Nov. 4, 1969 H. F. STRAIGHT, JR., ET AL 3,476,180

STUDDED HEAT EXCHANGER TUBES

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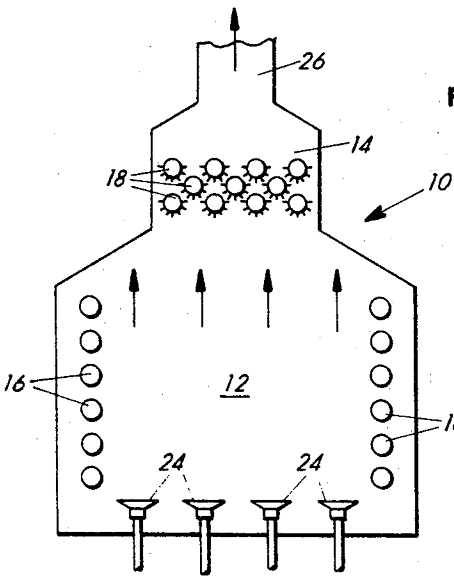

FIG. 1

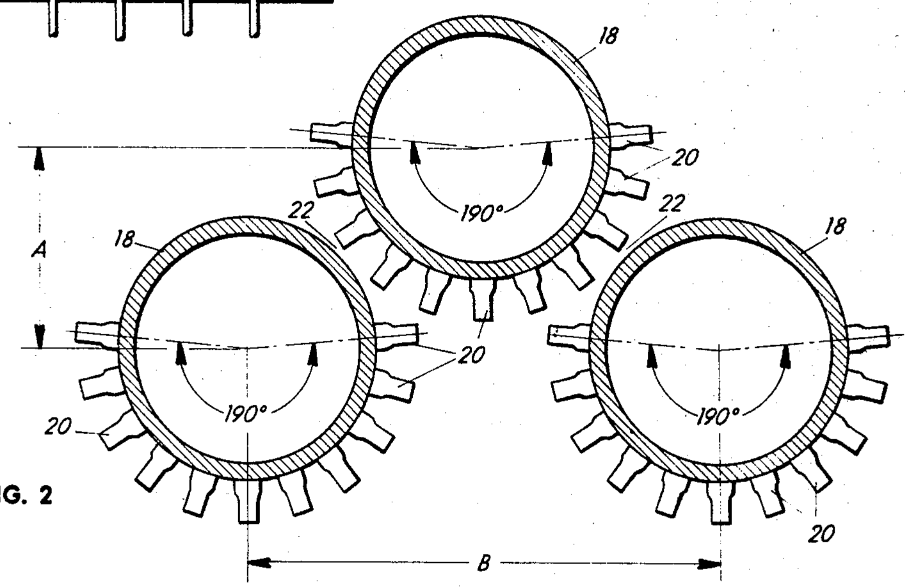

FIG. 2

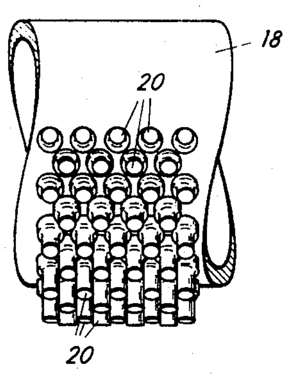

FIG. 3

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STUDDED HEAT EXCHANGER TUBES

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ABSTRACT OF THE DISCLOSURE

Heat exchange tubes having extended surface studs about approximately one-half of the tube periphery are compactly arranged in a furnace convection section to provide effective heat transfer capacity approaching heat transfer capacity of fully studded tubes.

DESCRIPTION OF THE INVENTION

This invention relates in general to furnaces, and in particular to improvements in extended surface tubes therefore permitting the contruction of a furnace heat exchanger which is smaller in size and lower in cost than conventional furnace heat exchangers employing prior art extended surface tubes.

In convection sections of conventional furnaces, either of the steam boiler or of the process furnace type used in the petroleum and chemical industries, it has been conventional practice to extend the surface area of the heat exchange tubes running therethrough by applying as many as possible studs to the outer surface thereof. The studding of tubes in the conventional manner, while greatly increasing their effective surface area and their corresponding heat transfer capacity, nevertheless, adds substantially to their cost and also to their effective outside diameter. The enlarging of the effective tube diameter necessitates the increase in spacing between tube centers, resulting in an overall increase in the size of the heat exchange enclosure. In accordance with the present invention, it has been discovered that substantially fifty percent of the studs may be eliminated from the portion of the tube periphery furthest most from the source of heat or on the downstream side of the flow of hot gases without substantially reducing the heat transfer capacity of the studded tube. The omission of the studs from the, so to speak, backside of each tube periphery permits the placement of the tube centers closer together, with the result that a smaller furnace enclosure may be constructed having the same number of heat exchange tubes running therethrough to thereby produce a substantial cost saving. In one form of the invention wherein the tips of the studs of one tube were positioned to lie within the stud-free zone of an adjacent tube, it has been possible to construct a convection section of a furnace having ninety to ninety-five percent of the heat transfer capacity with only approximately fifty percent of the extended surface of a prior art convection section using fully studded tubes. In addition, the closeness an the effect of the overlying relationship of the studs on one tube with the studs on the adjacent tube create an inter-acting turbulence or scrubbing of the hot gases passing thereover to enhance the heat transfer efficiency of the studs over similar studs in a non-overlying relationship.

Accordingly, it is an object of the present invention to provide a low-cost, extended surface heat exchanger tube, having substantially ninety to ninety-five percent of the efficiency of prior art fully studded tubes, yet employing only about fifty percent of the studs formerly employed.

Another object of the invention is to provide a tube studding arrangement wherein overlapping and a highly compacted tube arrangement is possible.

Another object of the invention is to provide a low-cost high efficiency convection section for a furnace.

These and other objects of the invention will become apparent and the invention will be fully understood from the following description and drawings in which:

FIG. 1 is a diagrammatic view of a typical cabin type process furnace;

FIG. 2 is a cross-sectional view of several heat exchange tubes in accordance with the invention; and

FIG. 3 is a side elevation view of a single tube of the invention.

It will be understood that the drawings represent merely a representative embodiment of the invention and that other embodiments are contemplated within the scope and claims hereafter set forth.

Referring to the drawings in particular, a conventional cabin heater **10** is diagrammatically shown having a plurality of up-firing burners **24** located along a bottom wall thereof. The burners **24** discharge combustion products upwardly to heat a plurality of primary heat transfer tubes **16** in the lower radiant heat section **12** of the furnace. Thereafter, the hot products of combustion continue their upward travel into a conventional convection or economizer section **14** thereabove which includes a plurality of transversely extending secondary heat transfer tubes **18** and outwardly through an uppermost flue **26**. Each of the tubes **18** includes a plurality of headed studs **20** which are attached in rows in staggered fashion typically by welding at their base directly to the outer surface of the tube **18**. The studs **20** include enlarged base portions and are preferably located relatively close together over approximately 190° of the tube pheriphery. The tube centers are located and positioned by suitable mounting structure not shown located in the side walls of convection section **14** in such a manner as to place the tips of the studs on one tube within the stud-free zone of an adjacent tube. This relationship of adjacent tubes on one horizontal layer to the stud-free zone on the tubes below it on the next horizontal layer permits closer horizontal spacing of adjacent layers as well as closer side-by-side spacing of tubes on the same layer due to the fact that clearance need not be provided between stud tips but only between a tube periphery which is stud-free and the adjacent stud tips. This relationship may best be seen at the spacing gap **22** of FIG. 2 wherein it may be readily appreciated that a substantial space economy has been effected by the omission of studs from the tube periphery from the two lowermost tubes at this point to permit the close positioning of the center and uppermost tube. It will be understood that in FIG. 2 the flow of hot heating gases is upward from the bottom of the figure to the upper portion of the figure so that essentially all of the studs look toward, rather than away from, the source of heat. In FIG. 2, as described above, the inventive omission of the nonessential studs from the backside of the tube periphery permits the substantial reduction in the vertical tube spacing between tube centers designated by the arrow A, as well as a substantial reduction in horizontal tube spacing between centers designated by the arrow B.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise and applied to numerous types of heating devices other than convection sections of furnaces without departing from the inventive principles. For instance, the invention is equally adaptable to economizers of steam power boilers, as well as other typical heat exchange equipment where it is desirable to obtain maximum heat transfer at the lowest possible cost of enclosure as well as tube cost.

What is claimed is:

1. In a heat transfer section of a furnace, a flue for heating gases; and a plurality of heat exchanged tubes arranged transversely of the flow of heating gases, each of said heat exchange tubes including a plurality of individual extended surface metallic studs welded thereto and positioned in staggered rows about approximately 190° of the tube periphery leaving the remaining tube periphery free of studs, and means for mounting adjacent tubes in said flue in compacted relationship wherein the tips of the studs on one tube lie within the stud-free zone of an adjacent tube.

2. In a heat transfer section of a furnace, a flue for heating gases; and a plurality of horizontal layers of heat exchange tubes arranged transversely of the flow of heating gases, each of said heat exchange tubes in each layer including a plurality of individual extended surface metallic studs welded thereto and positioned in staggered rows about approximately 190° of the tube periphery leaving the remaining tube periphery free of studs, and means for mounting tubes in one layer partially in the flow shadow of the tubes in the adjacent layer in compacted relationship therewith wherein the tips of the studs on one tube lie within the stud-free zone of an adjacent tube on the adjacent layer.

3. The combination in accordance with claim 2, wherein the end of each of said studs that is welded to said tube is substantially larger in diameter than the remaining diameter of said studs.

4. Apparatus comprising, in combination, a flue for the passage of heated flowing gases therethrough, a plurality of metallic tubes, each tube including a plurality of individual extended surface circular metallic studs welded

thereto and positioned in staggered rows about approximately 190° of the tube periphery leaving the remaining tube periphery free of studs, means mounting each of said tubes in said flue with its studs oriented to face upstream of said flowing gases in a plurality of layers with the tubes in one layer partially in the flow shadow of the tubes in the adjacent layer and in compacted relationship therewith, wherein the tips of the studs on one tube lie within the stud-free zone of an adjacent tube on the adjacent layer.

5. The combination in accordance with claim 4, wherein the end of each of said studs that is welded to said tube is substantially larger in diameter than the remaining diameter of said studs.

References Cited

UNITED STATES PATENTS

1,390,783	9/1921	Hering	165—1
1,521,864	1/1925	Broido	122—367 XR
1,942,211	1/1934	Hartwig	122—367 XR
3,163,153	12/1964	Griffin	122—356 XR

FOREIGN PATENTS

545,608	6/1942	Great Britain.
743,795	1/1933	France.
827,519	1/1938	France.

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