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HEAT EXCHANGER WITH CLEANING MEANS

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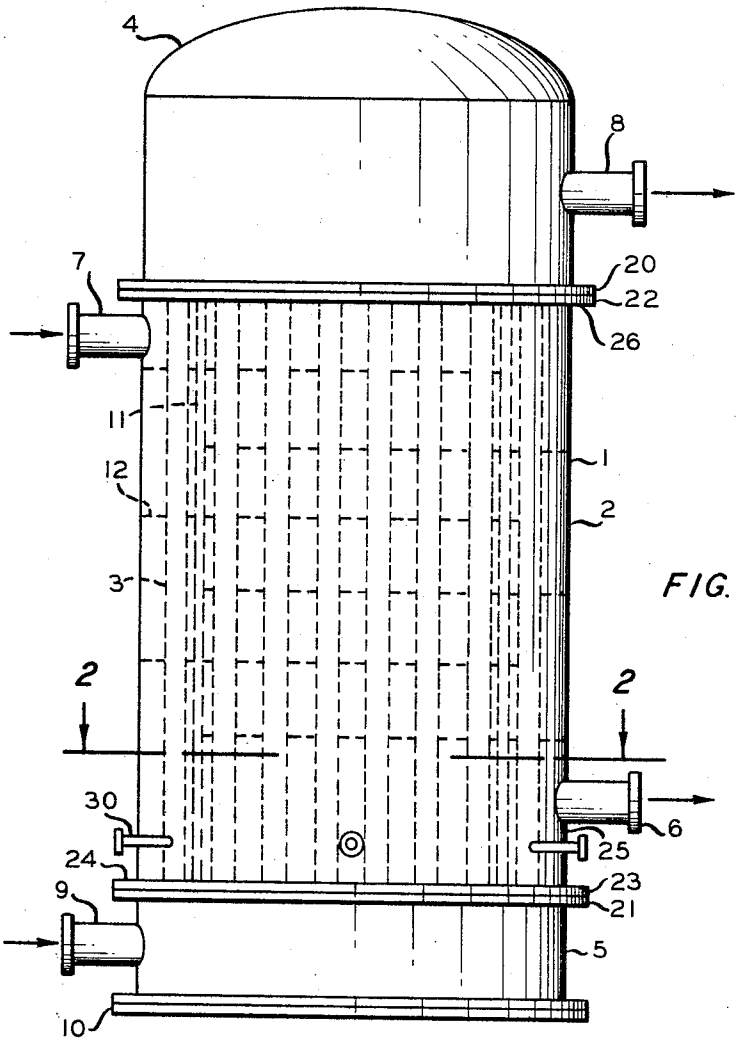

FIG. 1

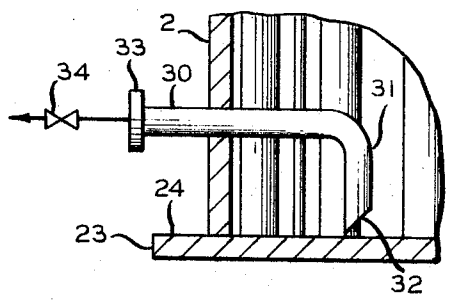

FIG. 3

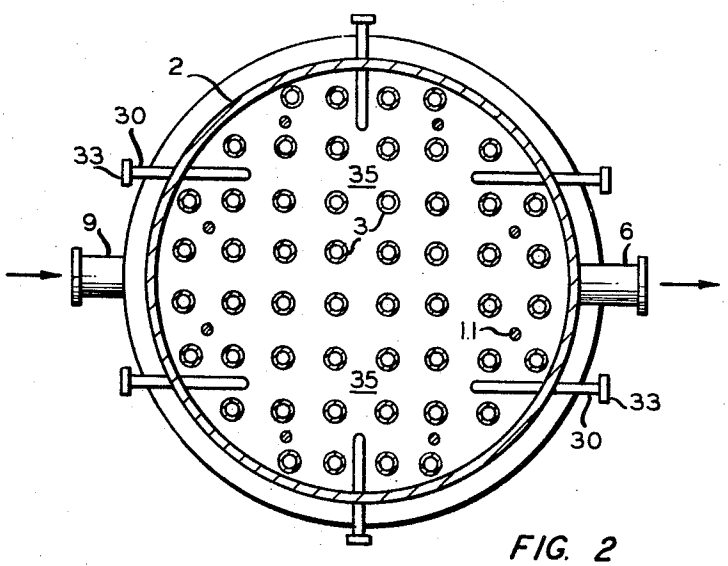

FIG. 2

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HEAT EXCHANGER WITH CLEANING MEANS

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ABSTRACT OF THE DISCLOSURE

A heat exchanger of the shell and tube type having a plurality of conduits providing passageway from the surface of the tube sheet to the external of the exchanger, the conduits being of sufficient size to allow passage therethrough of extraneous matter accumulated on the tube sheet.

This invention relates to heat exchangers. More specifically, this invention relates to a means for removing internal deposition of extraneous matter from heat exchangers.

Shell and tube heat exchangers may be subjected to considerable depositing of material on their internal surfaces. Such deposition is particularly undesirable because it acts to decrease heat transfer, creates hot spots within the heat exchanger, and results in fouling and plugging of the heat exchanger.

Such depositions can occur in a number of ways. For example, the deposits can drop out of the material charged due to the low velocity of the material through the exchanger. Deposits can accumulate as the result of vaporization of the material routed through the heat exchanger, such vaporization leaving solids behind.

Various methods are employed for cleaning heat exchangers but most of these methods can be used only when the heat exchanger is not in operation. Few, if any, methods have been developed to clean heat exchangers while in operation. As a result, problems involving the fouling of heat exchangers increase as length of operation of the heat exchanger increases.

Such problems are largely offset by the heat exchanger of this invention which employs means for removing such deposits from the heat exchanger without removing the heat exchanger from operation.

According to this invention there is provided a heat exchanger of the shell and tube type having a plurality of conduits communicating between the proximity of an inner surface of the lower tube sheet of a heat exchanger and the external of the exchanger, the conduit being adapted to permit the passage of extraneous matter therethrough.

Accordingly, it is an object of this invention to provide an improved heat exchanger.

It is another object of this invention to provide a means for cleaning heat exchangers without removing the heat exchanger from service.

The apparatus of this invention is particularly suited for vertical type heat exchangers in which the lower tube sheet is positioned in a relatively horizontal plane so as to permit accumulation of deposits thereon. Vertical positioning of heat exchangers in this manner is found in the installation of direct fire heaters, vertical waste heat boilers, reboilers and other installations.

The apparatus of this invention will be more easily understood by reference to the attached drawings showing one embodiment of this invention in which

FIG. 1 is an elevation view of a heat exchanger.

FIG. 2 is a plan view of the heat exchanger taken along section 2—2 of FIG. 1.

FIG. 3 is an enlarged view of a section of the lower tube sheet.

Referring now to FIG. 1, exchanger 1 has shell 2 with tube bundle 3 therein. Bonnet or upper head 4 contains tube side outlet nozzle 8 and lower channel 5 contains tube side inlet nozzle 9.

Inlet to the shell side is through shell inlet nozzle 7, the outlet from the shell side being through shell outlet nozzle 6. Channel 5 has bottom cover 10 such that material entering through tube side inlet nozzle 9 flows upward through tubes 3 into bonnet 4 and out tube side outlet nozzle 8.

In a similar manner, material entering shell 2 through shell inlet 7 leaves the shell through shell outlet nozzle 6.

It will be appreciated that the flow of the fluids through the exchanger can be other than that described and still be applicable in the present instance. For example, the direction of the shell and tube side fluid flows can be the reverse of that described or may be concurrent in either direction. In either instance, the fluids flowing on the respective sides of the exchanger do not commingle. Further, that fluid from which deposition will occur in routed through the shell side of the exchanger.

Tubes 3 comprise a tube nest or bundle which is fixed within the shell and has tube sheet 22 at its upper extremity and tube sheet 23 at its lower extremity. Tubes 3 extend between tube sheets 23 and tube sheet 22, being rolled or welded into the tube sheet to provide leak-proof joints. The tube bundle may also have tie rod and spacer arrangement 11 and baffles 12, the latter to distribute the flow of the material flowing through shell 2.

Channel 5 has removable channel cover 10. Channel 4 is shown as a bonnet type but can also be of the removable cover type.

Shell 2 with integral tube bundle 3 is attached to channel 4 by means of bolts fastened through bolt holes (not shown) in channel flange 20 and tube sheet 22 which also acts as a shell flange.

Similarly, shell 2 is attached to channel 5 by means of bolts fastened through bolt holes (not shown) in channel flange 21 and tube sheet 23 which also acts as a shell flange.

In its assembled, vertical position, tube sheets 22 and 23 have their shell side surfaces 26 and 24, respectively, exposed to the material flowing through the shell side of the exchanger. In this vertical position, lower tube sheet 23 is positioned in a relatively horizontal plane so that much of the deposition of solids from the material flowing through the shell side of the exchanger will take place on inner face 24 of lower tube sheet 23.

Inasmuch as acceptable fabrication codes prohibit the location of shell outlet nozzle 6 within the weld area which attaches tube sheet 23 to shell 2, there will be formed above tube sheet inner face 24 space 25 in which solids will tend to deposit and from which little flow of deposited material through nozzle 6 will occur.

As a result, space 25 between inner face 24 of lower tube sheet 23 and the lower edge of shell outlet nozzle 6 will gradually accumulate extraneous solid matter introduced with the shell side material through shell inlet nozzle 7. That surface represented by the corresponding length of tubes 3 in this area accordingly becomes ineffectual for heat transfer within the heat exchanger. Not only will the heat transfer surface of the exchanger be thereby decreased but should the temperature of that material entering the tube side be particularly high, failure to remove this heat by heat transfer in space 25 can eventually result in heat disintegration of the tubes in that area with attendant failure of the exchanger.

Tube holes in a tube sheet, and the tubes in a tube

bundle are laid out in a systematic order and, as shown in FIG. 2, are on square pitch. Triangular pitch may also be used. These arrangements establish passageways or aisles between the tubes. Generally when the tube side of the exchanger is subject to fouling or material deposition, square pitch is used. Preferable design practice dictates that tubes shall be spaced with a minimum center to center distance of 1¼ times the outside diameter of the tube. Accordingly, if 1 inch tubes are used, the distance between the outer surface of any two adjacent tubes is not less than ¼ inch. However, for units employing larger tube sizes such as boilers and the like, the distance between adjacent outside surfaces of tubes can be much larger.

Referring again to FIG. 2, it will be noted that into these lanes **35** between adjacent tubes **3** there have been positioned a plurality of conduits **30** which extend through shell **2** and into the tube nest and which, at their internal extremity, turn downward in the direction of tube sheet inner face **24**. This is further seen in elevation in FIG. 3 where conduit **30** is shown to have turned-down section **31** and end **32**.

While six such conduits **30** are shown in FIG. 2, any number may be employed. Similarly, while conduits **30** are shown extending into a tube nest **3** which has a square pitch, arrangement can be adapted to a tube nest having a triangular pitch.

Conduits **30** may be positioned in lanes **35** through the shell **2** in any satisfactory manner and to any length, and may be welded at their entry through shell **2** to insure that no leakage occurs from the shell side. Similarly, conduits **30** may be inserted at any height above tube sheet surface **24**, depending upon the depth of the deposit which is anticipated in space **25**. It is preferred, however that the height of the downward turned section **31** be less than the height of space **25**.

It is possible to position conduits **30** into shell **2** horizontally, and at tube sheet level, in a direction parallel to face **24** of the tube sheet **23**, omitting the turned down section **31** of the conduit. However, conduits **30** in their turned-down embodiment is preferable since this arrangement minimizes the amount of buildup within conduits **30** to that height of buildup of the extraneous matter within space **25**, whereas, in the horizontally positioned conduit, a considerable buildup within the conduit can occur with less depth of buildup on the tube sheet inner face.

The arrangement of a multiplicity of conduits as described possesses numerous advantages. A sufficiently large number of conduit can be employed being directed to a sufficient number of locations as to effect practically complete cleaning of the tube sheet or, at least, to effect cleaning over a principal portion of such surface. Further, the turned-down conduit allows minimum buildup within its entry so as to prevent plugging within the conduit. Also, the number of conduits which it is possible to employ provides such overlapping of effectiveness in respect to the various area concerned that should plugging of one tube occur, adjacent conduit will still clean the corresponding area to a large extent due to the overlapping effectiveness of the conduits in respect to the areas cleaned.

Referring now to FIG. 3, it will be noted that the conduit **30** as shown connects externally to flange **33** although any connection means can be employed. Conduit **30** terminates at its internal portion at end **32** which is shown in

angular relationship to inner face **24** of tube sheet **23**. End **32** of conduit **30** can be of any configuration. However, an angled termination is preferred as this permits the conduit to rest on the tube sheet and be supported therefrom while still being open for deposit removal and also facilitates a sweeping action when the conduit is opened for deposit removal.

Regardless of the number of conduits which are inserted into a tube bundle in the manner described or the depth to which they are inserted, they can be interconnected with a single valve which, when opened, causes all conduits to operate simultaneously, or, as in the embodiment shown, they can be equipped with individual valves **34** such that each conduit can be operated independently of the others with deposits removed from the inner face of tube sheet **24** being routed through a manifold system to a common collection means.

The operation of the heat exchanger deposition removal means is comparatively simple. At such times as are dictated, valve **34** is opened. Thereupon, the shell side material, which is normally under pressure, sweeps up into conduit **30** through opening **32**, sweeping the material deposited on inner face **24** of tube sheet **23** out of the exchanger, through valve **34** and hence into the manifold collecting system. Periodic openings of the valves will act to sweep the tube sheet clean over its surface with the result that the problem of internal deposition within the exchanger is solved.

It will be appreciated that while this invention has been shown in relationship to a single embodiment, it is also adaptable to other embodiments including gas fired heaters, boilers and the like, in which, for example, the channels or heads are integral with the shell.

It will also be appreciated that other embodiments of this invention are possible, but that these embodiments are not departures from the scope of the invention as described herein.

That which is claimed is:

1. In a shell and tube type heat exchanger having a tube nest disposed between tube sheets, access means to and from said shell and tubes, at least one of said tube sheets being horizontally positioned, the improvement comprising a plurality of conduits providing open communication between the shell side surface of said horizontally disposed tube sheet and the exterior of the exchanger, said conduits entering the exchanger through the shell wall beneath the access means from the shell, said conduits being arranged peripheral to said shell, and terminating in openings angularly disposed proximate the surface of said tube sheet and between the lanes of tubes of said tube nest, said conduits being externally commonly manifolded and adapted with means for restricting flow through said conduits.

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