Aug. 23, 1960 C. A. DI NIRO 2,950,092

HEAT EXCHANGE CONSTRUCTION

Filed Nov. 1, 1957

FIG. 1

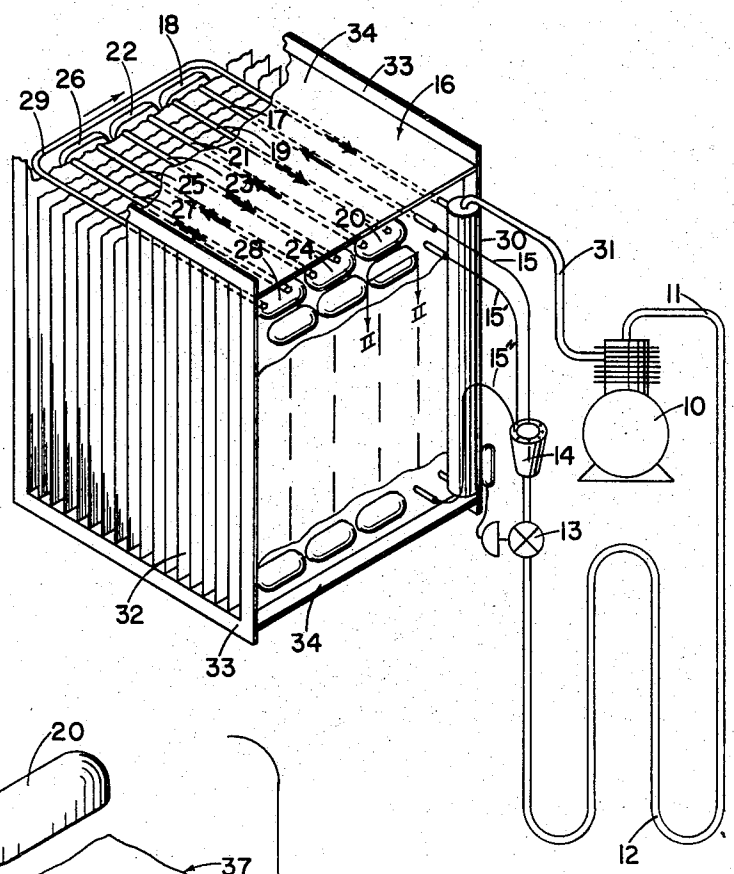
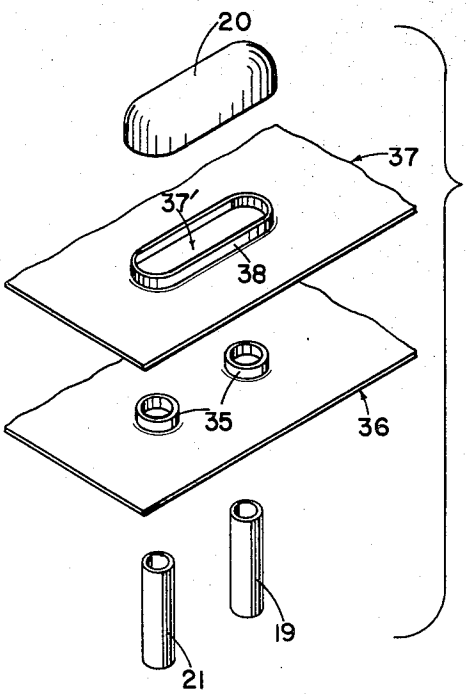


FIG. 3



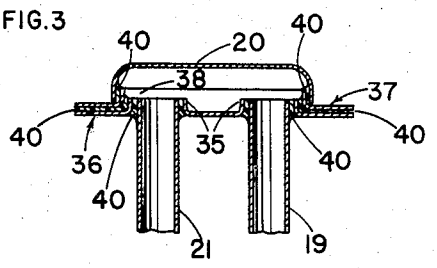


FIG. 2

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HEAT EXCHANGE CONSTRUCTION

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5 Claims. (Cl. 257—255)

This invention relates to heat exchangers and more particularly to an improved tube sheet assembly for a heat exchanger.

As is well known in the art, plate fin type of heat exchangers are fabricated by placing a plurality of tubes through a plurality of parallel plate fins. The ends of adjacent tubes are then placed in a tube sheet and connected by a return flow construction to provide a continuous path for fluid passing through the tubes. However, in manufacturing heat exchangers of the above type which are used in aircraft or the like where space is at a premium, adjacent tubes must be spaced very closely together to obtain a maximum amount of heat transfer from a heat exchanger occupying a minimum amount of space. This close spacing requires that the return flow construction be spaced very closely together. In the past a cap sheet having a plurality of caps drawn therein has been placed on the tube sheet and used for providing return flow by having each cap in the sheet positioned over the ends of two adjacent tubes so as to provide a fluid conduit between these adjacent tubes. However, this type of cap sheet cannot be made where adjacent tubes are very close to each other because the caps have to be so close together that there is insufficient material in the cap sheet from which to draw closely spaced caps. It is with the provision of a solution to the foregoing problem in an efficient and economical manner that the present invention is concerned.

It is therefore one object of the present invention to provide an improved tube sheet assembly where adjacent tubes of a heat exchanger are spaced very closely together.

Another object of the present invention is to provide a tube sheet assembly for a heat exchanger which is extremely strong and which is simple to manufacture. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

The present invention relates to a tube sheet assembly for a heat exchanger comprising a plurality of adjacent fluid conducting tubes, a tube sheet having first apertures therein, collars on said tube sheet surrounding said apertures, said collars adapted to be bonded to the ends of said tubes, a cap sheet bonded in face to face relationship with said tube sheet and having a second aperture bordered by an upstanding flange, said upstanding flange surrounding said first apertures, and a cap bonded in shear to said upstanding flange to provide a fluid flow path between adjacent tubes. The present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

Fig. 1 is a schematic representation of a refrigeration system utilizing a heat exchanger construction, partly broken away, made in accordance with the present invention;

Fig. 2 is an enlarged view taken along line II—II of Fig. 1; and

Fig. 3 is an exploded view of the various components

of the tube sheet assembly of the present invention on a still further enlarged scale.

The refrigeration ssytem of Fig. 1 includes a compressor 10 connected by discharge line 11 to a condenser 12 which is in turn coupled to a refrigerant expanding device such as an expansion valve 13. A receiver (not shown) may be placed at the discharge side of the condenser. A refrigerant distributor 14, which may be of conventional construction, is coupled to expansion member 13 and feeds refrigerant through a plurality of distribution tubes such as 15, 15', and 15'' to heat exchanger 16 which functions as an evaporator. It will be appreciated that a large number of tubes which serve the same function as tubes 15, 15', 15'' have been omitted from the drawing for the sake of clarity.

The refrigerant passing through tube 15 passes through the following path: It flows through tube 17, return cap 18, tube 19, return cap 20, tube 21, return cap 22, tube 23, return cap 24, tube 25, return cap 26, tube 27, return cap 28, and tube 29 to evaporator outlet header 30. The refrigerant then passes into suction line 31 from which it passes back to compressor 10. It will be appreciated that the refrigerant flow from tubes 15' and 15'' follow paths analogous to that described above relative to tube 15. These paths have been omitted from the drawing for the sake of clarity.

The heat exchanger 16 may be generally of conventional plate fin type of construction except as explained hereafter. It consists of a plurality of refrigerant circuits as described above which are positioned in heat exchange relationship with plate fins such as 32. Suitable frame members 33 and cover sheets 34 are provided to lend rigidity to the structure and to direct the air flow through the heat exchanger, respectively.

In Figures 2 and 3 the improved tube sheet assembly of the present invention is shown. For the sake of clarity, the structure at the ends of only a pair of tubes will be described and it is to be understood that other pairs of tubes have the same construction. Tubes 19 and 21 are adapted to have the ends thereof fit within collars 35 which are suitably formed in tube sheet 36. Collars 35 may extend downwardly instead of in the upward direction shown in the drawings. A cap sheet 37 is adapted to be positioned in face to face relationship with tube sheet 36. Cap sheet 37 is provided with apertures 37' having upstanding flange 38 on the periphery thereof providing a border which surrounds the pair of adjacent collars 35 of tube sheet 36. A return cap 20 is adapted to fit over upstanding flange 38 as shown in Fig. 2.

The foregoing elements 19, 21, 36, 37, and 20 are suitably bonded together by any suitable bonding agent. While solder bonding, plastic adhesive, and zinc bonding can be used, an epoxy resin such as "Epon 828" which is manufactured by the Shell Refining Company has been found satisfactory. As shown in Fig. 2, the bonding agent 40 provides a fluid tight seal between the above mentioned elements so that fluid passing from tube 19 will pass into return cap 20 and then back into tube 21.

As mentioned above the tube sheet assembly of the present invention provides a return flow construction which is economical to manufacture and which is extremely strong. It will be noted that the bonding agent 40 between return cap 20 and flange 38 and at collars 35 is always in shear when the system is under pressure. This shear type of bonding permits a minimum amount of bonding agent to be used while giving a maximum amount of strength which closely approaches the strength obtainable from a cap sheet having integral return caps.

While I have described a preferred embodiment of the present invention I desire it to be understood that it may be otherwise embodied within the scope of the following claims.

I claim:

1. A tube sheet assembly for a heat exchanger comprising a tube sheet having a plurality of first apertures therein, a cap sheet bonded in face to face contact with said tube sheet, a second aperture in said cap sheet, an upstanding flange on said cap sheet bordering said second aperture, said upstanding flange surrounding said first apertures, and a return cap bonded in shear to said upstanding flange, said tube sheet, cap sheet and cap cooperating to form a sealed fluid flow path between the first apertures.

2. A tube sheet assembly as set forth in claim 1 wherein said first apertures in said tube sheet have collars formed about the peripheries thereof.

3. A heat exchanger construction comprising a plurality of adjacent fluid conducting tubes, a tube sheet having first apertures therein, collars on said tube sheet surrounding said first apertures, said collars being bonded to the ends of said tubes, a cap sheet bonded in face to face relationship with said tube sheet, a plurality of second apertures in said cap sheet, an upstanding flange formed on the periphery of each second aperture, said upstanding flange surrounding a pair of adjacent first apertures, and a return cap bonded in shear to each upstanding flange to provide a fluid flow path between adjacent tubes.

4. A tube sheet assembly for a heat exchanger comprising a tube sheet having a plurality of first apertures therein, a cap sheet bonded in face to face contact with said tube sheet, a plurality of second apertures in said cap sheet, a plurality of upstanding flanges on said cap sheet bordering said second apertures, each of said upstanding flanges surrounding at least two of said first apertures, and return cap bonded in shear to each of said upstanding flanges.

5. A tube sheet assembly as set forth in claim 4, wherein said first apertures in said tube sheet have collars formed about the peripheries thereof.

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