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[54] **SHELL AND TUBE HEAT EXCHANGER**

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Related U.S. Application Data

[63] Continuation of Ser. No. 49,804, June 25, 1970, abandoned.

[52] **U.S. Cl.** **165/82,** 165/158, 165/173

[51] **Int. Cl.** **F28f 5/00**

[58] **Field of Search** 165/157–161, 165/81, 82, 76, 162

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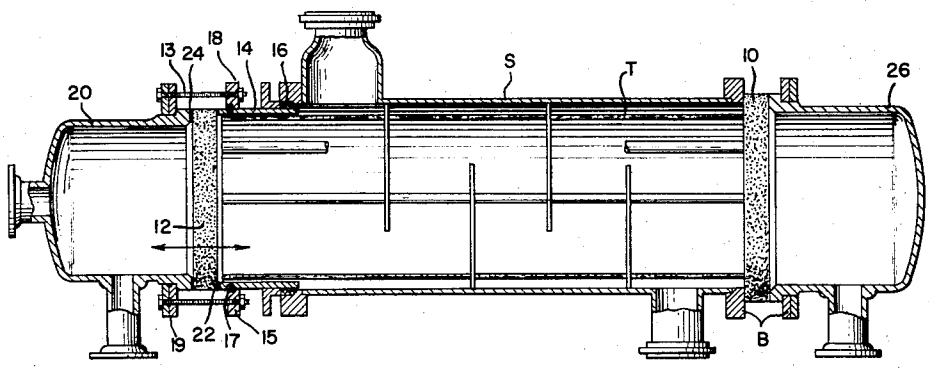
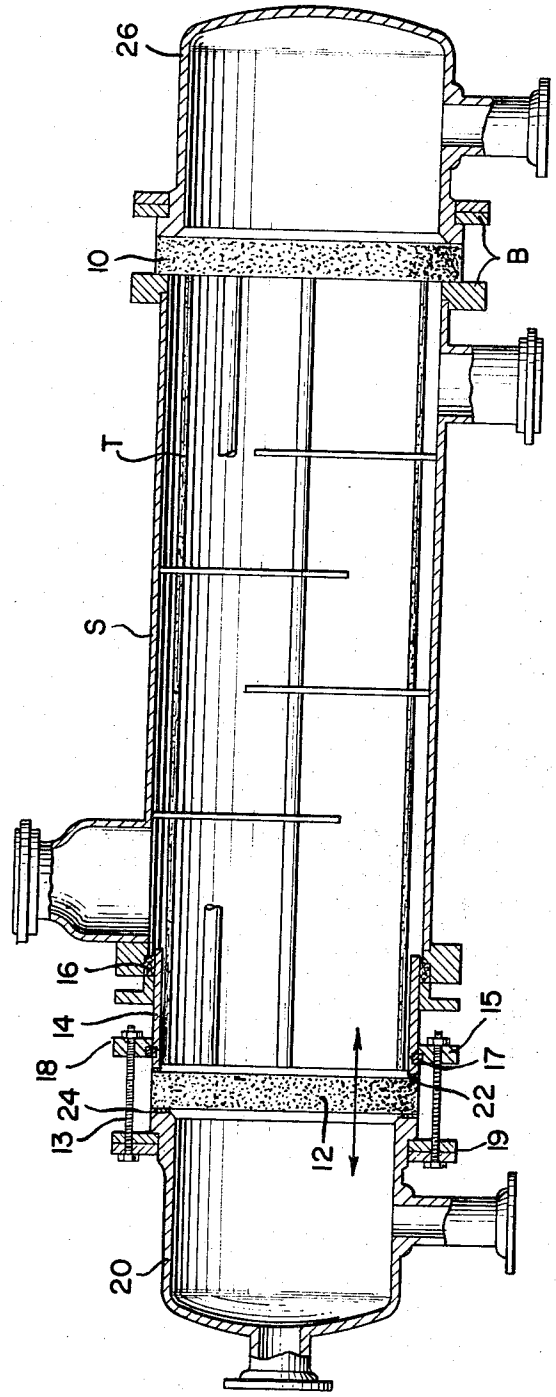
[57] **ABSTRACT**

A shell and tube heat exchanger having a cylindrical shell and carbonaceous tubes held in place by a pair of carbonaceous tube sheets. According to the present invention, a fixed tube sheet is used at one end and a floating tube sheet is used at the opposite end. The floating tube sheet is located entirely outside of the shell and is axially spaced from the end thereof by an elongated metal skirt extending from within the shell into contact with the carbonaceous floating tube sheet. In addition, a packing material is used for sealing while also permitting sliding motion of the metal skirt. The metal skirt is held tightly in contact with the floating tube sheet by clamping means.

2 Claims, 1 Drawing Figure





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SHELL AND TUBE HEAT EXCHANGER

This is a continuation of application Ser. No. 49,804 filed June 25, 1970.

This invention relates to shell and tube type heat exhangers and particularly to heat exchangers of this type which have carbonaceous tubes. Heat exchangers of this general class are commonly used for handling corrosive liquids.

Generally heat exchangers of this type are formed with a cylindrical outer shell, usually made of steel, and a large number of inner tubes, usually formed of graphite. The tubes are normally held in place and separated from one another by a pair of carbonaceous tube sheets, each of which is positioned at opposite ends of the heat exchanger.

In order to provide for differing rates of thermal expansion between the shell and the tubes various techniques have been suggested by the prior art. One such method is to incorporate a bellows in the shell while having both tube sheets rigidly fixed to the shell ends such that the differential expansion between the tubes and the shell is taken up by the bellows. The primary disadvantage of this technique is that it becomes very costly with large size heat exchangers. In addition, and more importantly, since the tube sheets are usually cemented to the tube ends and the tube sheets are rigidly attached to the shell ends, it is not possible to readily remove the tube bundle during periodic maintenance. Further it is not possible to easily inspect the shell side of the tube bundle because of the rigidly fixed tube sheets.

Another method of providing for differing rates of thermal expansion is to employ a floating tube sheet and cover assembly at the opposite end, the floating end parts being surrounded by shell side fluid and sealed within the shell. While this technique is useful, it is not entirely satisfactory in that it requires longer shells than would be required with an exchanger utilizing a bellows, it requires a separate closure for the floating end of the shell as well as an extra gasketed joint for this closure. In addition, any internal gasket leakage is hidden from view and thus mixing of the process liquids cannot be readily detected and the cuase isolated. A significant disadvantage with an exchanger of this type is that it is difficult to readily inspect the shell side of the tubes for scaling or tube damage.

It is an object of the present invention to provide a heat exchanger having a floating tube sheet but which overcomes the abovementioned difficulties.

More specifically, it is an object to provide a shell and tube heat exchanger having a floating tube sheet which facilitates the easy inspection of the shell side of the tubes, which can be disassembled easily permitting all gaskets to be readily observed and replaced, which does not require an extra shell side closure for the shell end and which does not prevent the easy removal of the tube bundle.

The above objects, as well as others which will be apparent from the remaining specification and claims, is achieved according to the present invention by providing a floating tube sheet type heat exchanger wherein the tube sheet is located entirely outside of the shell and is axially spaced from the end thereof. The means for accomplishing this preferably comprises an elongated cylindrical metal skirt extending axially from within the shell into contact with the carbonaceous

tube sheet. In addition, a packing material is utilized for sealing while permitting sliding motion between the inside wall of the shell and the outside wall of the cylindrical metal skirt. Clamping means are also employed for tightly holding the metal skirt in contact with the floating tube sheet so that the tube sheet and the skirt can float as a unit within the packing material. A gasket is utilized between the contacting surfaces of the floating tube sheet and the elongated metal skirt. Since this gasket is located outside of the exchanger shell, it is relatively simple to change in the event of leakage.

The sole FIGURE in the drawing is a sectional view in elevation of the cylindrical shell and tube heat exchanger of the inention.

As shown in the drawing, the heat exchanger includes a cylindrical outer shell S containing a large number of graphite tubes T, the tubes being held in place and separated by a pair of graphite tube sheets **10** and **12** to which the tubes are cemented. The tube sheet **10** is rigidly attached to the shell S by bolts (not shown) passing through the flanges B. The tube sheet **12** is not rigidly attached to the shell but instead is spaced axially from the shell end by means of an elongated cylindrical metal skirt **14** which extends axially from within the exchanger shell into contact with the inboard surface of the tube sheet **12.** The opposite end of metal skirt **14** slideably contacts an external packing material **16** which provides a seal between the shell and the ambient atmosphere. A suitable packing material for this purpose is asbestos, graphite, teflon, etc. The packing material also permits sliding motion between the inside wall of the shell S and the outside wall of the metal skirt **14.** Clamping means **18** is provided for tightly holding the skirt **14** in contact with the floating tube sheet **12.** This clamping means may consist of a split ring **17** which seats in a groove within the skirt **14.** The split ring **17** is engaged by a loose back-up ring **15** which is in turn bolted to cover flange **19.** The outer face of the floating tube sheet **12** is enclosed within a cover **20.** A gasket **22** is provided between the contacting surfaces of metal skirt **14** and tube sheet **12** to prevent leakage of shell side liquid.

In operation, differential thermal expansion and contraction of the graphite tubes T with respect to the cylindrical shell S will be accommodated by axial movement of the floating tube sheet **12,** clamped metal skirt **14** and cover **20** as shown by the arrows in drawing. Fluid leakage is prevented during this movement by the packing material **16.**

In order to quickly inspect the shell side of the tubes, all that is required is to remove the bolts **13** holding the cover in position and thereafter sliding the back-up ring **15,** split ring **17** and metal skirt **14** axially toward the fixed tube sheet **10,** thereby exposing the tubes to visual inspection. It should be noted that only gaskets **22** and **24** are required at the floating end and these are both exposed at all times for inspection and replacement whenever necessary.

In order to remove the entire tube bundle including both tube sheets, the same procedure as above described for tube inspection is carried out, followed by the removal of cover **26.** Thereafter the tubes with both tube sheets attached may be pulled out of the shell.

What is claimed is:

1. In a shell and tube heat exchanger having a cylindrical outer shell and carbonaceous inner tubes held in place and separated by carbonaceous tube sheets, one

of said tube sheets being a floating vertical member tube sheet, adapted to slide axially with respect to the shell, the improvement comprising:

a. the floating tube sheet located entirely outside of the shell and axially spaced from the end thereof by an elongated cylindrical metal skirt extending axially from within the shell and into contact with only the tube side of the tube sheet;

b. packing material sealing and allowing sliding motion between the inside wall of the shell and the outside wall of the cylindrical metal skirt; and

c. clamping means including an ejnclosing metal cover of said heat exchanger for tightly holding the skirt in contact with the floating tube sheet, said metal cover being secured to said metal skirt whereby the floating tube sheet and skirt can float axially as a unit within said packing material.

2. The apparatus as defined in claim **1** further including a gasket seal outside of the exchanger shell between the contacting surfaces of the floating tube sheet and the elongated metal skirt.

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