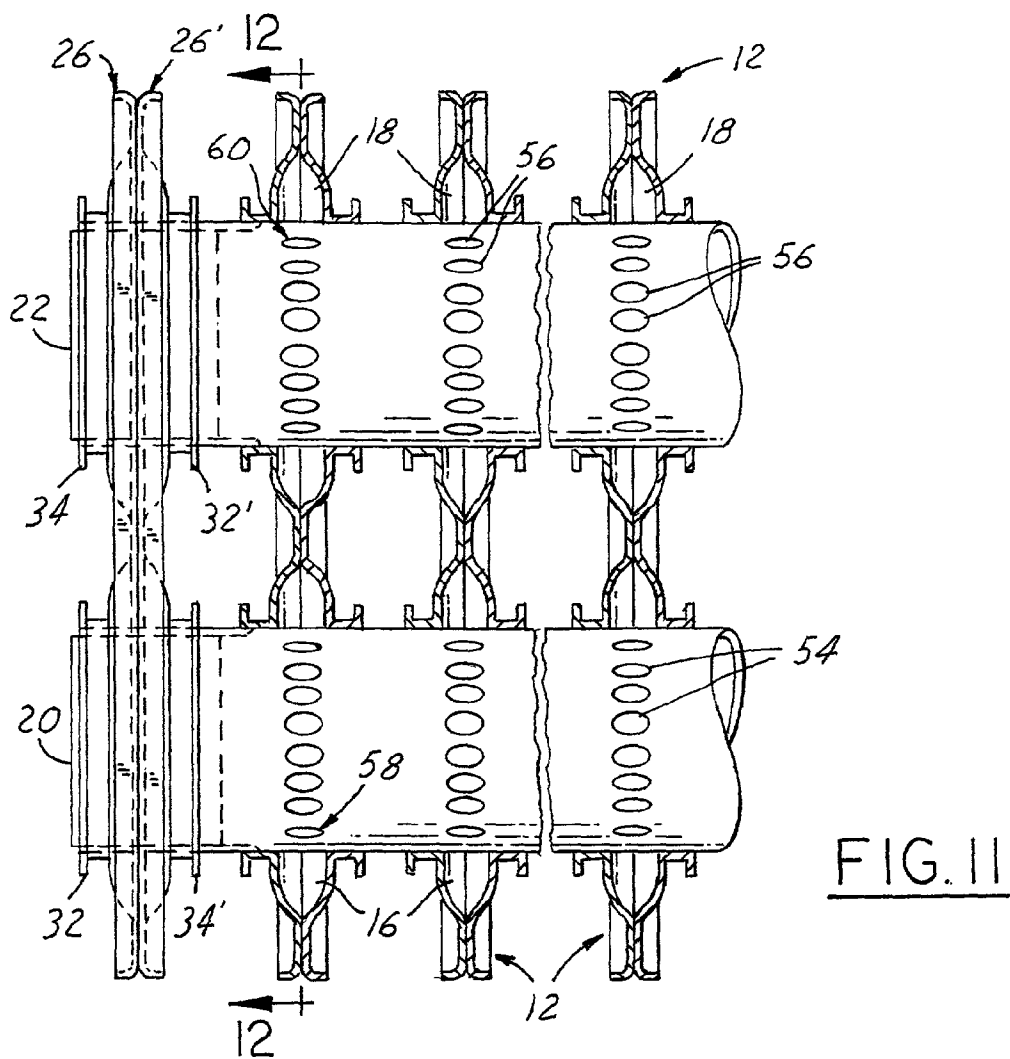


FIG. 12

FLAT TUBE HEAT EXCHANGER CORE WITH INTERNAL FLUID SUPPLY AND SUCTION LINES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to heat exchangers and more particularly to new and improved multi-tube heat exchanger cores in which the majority of the tubes are formed by identical flattened plates operatively joined in an interfacing relationship and in which discrete fluid supply and suction lines extend through tank portions of the core and mechanically connect thereto to strengthen the core.

[0003] 2. Background Art

[0004] Prior to the present invention various compact and lightweight heat exchanger cores have been designed and developed for automotive air conditioning and other uses. Many of these prior units involve the employment of narrow-width refrigerant U-flow tubes fabricated from mated pairs of thin plates stamped from aluminum or other suitable sheet metal materials. These tubes are generally provided with side-by-side tanks, formed by deep-drawn, laterally-extending bulges or protrusions in each of the plates at the upper ends thereof. These tanks conduct and distribute the flow of heat exchanger fluid from a supply into the tubes and exhaust the fluid from the tubes back into a return. The tubes are brazed or otherwise operatively connected together when stacked into a core with thin corrugated air centers secured therebetween. These cores and their tubes generally include a plurality of variously configured plates including blocker plates, require extensive development costs and time to provide a highly efficient unit and are difficult to build. Moreover, the employment of deep draw tanks found in many prior plate type units adds to manufacturing costs because of plate scraping from tears, wall thinning or other defects particularly occurring in the deep draw tank sections during plate forming.

SUMMARY OF THE INVENTION

[0005] In the present invention, special internal supply and suction lines are employed to separately feed and exhaust heat exchanger fluid to and from each of the tubes of a heat exchanger unit such as an evaporator or of an air conditioning system so that the draw depth of the tank section of the tubes can be substantially reduced. The decrease in the draw depth of the tank as in this invention optimizes plate stamping since a reduced amount of material is moved during stamping and production defects are minimized. In contrast, deep draw tanks of prior units require displacement of more material by the tooling that may result in splitting, tearing or thinning of the aluminum materials in the tank areas. Accordingly, the scrap or rebuild costs associated with deep draw tanks designs and their attendant torn or thin areas are effectively eliminated in this invention with new and improved construction.

[0006] More particularly this invention further involves the use of elongated tubular supply and suction lines of a suitable metal or metal alloy that are rigid and pass through or into the reduced draw tank sections of the core. These lines importantly mechanically strengthen the core and serve as improved refrigerant distributors throughout the evaporator. More particularly these lines are holed with fluid

transmitting openings that beneficially insure that there is an even flow of heat exchanger fluid into and out of each of the tubes for improved operational efficiency. This function was previously achieved by using special blocker plates to effect a change in flow direction in a heat exchanger fluid in the core so that the refrigerant flows to all parts of the evaporator. Such blocker plates are not needed in this invention.

[0007] The present invention importantly provides a reduction in complexity and utilizes a minimum number of plate styles or designs that go into a heat exchanger unit such as an evaporator. This accordingly simplifies heat exchanger core constructions with minimized chance for core misbuilds. The number of storage locations and part handling burden are reduced in this invention because there are fewer stamped plate designs and no blank plates used in the heat exchanger.

[0008] It is a feature object and advantage of this invention to provide a new and improved heat exchanger cores comprising stacked U-flow heat exchanger tubes formed from an optimal number of operatively connected and flattened plates and cooperating supply and suction lines extending internally through tank sections of the core to improve core strength. The lines are perforated with sized fluid flow openings at strategic locations to optimize the distribution of heat exchanger fluids throughout the tubes of the core for improved operational efficiency.

[0009] These and other features objects and advantages of this invention will become more apparent from the following description and drawing in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a pictorial view of a heat exchanger core having a plurality of flattened tubes conducting heat exchanger fluid from an inlet to an outlet;

[0011] FIG. 2 is a rear plan view of a plate for making one of the tubular passes of the heat exchanger of FIG. 1;

[0012] FIG. 3 is a front plan view of the plate of FIG. 2;

[0013] FIG. 4 is an enlarged side view taken along sight lines 4-4 of FIG. 3;

[0014] FIG. 5 is a front view of one of the tubular passes formed from the joining of the plates of FIGS. 2 and 3;

[0015] FIG. 6 is a top view taken generally along sight lines 6-6 of FIG. 5;

[0016] FIGS. 7, 8 and 9 are cross sectional views respectively taken along sight lines 7-7, 8-8 and 9-9 of FIG. 5;

[0017] FIG. 10 is a bottom view taken generally along sight lines 10-10 of FIG. 5;

[0018] FIG. 11 is an enlarged view of a portion of the heat exchanger of FIG. 1; and

[0019] FIG. 12 is a cross sectional view taken along lines 12-12 in FIG. 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0020] Turning now in detail to the drawings there is shown in FIG. 1, one preferred form of this invention comprising a cross-flow heat exchanger 10 exemplified as an

evaporator for an automotive air conditioning system. The heat exchanger **10** comprises a plurality of flattened and generally rectilinear, fluid-conducting, U-flow tubes **12**. Some of the tubes in the center of the evaporator are not illustrated so that interior components are apparent. In any event, these tubes are stacked in spaced alignment with respect to one another and have serpentine metallic air centers **14** operatively mounted therebetween to form a heat exchanger core. Streams of air to be cooled are blown or otherwise forced to flow through the air centers illustrated by flow arrow **A**.

[**0021**] The tubes have side-by-side and laterally-bulging tank portions **16, 18** formed in their upper ends. These tank portions are formed with axially-aligned, annular openings that receive a pair of cylindrical, fluid-conducting lines **20, 22** that extend internally through the tank portions and terminate in stoppered or blanked terminal ends in the tank portion of the end most tube. As illustrated in **FIG. 1**, line **20** feeds the volatile heat exchanger fluid in its liquid phase from a condenser to the supply side tank portion **16** of each tube and Line **22** is a suction pipe that exhausts the heat exchanger fluid in its gaseous phase from the suction side tank portion **18** of each tube to the compressor of the air conditioning system.

[**0022**] Each of the interior tubes of the heat exchanger is fabricated from a pair of identical mating plates illustrated in **FIGS. 2 and 3** and here identified for purposes of description as the bottom plate **26'** and top plate **26**. The top plate **26** is simply a plate like the bottom plate **26'** but turned 180 degrees on the right hand edge thereof so that the interior face of the bottom plate and the exterior face of the top plate are shown. The interior faces of each tube are formed by inner faces of a pair of plates. Each plate is a flattened aluminum stamping except that the upper ends have enlarged and side-by-side and outwardly or transversely extending protuberances **28, 30** and **28', 30'** shallow drawn during the stamping process which cooperate to form the shallow drawn tank portions **16, 18**. Each protuberance has a transversely oriented opening therein with a cylindrical neck that extends outwardly of this opening. Each neck portion terminates in an annular radial flange **32, 34** and **32', 34'**. These neck portions and associated openings are sized to closely receive and provide support for the elongated fluid conducting lines **20, 22** that extend through the tank portions of the unit.

[**0023**] Moreover each plate has an elongated inwardly indented and centralized divider rib **36, 36'** respectively which mate as shown in **FIG. 8** when the two plates are joined together in an interfacing and fluid tight relationship and define side flow sections **38** and **40** as well as a lower cross over section **42** at the bottom of the tube. The tubes provide for the U-flow path for the heat exchanger fluids from the supply side tank portion **16** to the suction side tank portion **18**. As shown these plates have an indented pattern of elongated and aligned long and short oval ribs **44, 44'** and **46, 46'** respectively that extends longitudinally in the sides of the tubes. Additionally the plates have obliquely inclined ribs **48, 48', 50, 50'** indented therein and semi-spherical indentations **52, 52'** in the cross over section. These ribs and other indentations interfit with one another to form tortuous or meandering flow paths in the side flow and cross over sections for the refrigerant coursing therethrough as illustrated in **FIG. 5**. Such flow paths ensures an even distribu-

tion of the heat exchanger fluids in the tubes as they course through the tubes leaving no dry out areas and thereby improving efficiency of the core.

[**0024**] Turning in greater particularly to **FIGS. 1, 11** and **12**, the supply and suction lines **20** and **22** are respectively provided with circumferential fluid flow openings **54, 56** for feeding liquid refrigerant to the supply side of the tubes and for exhausting vaporized refrigerant from the suction side of the tubes. The openings may be formed in annular bands **58, 60** of circumferentially spaced openings which respectively align with the tank portions **16, 18** of the tubes. These openings are sized to ensure an even rate of flow of the heat exchange fluid from line **20** into the supply side of each of the tubes and from the suction side back of each tube into the suction line **22**.

[**0025**] If needed the flow capacity of the holes can be tailored by sizing the holes or by varying the number of holes to reduce pressure drop and to ensure that each tube processes substantially the same quantity or different quantities of heat exchange fluid during evaporator operation. The plates are assembled in an interfacing relationship in a fixture to form the discrete fluid tight tubes and air centers are placed between the tubes. The tubes may be serially installed on the supply and suction lines or alternatively the supply and suction lines are installed through the aligned opening in the tubes. In any event, the assembly is banded or otherwise held and subsequently brazed in an oven at predetermined temperatures and for a fixed time so that the parts are fused together in a fluid tight and sturdy arrangement. In particular the neck portion of the tanks are fused in fluid tight manner to the supply and suction lines and so that improved structural support is thereby provided.

[**0026**] **FIG. 11** further illustrates the reduced draw depth of the plates formed from the blanks. The increased spacing provided between adjacent tubes provided by their fluid tight connection to the lines may result in larger air centers and more area for improved heat management. However, if desired, the tank portions could be securely joined by brazing their flanges in an interfacing relationship to further increase unit strength.

[**0027**] While the above descriptions constitutes preferred embodiments of the invention, it will be appreciated that the invention can be modified and varied without departing from the scope and fair meaning of the accompany claims.

What is claimed is:

1. A heat exchanger having a plurality of flattened fluid flow tubes operatively mounted adjacent one another to provide passage for volatile heat exchanger fluid there-through, each of said tubes having a leading edge, a trailing edge and a lower end, said edges bounding flattened side portions that are laterally spaced from one another, a divider rib extending in each of said tubes to a terminal end therein to define separate first and second side flow sections in each of said tubes and a crossover section at the lower end thereof for transmitting said heat exchanger fluid from said first side flow section to said second side flow section, and an inlet line extending into each of said tubes for feeding heat exchanger fluid into each of said first side flow section of each of said tubes and an outlet line extending in each of said tubes for exhausting heat exchanger fluid from said second side flow section of each of said tubes.

2. The heat exchanger of claim 1 wherein said fluid inlet line has fluid flow openings spaced at predetermined intervals along the length thereof for respectively transmitting heat exchanger fluid into a first of said side flow sections of each tube, said outlet line has fluid flow openings spaced at predetermined intervals along the length thereof for transmitting heat exchanger fluid from said second side flow sections of each tube into said outlet line.

3. The heat exchanger of claim 1 wherein said tubes have laterally extending tank portions formed in side-by-side relationship at the upper end thereof, each of said tank portions having a laterally extending neck portion each of said neck portions defining a laterally oriented opening, and wherein said tubes are closely received in said openings and are supported by said neck portions in a side-by-side relationship.

4. The heat exchanger of claim 2 wherein said flow openings in said pipes are sized so that each tube receives and discharges fluid substantially at the same fluid flow rate during heat exchanger operations to optimize the operating efficiency of said heat exchanger.

5. A heat exchanger having a plurality of flattened fluid flow tubes operatively arranged adjacent to one another to provide passage for volatile heat exchanger fluid there-through, a connection for interconnecting said tubes so that air can externally pass between said tubes, each of said tubes

having a leading edge and a trailing edge and flattened side portions that are laterally spaced from one another, divider rib means in each of said tubes extending between the walls of said tubes to a terminal end therein to define first and second discrete side flow sections in each of said tubes and a crossover section for transmitting said volatile heat exchanger fluid from one side flow section to the other side flow section, an elongated inlet line and an elongated outlet line extending into each of said tubes of said heat exchanger and out of each of said tubes, said lines having fluid flow openings therein for transmitting heat exchanger fluid into a first side flow section of each of said tubes and for transmitting fluid from said second side flow section each of said tubes.

6. The heat exchanger of claim 5 wherein each flattened tube has protuberances formed therein extending laterally outwardly from the plane thereof and wherein said protuberances define tank portions for each of said tubes, said protuberances further having neck portions which engage and support said supply and suction lines.

7. The heat exchanger of claim 5, wherein said tubes are completely spaced from one another and wherein said tubes are mechanically connected to one another by said outlet and inlet lines.

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