Feb. 3, 1959 N. H. RANSTEAD 2,872,163

HEAT EXCHANGER

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Figure 1

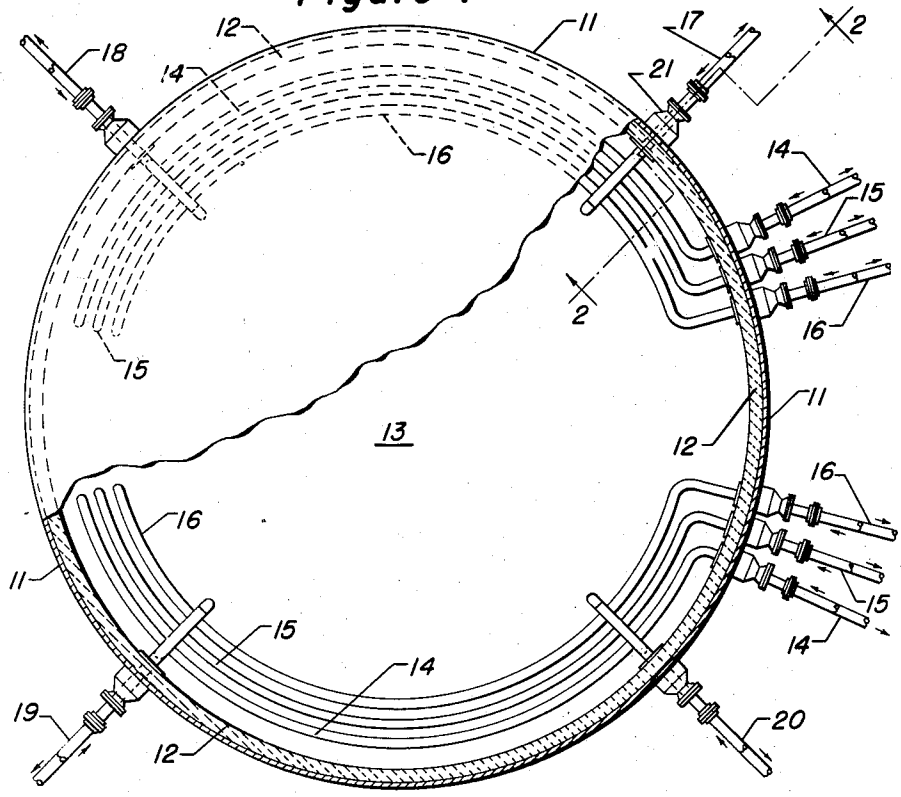
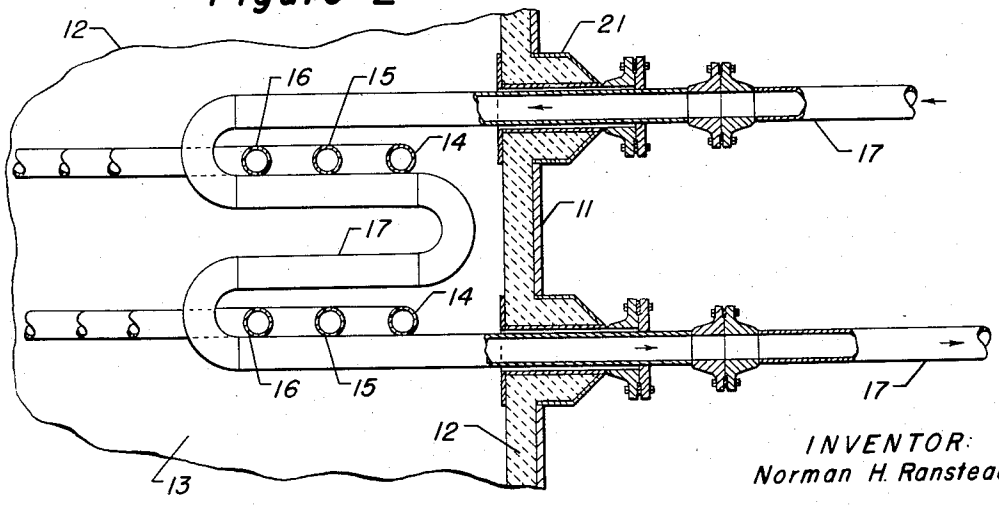


Figure 2



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HEAT EXCHANGER

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This invention relates to a method for disposing heat exchange tubes carrying relatively cool fluid in indirect heat exchange with the heating medium. In particular, this invention relates to a method for supporting heat exchange tubes in an unusually hot environment.

Heat exchange tubes, particularly in direct fired heat exchangers, are subjected to an extremely hot environment. Although good heat exchange is effected with a high temperature differential between the furnace and the fluid being heated, there are some inherent difficulties characteristic of extremely hot heaters. One difficulty is supporting the tubes passing through the heater. As is well known, metal loses its strength rapidly as the temperature increases therefore requiring the metal tube supports to be of expensive high alloy material in order to withstand the conditions of operation. Even the finest of alloys, however, suffer embrittlement and oxidation even though they retain their structural characteristics at high temperatures and it is therefore a continuous problem to maintain heater tubes supported. Besides the difficulty of maintaining the supports in operative condition, in high temperature heaters it is necessary to insulate the metal shell from the interior of the heater in order to construct the shell of ordinary carbon steel. Insulation is usually ceramic or earthen in nature and includes such materials as fire brick, fireproof cement, alumina blocks, etc. To obtain material having insulating and heat-resistant qualities, however, one must sacrifice physical strength since these materials although capable of supporting their own weight, cannot be used structurally to any great extent. It is therefore necessary to attach the tube supporting members to the outer metal shell of the heater and in doing this a path for conducting heat at high temperatures directly through the insulation is provided via the tube support. There results a hot spot on the metal shell at the point where the tube supporting member is attached and this hot spot is a source of weakness, rapid oxidation and danger.

It is an object of this invention to provide a simple but extremely effective means of overcoming the difficulties associated with supporting heat exchange tubes in high temperature environments. In effect, this invention provides for a cool supporting member which is obtained by disposing some of the heat exchange tubes to be used within the shell in such a manner and in such a shape as to have structural strength and to employ the thus disposed tubes as support members for longer and differently disposed tubes.

In one embodiment this invention relates to the method for disposing heat exchange tubes in a vessel which comprises externally supporting some of said heat exchange tubes, passing the latter tubes substantially horizontally through the shell of said vessel in tube-supporting relationship with the interior of said shell and supporting other heat exchange tubes on the first of said tubes.

This invention may be better described with reference to the accompanying drawing which shows one embodiment thereof and which is intended to be illustrative rather

than limiting upon the broad scope of the invention. Figure 1 of the drawing is a sectional plan view of one suitable arrangement of heat exchange tubes within a vessel and Figure 2 shows a partial sectional elevation view of the vessel of Figure 1.

Referring to Figure 1, there is shown a circular vessel **11** in which heat exchange tubes are disposed. The vessel **11** is insulated with insulating material **12** so that the iron shell **11** may be relatively cool with respect to the inside temperature in chamber **13**. In this particular embodiment, horizontally disposed tubes **14**, **15** and **16** which run parallel to the cylindrical shell **11** are in the interior of the vessel in chamber **13**. As here shown, the outlets and inlets of tubes **14**, **15** and **16** are adjacent. The tubes are bent to conform with the interior contours of shell **11** and extend half way around. A U-bend then causes the tubes to double back to the outlet, which is disposed immediately below the inlet. This arrangement allows for thermal expansion by permitting the U-bend end of the tubes to move freely. Tubes **14**, **15** and **16** are long and have an extended length within chamber **13** in order to have sufficient heat transfer area to obtain the desired temperature of fluid flowing therein. It is therefore necessary that these tubes be supported within chamber **13** since the high temperature conditions therein would cause tubes **14**, **15** and **16** to lose their structural strength and warp or break when in operation. To that end, tube supporting members **17**, **18**, **19** and **20** are employed and shown herein spaced 90° apart around the periphery of the vessel **11** although more or less supports may be used spaced at closer intervals. In Figure 2 the shape of the latter tube supporting members is better illustrated. In Figure 2 member **17** is shown to be relatively short in length and disposed vertically within the chamber. It is preferred that the center portion of member **17** does not bear against the interior wall of the vessel so that the insulation will not be disturbed by its thermal expansion. It may be noticed from Figure 2 that tube **17** is externally supported by support member **21**, which may be of any suitable shape, and passes through holes in the chamber wall which may be insulated as shown herein with insulating cement or loose packing of some well known variety. The pictured external support wherein the tube is supported by a flange is preferred since this support provides for a cool attachment to the vessel wall and furthermore permits this invention to be used on a pressure vessel, since the flange seals the interior of the vessel from the atmosphere.

In this embodiment, it may be seen that tube **17** which carries cool fluid to be heated will remain relatively cool because of cooling effect of the fluid passing therethrough and therefore will retain most of its structural strength. It may also be seen that tube **17** is supported by support member **21** which is connected to the outside of vessel **11** and therefore remains cool and unaffected by the temperatures within chamber **13**. This arrangement not only provides for the support of tubes in heat exchange relation but also provides a heating means for the fluid that cools the supports.

As hereinbefore stated, Figures 1 and 2 are intended merely to illustrate one embodiment of this invention which is typical of a class included within its broad scope. Therefore, the vessel **11** may be square, rectangular, oval or any other shape and may contain one or more walls within to break the heater into segments. It may be direct fired and if so may be of the upshot, downshot or horizontally fired type and it may be heated by radiation from a glowing ceramic wall, by radiation from a direct flame, by convection from hot gases or any combinations thereof. The heater may also be employed in indirect heat exchange with a hot fluid. The method of this invention may also be employed as a cooling means,

Therefore in a catalytic cracking process wherein spent catalyst is reactivated by oxidizing carbonaceous deposits from the surface thereof, the regeneration zone frequently requires cooling in order to prevent the temperature from becoming so high as to deactivate the catalyst. The regeneration zone also represents a heat source which may conveniently be used to supply process steam for other applications. To this end the process of the present invention provides a very suitable means for disposing heat exchange tubes within a catalyst regenerator vessel inasmuch as the temperature within such a vessel is extremely high, in the range of 1400° F., and the size of modern catalyst regenerators is of such magnitude that long heat exchange tubes are required and these heat exchange tubes require support at frequent intervals along their length. From the above illustrations it may be seen that this invention may be adapted to virtually any heat exchanger.

The various heat exchange tubes illustrated in the embodiment of Figures 1 and 2 and in other embodiments of this invention may be independent of each other or arranged serially. Therefore, the cooling fluid flowing through support member **17**, **18**, **19** and **20** may be passed into lines **14**, **15** and **16** for further heating and in this embodiment all of the tubes may be in series so that all of the fluid passes through all tubes or in various parallel arrangements. For example, one third of the fluid passing through tubes **17** through **20** may pass through each of tubes **14** through **16**. In other modifications each of the tubes may be in parallel so that different fluid passes through each and in fact, some of the tubes might be employed for generating steam by passing water therethrough and others may be employed, for example, for heating a petroleum fraction to be processed. It will, of course, be preferred that the coolest fluid pass through support members **17**, **18**, **19** and **20** inasmuch as these members require structural strength whereas the elongated tubes **14**, **15** and **16** are supported, however, various arrangements may be made to adapt this invention to the particular needs of the process.

In the embodiment herein shown, particularly in Figure 2, tubes **14**, **15** and **16** are disposed within the interior loops of support member **17** and therefore, restricted from free expansion although as herein shown, sufficient distance is left between the tubes so that expansion may be effected, the tubes may be supported merely by laying on the upper surface of tube **17** when desired and tube **17** may have more or less loops than as shown herein. It is preferred that the supporting member formed by tube **17** be relatively short in order to be structurally effective, however, depending upon the material of which it is constructed, the conditions of use and other considerations, tube **17** may be longer, shorter, formed with varying contours or otherwise modified to better perform its function of supporting other internal heat exchange tubes.

In a preferred embodiment, support member **17** is a vertical, externally supported coil composed of a series of short horizontal tube members arranged in a vertical plane and connected in series with U-bends. The long, horizontal heat exchange tube coils are then supported on the short horizontal tube members of the externally supported coil, as pictured in Figure 2. This arrangement is particularly suitable for regenerator vessels and radiant heating zones where the interior of the vessel need not be filled with tubes, but where the heat exchange tubes are disposed along the wall of the vessel.

I claim as my invention:

1. A heat exchange apparatus comprising a chamber, a plurality of spaced coils within said chamber, means for supporting said coils externally of the chamber, each of said coils comprising relatively short horizontal tubular members disposed in a vertical plane in the chamber and said coils as a group having corresponding tubular members positioned in the same horizontal plane in the chamber, means for passing cooling fluid through said coils, and a plurality of relatively long horizontal fluid conduits supported in a horizontal plane on said corresponding tubular members and disposed substantially at right angles to said corresponding tubular members.

2. A heat exchange apparatus comprising a chamber, a plurality of spaced coils extending inwardly from the periphery toward the interior of said chamber, means for supporting said coils externally of the chamber, each of said coils comprising relatively short horizontal tubular members disposed in a vertical plane in the chamber and said coils as a group having corresponding tubular members positioned in the same horizontal plane in the chamber, means for passing cooling fluid through said coils, and a plurality of relatively long horizontal fluid conduits adjacent the periphery of the chamber supported in a horizontal plane on said corresponding tubular members and disposed substantially at right angles to said corresponding tubular members.

3. A heat exchange apparatus comprising a cylindrical chamber, a plurality of spaced coils extending radially from the periphery toward the center of said chamber, means for supporting said coils externally of the chamber, each of said coils having relatively short horizontal tubular members disposed in a vertical plane in the chamber and said coils as a group having corresponding tubular members positioned in the same horizontal plane in the chamber, means for passing cooling fluid through said coils, and a plurality of relatively long horizontal fluid conduits supported in a horizontal plane on said corresponding tubular members, said conduits being disposed adjacent and parallel to the periphery of said cylindrical chamber and substantially at right angles to said corresponding tubular members.

4. The apparatus of claim 1 further characterized in that said coils have at least two groups of corresponding horizontal tubular members disposed in different horizontal planes in the chamber and in that horizontal fluid conduits are supported on each of said groups of tubular members.

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