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E. F. SPANNER

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TUBULAR HEAT EXCHANGE APPARATUS

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FIG. 1.

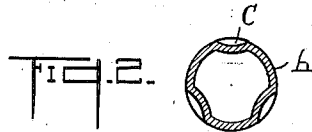
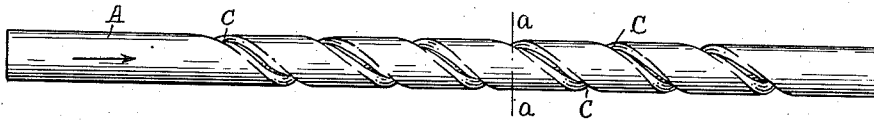


FIG. 3.

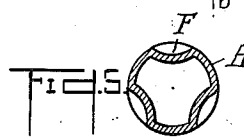
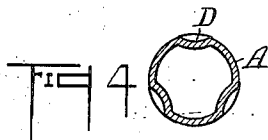
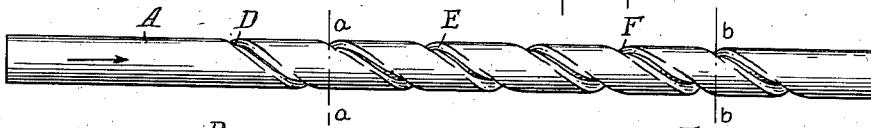


FIG. 6.

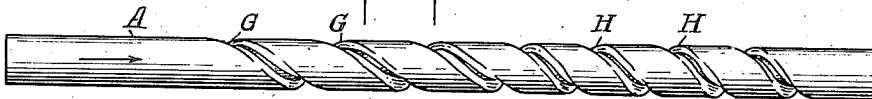


FIG. 7.

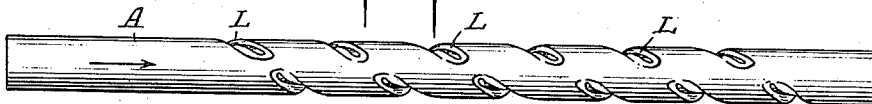


FIG. 8.

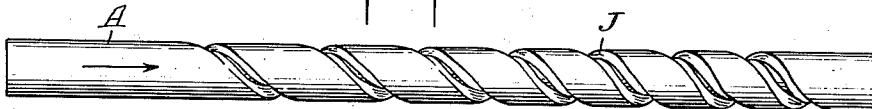
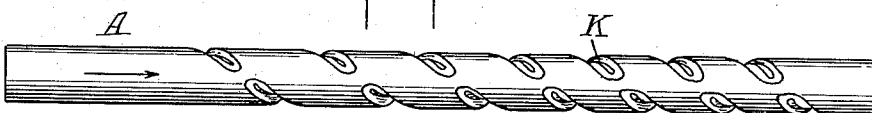


FIG. 9.



INVENTOR
EDWARD FRANK SPANNER

BY 
his ATTORNEY.

UNITED STATES PATENT OFFICE

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TUBULAR HEAT EXCHANGE APPARATUS

Edward Frank Spanner, Blackheath, London,
EnglandApplication January 4, 1940, Serial No. 312,376
In Great Britain October 18, 1938

3 Claims. (Cl. 138—38)

This invention is concerned with tubular heat exchange apparatus in which heat transfer is required between hot and cold fluids, and in which the hot fluid i. e. gas or liquid is passed from an inlet chamber to an outlet chamber through a multiplicity of straight tubes expanded into tube plates at the ends of a shell containing or confining the cold fluid i. e. gas or liquid, to which heat is to be transferred.

Efficiency of heat transfer is dependent upon bringing all parts of the hot stream of fluid passing through each individual tube into intimate contact with the wall of that tube, and in preventing "coring" of the hot fluid i. e. passage of a central core of hot fluid along the tube, from the wall of which it is separated by outer layers of cooler fluid. Such coring is particularly disadvantageous to efficiency in heat transfer when the hot fluid is a gas.

In apparatus of normal practice using plain round straight tubes, there is a short portion of tube near the inlet end, of length from about 4 times to about 6 times the internal diameter, along which the rate of heat transfer is high by reason of the turbulence which exists in this region as the result of the fluid having suddenly been accelerated in a confused manner while entering the tube.

This turbulence does not persist beyond this distance and the present invention artificially reinstates and accentuates this condition of turbulence before coring can commence, by providing that each tube according to this invention shall have pressed into it two or more grooves to form ridges, these grooves starting from a point a distance of from about four times to about six times the internal diameter from the inlet end of the tube, and being carried along the tube in a spiral form to a point within two to three diameters of the outlet end.

When the hot fluid being dealt with is a gas the invention does more than simply accentuate turbulence. It is well known that gas contracts very rapidly with reduction in temperature. Also that exchange of heat between a hot gas flowing along a tube, and the wall of that tube, is adversely affected by a falling off of the linear velocity of the gas relative to the wall surface.

The present invention secures that the linear velocity of flow of the gas relative to the wall of the tube shall be prevented from falling off, although the gas is being cooled and reduced in volume as it passes along the length of the tube from inlet to exit, by providing that the depth of the spiral grooves or ridges shall be increased

from the inlet towards the outer ends, either in a series of steps, or as a gradual taper; or that the number of turns of the spirals per unit length of the tube shall become greater towards the outlet end of the tube than it is at the inlet end; or that both of these devices shall be used together for the purpose of securing the objects already set forth. The invention also provides that, for simplicity of manufacture, the spiral grooves may be interrupted—that is made in short lengths.

It is very important that the depth and pitch of the spiral grooves or ridges should be carefully chosen in order that (a) there shall be no undue increase in the amount of resistance offered to the passage of the gas through the tubes such as would occur with too deep grooves of too small a pitch, (b) that there shall be no undue reduction of strength of the tube against external pressure such as would occur with grooves of too large a pitch, and (c) that it should be a simple and straight-forward matter thoroughly to wire brush the inside of the tube using spiralled brushes of ordinary commercial standards. The invention secures that these several requirements shall be satisfied by providing that the maximum depth of the grooves shall not exceed about one-eighth the external diameter of the tube, and that the pitch of the grooves should be between six and eight times the internal tube diameter.

Finally, since, in the case of hot gas, the effect of these devices falls off somewhat with slowing down of the linear velocity of gas flow, the invention provides that, when desired, the number and size of the tubes chosen shall be such that the linear velocity of gas flow along the tube at its entrance shall be not less than sixty feet per second.

The invention applies to all kinds of heat transfer apparatus, in which hot gases or liquids pass through tubes surrounded by cold gases or liquids and equally to cases in which cold gases or liquids pass through tubes surrounded by hot gases or liquids. It is immaterial also from what sources the supplies of hot gas or liquid are obtained, or whether the hot gases are produced by combustion taking place within the tube itself at the inlet end.

Referring to the attached drawing, Figure 1 shows an outside view of a tube according to this invention, in which A is the tube, and CCC are the grooves or ridges.

Figure 2 shows a cross section across the tube shown in Figure 1 on the line aa.

Figure 3 shows an outside view of a tube A according to this invention, in which the grooves

get deeper along the length of the tube, the groove at F being deeper than the grooves at E and the groove at E deeper than the groove at D.

Sections of the tube at *aa* and *bb* are shown in Figure 4 and Figure 5 respectively.

Figure 6 shows the outside of a tube A according to this invention in which the distance between the grooves GG towards the entrance to the tube is greater than the distance between the similar grooves HH towards the end of the tube.

Figure 7 shows a tube A according to this invention in which the spiral grooves L are interrupted i. e. made in short lengths.

Figure 8 shows an outside view of an alternative form of tube A according to this invention in which the grooves or ridges J are of gradually increasing depth and decreasing pitch towards the exit end of the tube.

Figure 9 shows an outside view of tube A somewhat like Figure 8 but distinguished therefrom in that the grooves or ridges K are divided into short lengths.

In the drawing it will be understood that the number of grooves provided in the tube may be two or more.

I claim:

1. A straight tube for use in non-radiant heat exchange apparatus, having a smooth cylindrical internal surface divided into helical paths of constant diameter by a plurality of series of angularly arranged disconnected ridges aligned in helices about the tube axis, the pitch of said helices gradually decreasing from the admission to the exit end of said tube and the depth of said ridges gradually increasing from the admission to the exit end of said tube.

2. A straight tube for use in non-radiant heat exchange apparatus having two or more spiral grooves inwardly pressed into it along practically the whole of its length, these grooves being of gradually increasing depth and decreasing pitch towards the exit end of the tube.

3. A straight tube for use in non-radiant heat exchange apparatus having two or more spiral grooves inwardly pressed into it along practically the whole of its length, these grooves being made in short lengths, successive lengths being of greater depth and decreased pitch towards the exit end of the tube.

EDWARD FRANK SPANNER.