Aug. 27, 1963 A. HUET 3,101,930

TUBULAR HEAT EXCHANGER

Filed Sept. 8, 1959 2 Sheets-Sheet 1

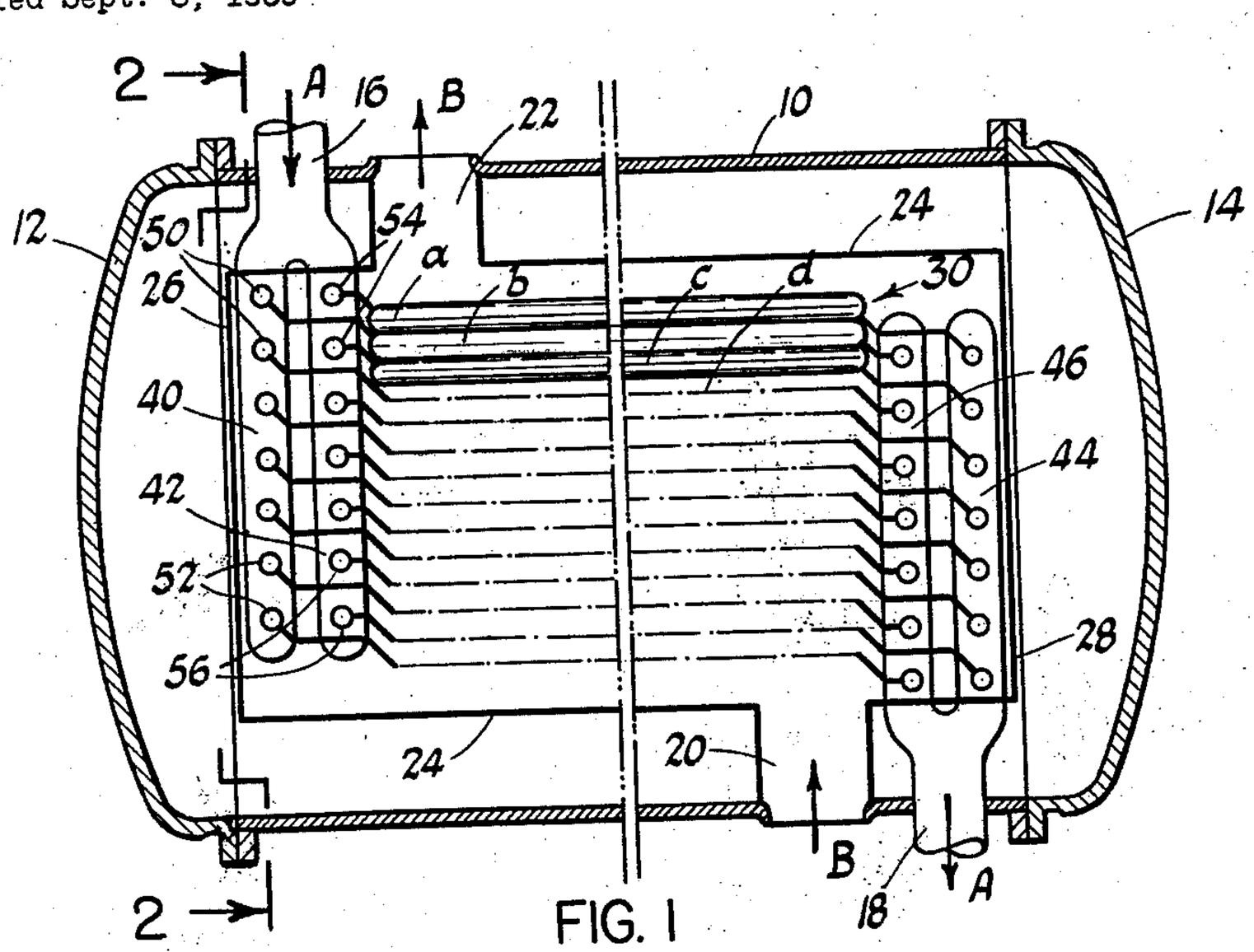

FIG. 1

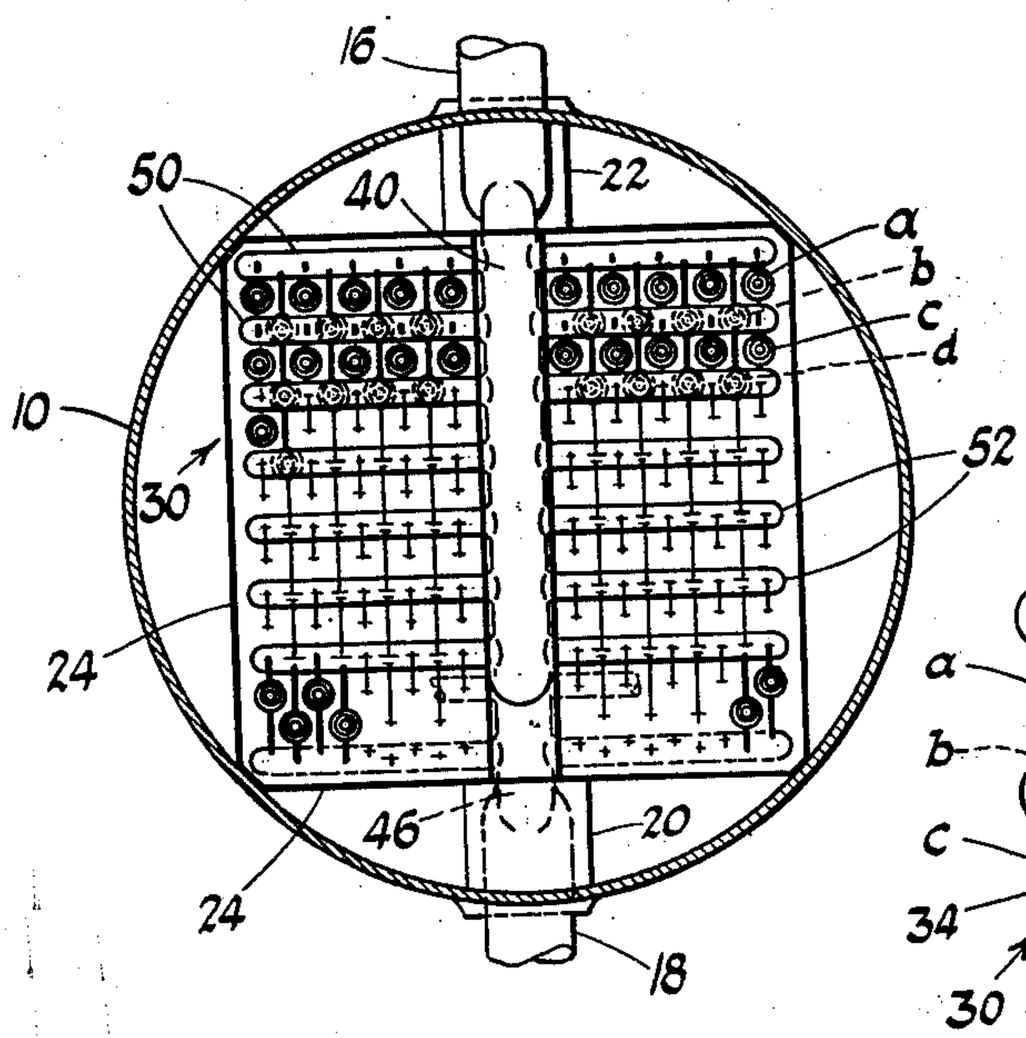

FIG. 2

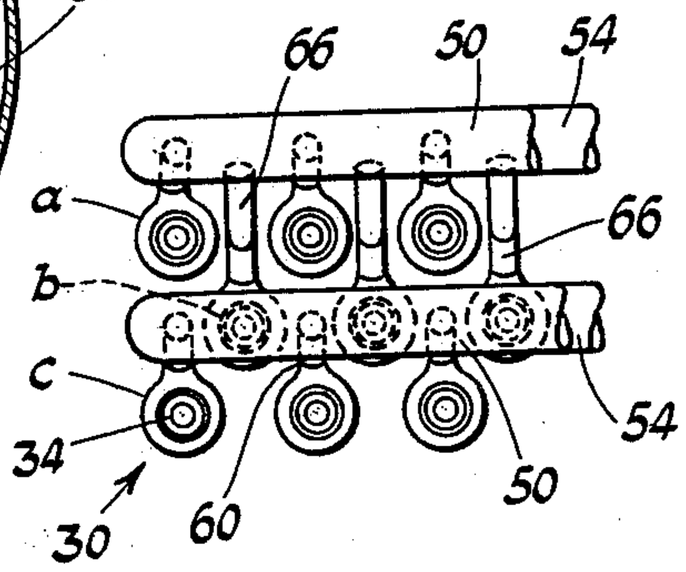

FIG. 3

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TUBULAR HEAT EXCHANGER

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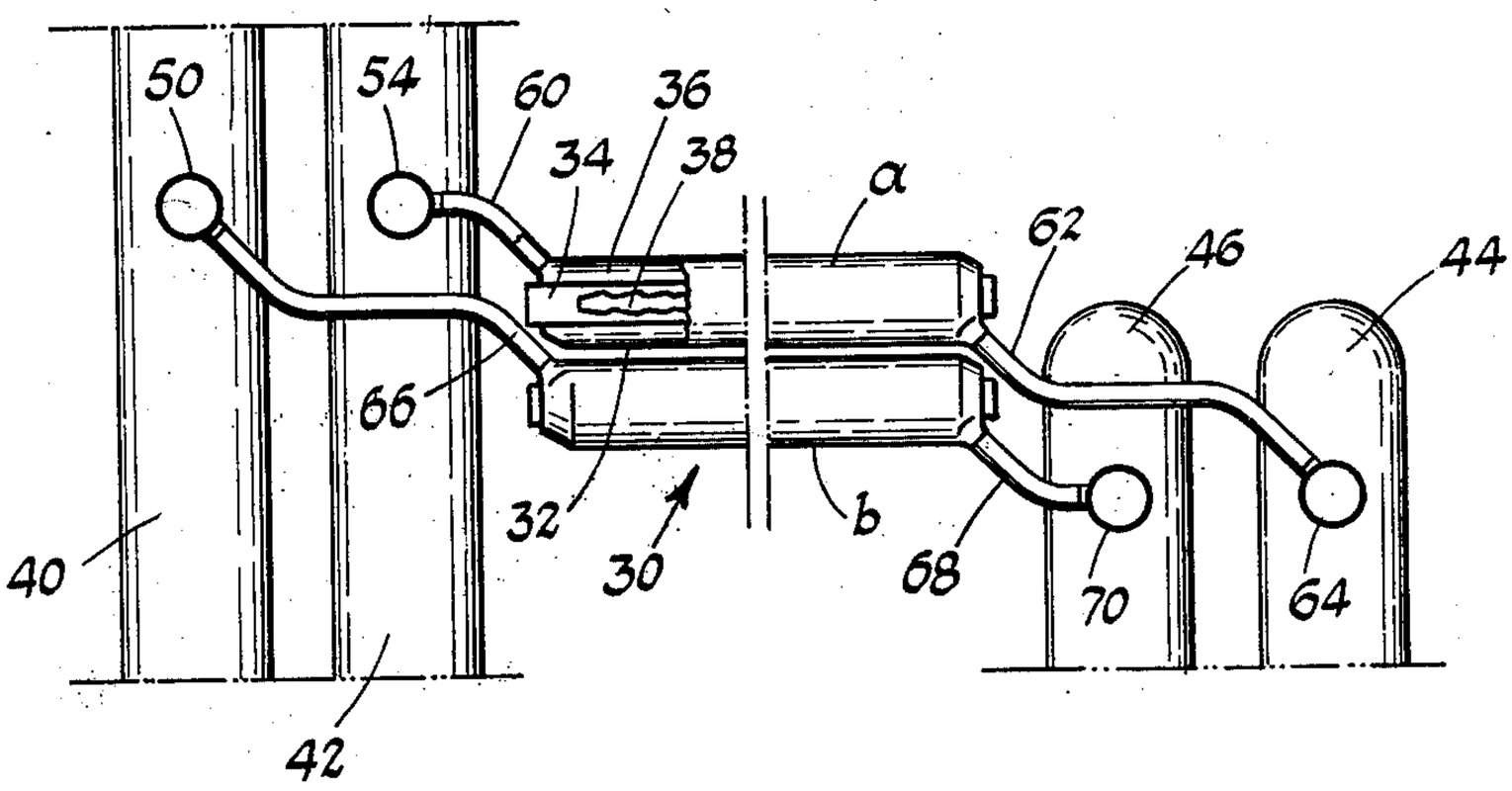

FIG. 4

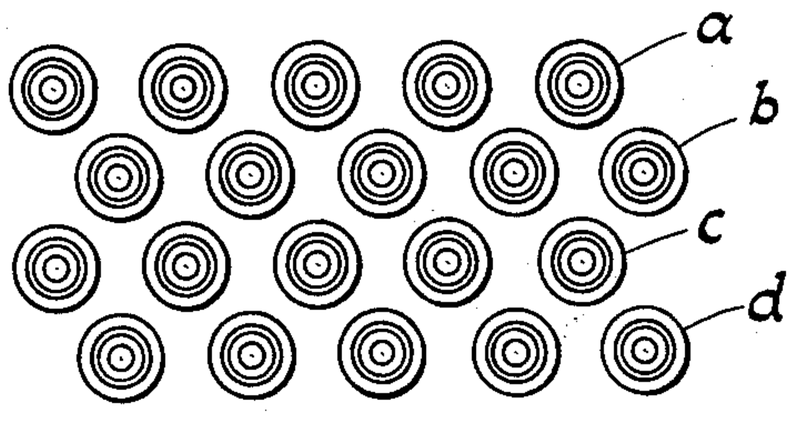

FIG. 5

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TUBULAR HEAT EXCHANGER

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1 Claim. (Cl. 165—143)

This invention relates to heat exchange apparatus and particularly to improved, distributing header arrangements for a bank of tube assemblies each providing an annular passage for one fluid and a central space through which the other fluid flows as well as over the outer tube surfaces.

The present invention is embodied in a tubular heat exchanger for the exchange of heat between two fluids. While the heat exchange presents a large exchange surface, the general arrangement of the tube assemblies and the distributing headers which feed the annular passages of said tubes, is such as to occupy a very compact volume. The connections between the bank of tubes arranged in rows and the headers also permits in the introduction of cleaning devices through the ends of the exchanger casing to clean the outer surfaces of the annular tubes as well as the central space through which the outer fluid also flows.

Such an exchanger is planned particularly for the exchange of heat between two fluids; one of which must be utilized in as small a quantity of volume as possible because of its cost. For instance, this exchanger will be utilized in a thermal installation associated with employing an expensive chemical fluid and exchanging its heat with an inexpensive fluid such as ordinary water.

The following description when read in conjunction with the accompanying drawings of an illustrative embodiment will afford an understanding of the manner in which the invention can be carried out.

FIGURE 1 is a longitudinal section, partially schematic, of a heat exchanger embodying the invention.

FIGURE 2 is a transverse sectional view of the exchanger on the line **2—2** of FIGURE 1 showing the tube bundle from the left with the end cover removed.

FIGURE 3 is a view on a larger scale of a portion of FIGURE 2 and shows the tube rows, seen from the end in FIGURE 2.

FIGURE 4 shows schematically on a larger scale than in FIGURE 1 the distribution of fluid to feeding the annular spaces of the exchanger tubes from the sub-headers and also shows the annular form adopted for the tubes.

FIGURE 5 shows the staggered arrangement of tubes *a*, *b*, *c* and *d*.

As seen in FIGURE 1, the exchanger is contained in a cylindrical casing **10** with removable end closures **12** and **14**. Within this casing is placed a nest or bank of tubes placed in staggered fashion in parallel rows as shown in FIGURES 2 and 3. The whole bank arranged in the form of a parallelipiped rectangle is fed, on the one hand, with the heating fluid, entering via a header **16** and leaving via a header **18**, the flow being in the direction of the arrows A. The fluid, taking heat circulates in the direction of the arrows B, from the inlet **20** to the outlet **22**. This second, heated fluid circulates over the tube nest and is confined within a parallelipipedic shell or envelope **24** having removable end plates **26**, **28** so that the envelope **27** entirely surrounds in fluid tight fashion as seen in FIGURES 1 and 2, the tube nest and the headers therefor except for minor parts of the latter.

The tube assemblies **30** are arranged in staggered rows *a*, *b*, *c* etc., according to horizontal planes. In FIGURE 1 the tubes of odd rows are heavily outlined and shaded while tubes of even rows are drawn lightly or indicated by center lines to facilitate reading the drawing. These

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tube assemblies are preferably constituted by two concentric tubes **32**, **34** (FIG. 4) and it is in the interval **36** between both concentric envelopes that the expensive heating fluid circulates. Plain water or other fluid to be heated passes around the outer envelope **32** of tube assembly I, FIGURE 4, and also within the inner tube **34**. Within the inner tube **34** may be placed a deflecting core **38** which has, as we know, the advantage of improving the heat exchanger by producing "pulsations" in the circulation. Likewise, deflecting bands of corrugated metal, forming deflectors or baffles, may be introduced in the spaces between the tube assemblies **30** to create pulses in the fluid which circulates exteriorly.

The original arrangement of the exchanger resides in the mode of liaison of the exchanger tubes with the circuit A.

With the view of disposing the fluid circuit constituted by the tube bundle in the smallest space possible, the exchanger tube assemblies are very closely spaced as seen in FIGURES 2 and 3. The heating fluid arrives via the header **16** split into two branches **40**, **42** situated, as seen in FIGURES 1 and 2, on the vertical and longitudinal symmetry plane of the exchanger. The outlet is through the header **18**, itself assembling two branch headers **44**, and **46**, arranged in the same way on the opposite end of the exchanger tube bundle. From either side of each inlet header **40** and **42** and at the same height level on each header are parallel transverse sub-headers extending laterally to the side boundaries of the tube bank. FIGURE 2 may be seen at the inlet header **40** and the parallel transverse sub-headers **50**, **52** which are fed by it. The similar arrangement of the header **42** and its transverse headers **54**, **56** is hidden entirely in FIG. 2 by **40** and **50**, **52**.

Generally speaking, header **42** feeds by means of the transverse sub-headers **54**, **56** the odd rows *a*, *c* of tubes **30**. The header **40** feeds by means of the sub-headers **50**, **52** the even rows *b*, *d* of tubes **30**.

Referring to FIGURE 4 it is seen that a tube **30** of the odd row *a* has its annular space **36** fed by a duct **60** connected to the sub-header **54** of the header **42**. At the other end of the annular space **36**, a pipe **62** joins this space to the transverse sub-header **64** leading into the outlet header **44**. The tube **30** of the even row *b* located below the similar tube of row *a* is fed by a duct **66**, connecting its annular space to the sub-header **50** leading from the inlet header **40**, and a duct **68** at the outlet end joins this tube of the even row *b* to the transverse sub-header **70** of the outlet header **46**. Thus, as has been said and as seen more in detail in FIGURE 3 which represents the inlet transverse headers **50** (which hide the transversal sub-headers **54** of the header **42** situated immediately behind); each header **50** feed by means of ducts **66** the tubes **30** of the even rows, *b*, *d* which are seen represented by broken lines in FIGURE 3 because they are hidden by the header **50** located next below. The tubes of the rows *a* and *c*, are seen in full lines in FIGURE 3, and are fed by the ducts **60** from the sub-headers **54** concealed by the sub-headers **50** in FIGURE 3.

This arrangement of the sub-headers **50**, **54**, and the ducts **60**, **66** is adopted in order that, when it is desired to proceed with cleaning the exchanger tubes, after having taken off the end closures **12** and **14** and the plates **26**, **28** at the end of the parallelipipedic shell **24**, through which the heated fluid flows, so as to expose the interiors **34** of the tubes **30** of the odd rows *a*, *c* shown between the headers **50**, as for instance in FIGURES 2 and 3. Cleaning devices may then be introduced in these interiors **34**. And, likewise, there still remains (FIGURES 2 and 3) between the exterior of the tubes of the odd rows *a*, *c* and feed ducts **66** and **60** a space allowing the introduction of devices to clean the outer parts of tubes in row *a*.

Internally and externally all the tubes of the odd rows can then be cleaned from this side of the exchanger.

From the other end of the exchanger, after taking out the plate 28, the similar arrangement of the subheaders 64, 70 and the ducts 62 and 68 exposes the interiors and the exteriors of the tubes 30 of the even rows *b, d* which can be cleaned.

The ducts 60, 62 and 66, 68 connecting the annular spaces 36 of the tubes to the sub-headers, are, as we can see in FIGURE 4, arched in such a manner as to permit a certain tolerance due to differences in expansion. It is to be noted that, for each tube 30, at least one of the connecting ducts (62 for the tubes of the odd rows) is longer and more strongly bent than the other (e.g. 60). It is the inverse, namely, the inlet duct 66 which is more bent for the tubes of the even rows.

The exchanger is shown in horizontal position in the drawings but it could be more or less inclined to the horizontal by placing it on a proper foundation, for instance, to facilitate the circulation of the fluid within the interiors 34 of the inner tube of each assembly 30.

I claim:

A heat exchanger in which two fluids flow at cross currents and embodying a casing containing a bank of generally horizontal rows of rectilinear tubular elements with the elements in adjacent rows arranged in staggered relation, all the tubular elements of said bank being made up of a pair of concentric tubes joined at their two ends to form an annular space for one fluid, called inner fluid, and a central space through which the other fluid, called outer fluid, flows from the interior of said casing as well as around the exterior of each tube, inlet and outlet headers for the inner fluid arranged vertically at the opposite ends of the bank of tubes and each being bifurcated to provide two parallel branches disposed perpendicularly to the axis

of the tube rows and situated in the same vertical plane; vertically spaced pairs of subheaders fixed perpendicularly on the branches of each bifurcate with the subheaders of each pair disposed in horizontally spaced relation at the same height on the one and the other branch, the distance between vertically spaced pairs of subheaders being substantially equal to double the distance between two horizontal tube rows to leave clear the ends of one tube row out of two and the inlet and outlet headers being relatively arranged so as to leave clear the ends of each tube row at opposite ends; bent connections between the subheaders and the tubes of the rows they supply, said tube rows being situated below the related subheaders at the inlet end and above the related sub-headers at the opposite end, said connections being shifted in a vertical direction when passing from a sub-header mounted on one of the branches of the bifurcate to the similar sub-header mounted on the same level on the other branch of the same bifurcate so as to be clear of the odd numbered rows of tubes at one end of the exchanger and of the even numbered rows of tubes at the other end of the exchanger.

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