Dec. 7, 1937. M. H. KUHNER 2,101,782

HEAT EXCHANGE APPARATUS

Filed Oct. 27, 1936 2 Sheets-Sheet 1

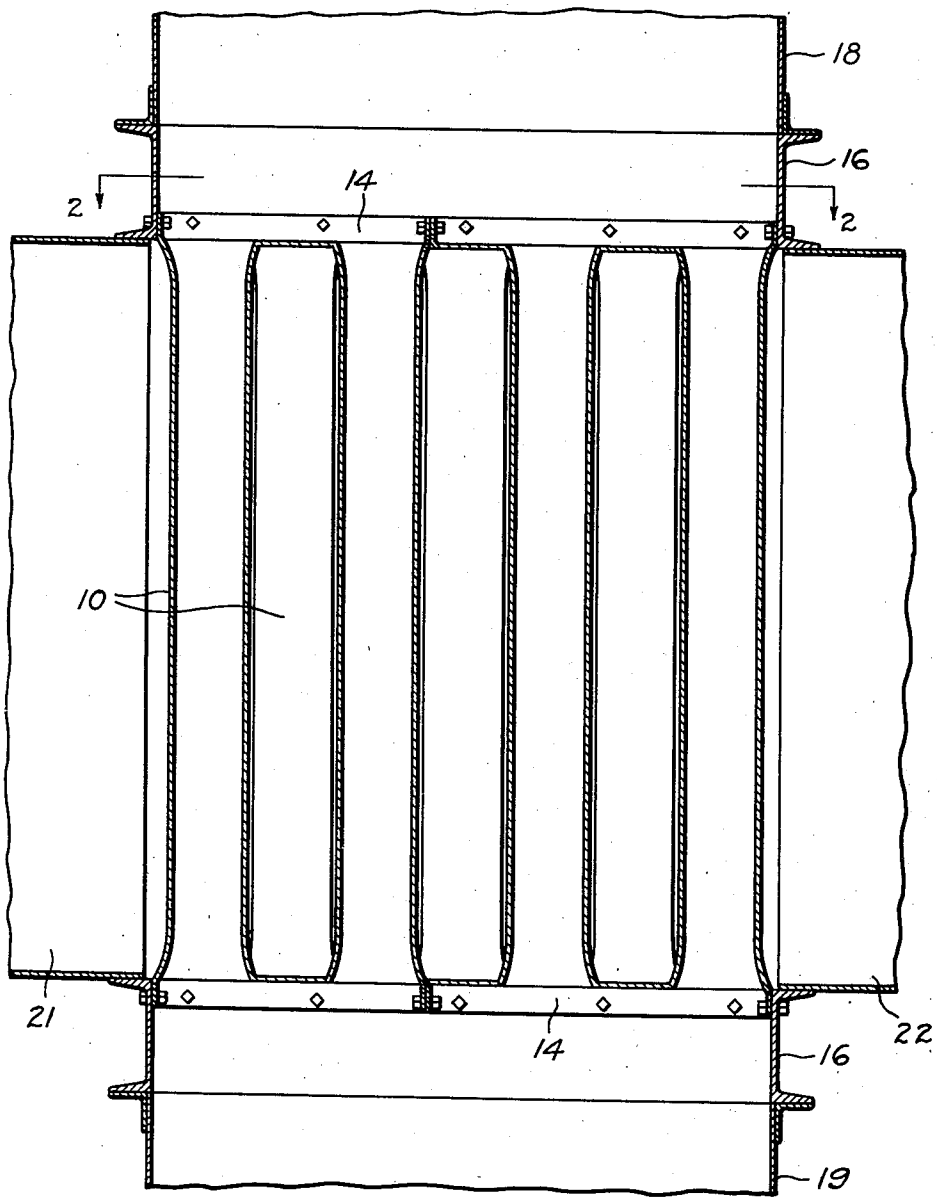

Fig. 1

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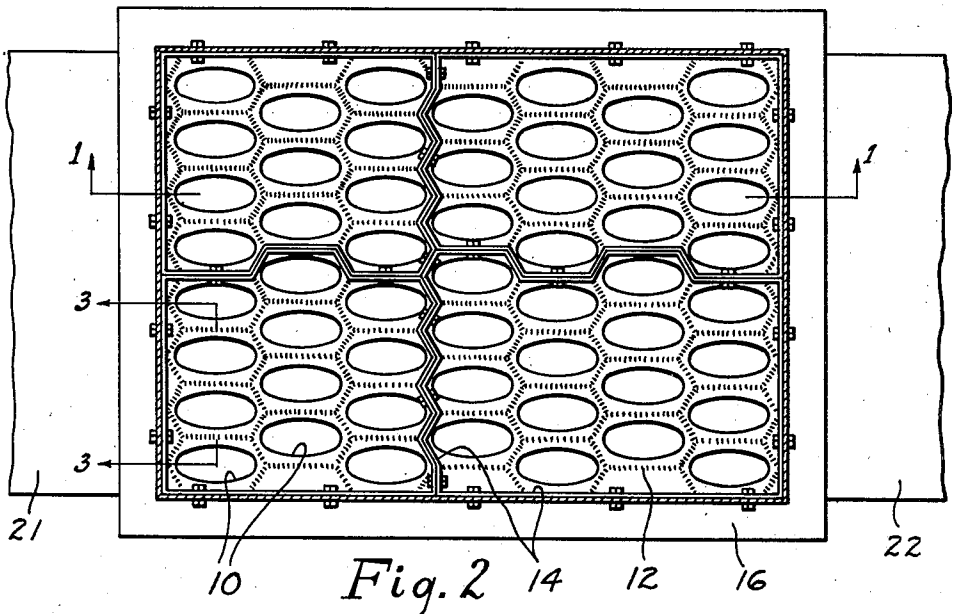

Fig. 2

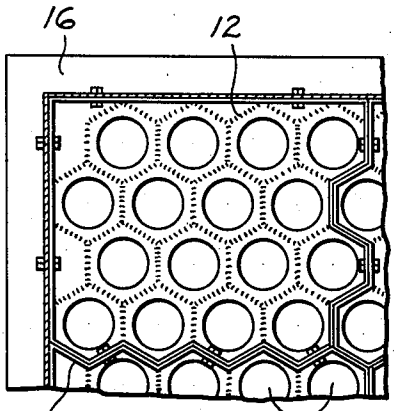

Fig. 4

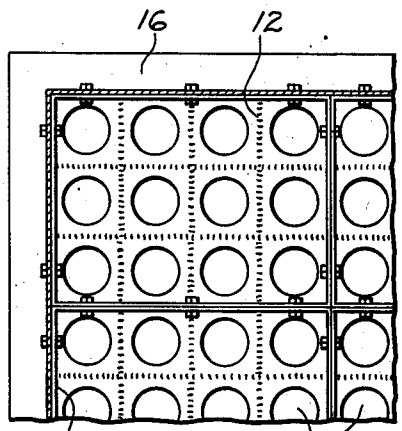

Fig. 5

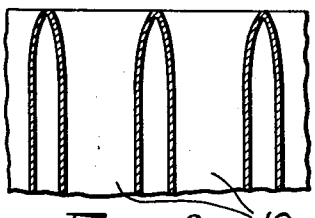

Fig. 3

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UNITED STATES PATENT OFFICE

2,101,782

HEAT EXCHANGE APPARATUS

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Application October 27, 1936, Serial No. 107,831

1 Claim. (Cl. 257—224)

This invention relates to heat exchange apparatus, and more particularly to apparatus of the type having tubes through which a fluid flows in heat exchange relation to a second fluid, the latter flowing through the spaces between the tubes.

Heretofore it has been the practice to support the ends of the tubes in metal plates known as "tube sheets," the tubes being rolled or expanded into openings in the plates. Since the plates are weakened by a multiplicity of closely spaced openings, they must be of considerable thickness in order to withstand the load imposed upon them by the weight of the tubes. The plates are therefore expensive both by reason of the material required and also because of the many openings which must be machined. Moreover it is often desirable to utilize tubes of oval cross-section in order to reduce the resistance to the flow of fluid transversely of the tubes and to obtain more efficient heat transfer, but it is difficult to employ such tubes in apparatus as heretofore constructed.

It is accordingly one object of the invention to provide a heat exchange apparatus of the tubular type in which no tube sheets will be required.

It is a further object of the invention to provide a heat exchange apparatus of the tubular type which will be comparatively simple and inexpensive to manufacture and install.

It is a further object of the invention to provide a comparatively simple and inexpensive heat exchange apparatus having tubes of oval cross-section.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claim appended hereto.

Referring to the drawings illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a vertical section through a heat exchange apparatus, the section being taken on the line 1—1 of Fig. 2;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary section on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view similar to Fig. 2, showing a modified form of the invention; and

Fig. 5 is a view similar to Fig. 4, showing a further modification.

The embodiment illustrated in Figs. 1 to 3 comprises a series of upright metal tubes 10 arranged in a staggered formation. Each tube is oval in cross-section except for its end portions, these being enlarged or flared into the shape of a hexagon as shown particularly in Fig. 2. This shape may be readily imparted to the tubes by a suitable pressing or forging operation. The hexagonal portions of adjacent tubes are welded together, as indicated by the broken lines 12 in Fig. 2, to form groups of tubes (four groups being shown). A metal strip or flange 14 extends around each group of tubes at the ends thereof, these strips being welded to the tubes. The strips 14 of adjacent tube groups are bolted together.

A rectangular frame 16 is provided at each end of the tubes, and the strips 14 are bolted to these frames. Inlet and outlet ducts 18 and 19 respectively are connected to the frames 16 so that fluid may be caused to flow through the tubes. A second fluid flows in contact with the outer surfaces of the tubes, and for this purpose suitable inlet and outlet ducts 21 and 22 respectively are provided to communicate with the spaces between the tubes, these ducts being connected at the top and bottom to the frames 16. It will be understood that upright plates (not shown) extend between the frames 16 to form the side walls of a passage connecting the ducts 21 and 22.

It will be noted that one fluid flows through the tubes and the second fluid flows transversely of the tubes in contact with their outer surfaces. Moreover, the major axes of the oval tubes are arranged to extend in the general direction of travel of the second fluid. This results in a stream-line effect whereby substantially the entire surface area of the tubes is utilized for heat transfer. Furthermore, the resistance to flow is decreased, and a large heat transfer surface can be installed in a comparatively small space. No tube sheets are required, and if desired all welding may be completed in the shop prior to shipment of the groups of tubes.

In Fig. 4 I have shown a slightly modified construction utilizing tubes 25 of circular cross-section, the end portions of the tubes being flared into the shape of a regular hexagon. In Fig. 5 I have shown a further modification utilizing tubes 28 of circular cross-section, the end portions of the tubes being flared into the shape of a square. The tubes 28 are aligned in rows in both directions, as may be desirable in some cases. The constructions in all three of the illustrated embodiments are the same except for the slight changes resulting from differences in the shape of the tubes.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

Heat exchange apparatus comprising a series of parallel metal tubes arranged in a plurality of groups and having their end portions enlarged into the shape of a polygon, the polygonal portions of adjacent tubes within each group being welded together, a metal strip extending around each group of tubes and welded to the polygonal portions thereof, and means to fasten together the strips of adjacent groups.

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