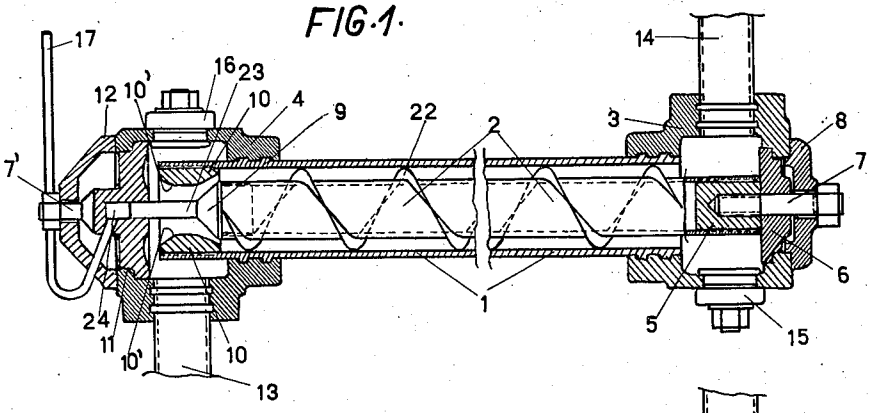
Dec. 15, 1936. P. DMITREVSKIJ ET AL 2,064,246

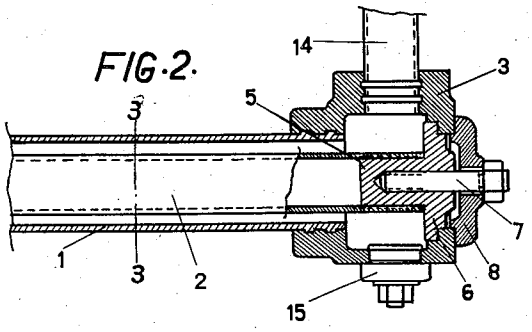
TUBE SYSTEM FOR HEAT EXCHANGE

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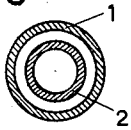
FIG·1·



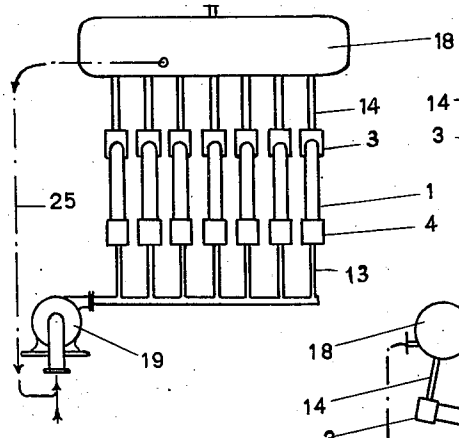
FIG·2·



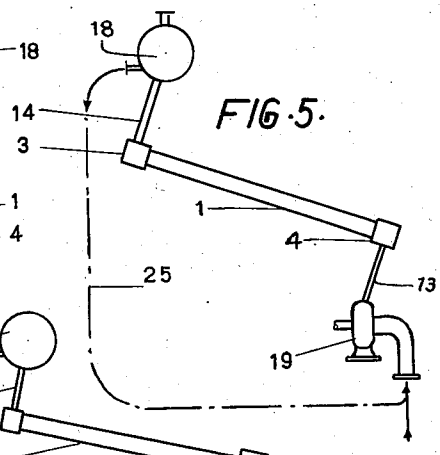
FIG·3·



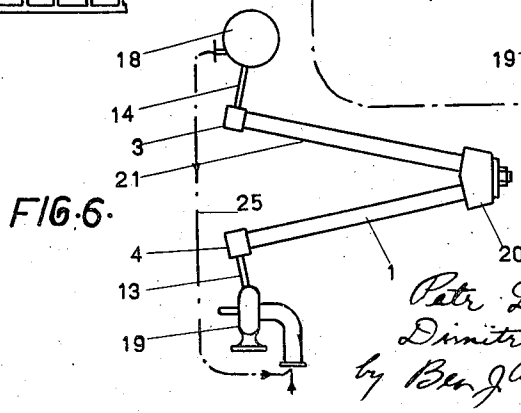
FIG·4·



FIG·5·



FIG·6·



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TUBE SYSTEM FOR HEAT EXCHANGE

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Application April 7, 1934, Serial No. 719,522
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3 Claims. (Cl. 257—249)

The subject of the invention relates to improvements in and relating to tube systems for heat exchange of a type wherein e. g. the heated liquid medium inside the tubes is subjected to an uninterrupted forced circulation, for instance by means of a pump, while the gaseous medium used for heating, flows round the tubes.

According to the invention the effective area of the tube is an annular channel formed by introducing into the tube for its whole length a core, which compels the liquid to flow merely through the annular channel. A helically shaped body is furthermore introduced into the said annular channel so that the water flowing through the tube under pressure is thrown by centrifugal force against the inner surface of the tube and receives a helicoidal movement round its longitudinal axis. If the flowing liquid surpasses a certain angular velocity it is separated by centrifugal force from steam and since specific weight of the liquid is greater than that of its steam it will form a continuous layer on the periphery of the pipe and the steam will collect at the inner surface of the annular channel.

In the tube system, according to the invention the speed of the liquid forced through the helical passage is such that when using a heating intensity of about 20,000 calories per square foot of heating surface the liquid should make about 25 to 30 turns per second round the axis of the tube. The corresponding axial speed of the liquid through the tube depends upon the pitch of the helical guide surface.

The invention refers, further, to means for automatic control of the amount of liquid flowing through the annular channel in relation to the rate of heating; the result aimed at is obtained by fixing the core of the tube only at one end, whereas its other extremity is relatively movable. If the heating of the tube be increased, the latter will be subjected to thermal dilatation more than the core, which causes an increase of the intake annular cross section between core and tube at the free extremity of the core.

On the accompanying drawing, several modes of carrying the invention into practice are given by way of example. Fig. 1 is an axial elevation of a heat exchange tube according to the invention, Fig. 2 shows an elevation of a simplified arrangement, Fig. 3 is a lateral section of a tube with a core of the same design, on the line 3—3 of Fig. 2; Fig. 4 is a schematic general view of a system of water tubes for a steam boiler (front view); Fig. 5 is the corresponding schematical side view, and Fig. 6 is a similar side view of the system with double tubes.

According to the example shown in Fig. 1, a cylindric core 2 preferably being in itself a tube is located in the outer tube 1. The tube 1 extends on both its extremities to the headers 3 and 4, into which it is expanded. The tubular core 2 is closed at its right end by means of plug 5, which is attached to an inner cover 6, placed inside the header 3, which itself is closed from outside by the outer cover 8. The plug 5, the outer and inner covers 6 and 8 are connected together and tightened to the header 3 by a screw 7 and an outer nut. In this manner the tubular core 2 is rigidly and unmovably secured in the header 3 at one end of the tube 1.

In the free end of the tube 1, which extends within the header H, there is secured a ring 10 having a conical inner surface 10′ adjacent the conical end of the core 2.

The header 4 is provided with an intake pipe 13 and a removable cover 16; the header 3 has, similarly, an outlet pipe 14 and a removable cover 15. These covers 15 and 16 are provided for the headers 3 and 4, respectively, for the purpose of permitting access to the interior of said headers and the pipes attached thereto.

In the annular channel between the inner surface of the pipe 1 and the outer surface of the core 2 a helicoidal guiding surface 22 is placed which is fixed e. g. to the surface of the core 2. The liquid medium, e. g. water, forced through the tube by pressure generated by a suitable pump must flow through the annular channel between the inner surface of pipe 1 and the core 2 along the helical course 22, thus being subjected to a rotary motion; the liquid is thereby subjected to centrifugal force which throws it from the axis of the tube 1 to the inner surface thereof and owing to its higher density, separates the water from the steam which is formed by the heat received from the outer tube 1. The steam flows in a helical path along the surface of the inner core 2. The greater the temperature of the heating medium which heats the outer surface of the pipe 1, the greater should be the amount of the heated medium, flowing through the annular channel between the tube 1 and the core 2. This amount is automatically regulated by varying the space between the ring 10 in the free end of the tube 1 inside the chamber of the header 4 and the conical extension 9 on the free end of the core 2, which latter, not being heated directly is subjected to smaller dilatation than the tube 1.

Hence, with increased heating of the pipe, the intake space between the bodies 9 and 10 for the heated medium is increased also, since the ring 10 slides away from the conical extremity 9 of the core 2, which expands less than the tube. If the heating of the tube 1 is smaller it expands less and therefore the cross-section for the flowing liquid is correspondingly less.

The length of the core 2 with its conical extension 9 and the rod 23 varies also with the intensity of heating. Under such conditions the rod 23 slides in the bore 24 and the size of the cylindrical space 24 between the free end of the rod 23 and the bottom of the cover 11 varies correspondingly, which may be utilized in the following three ways:

1. For the control of efficiency either of the whole tube system or of its individual parts,

2. For the automatic variation of the amount of the medium which circulates through the system,

3. For automatic regulation of the amount of heat which serves to heat the whole system of tubes.

It is sufficient for this purpose to fill the hollow space 24 with a liquid and connect this space by means of a pipe 17 to a pressure cylinder of a suitable design which serves either to record a graph of pressure variations or to control a suitable gear for introducing the heating medium into the system or to control the development of the heat.

Figure 2 shows a modified form of an embodiment of this invention, similar to the form shown in Figure 1, except that the spiral rib 22 is omitted. In certain cases it has been found sufficient to provide control of the water flow through the tube by means of the automatic valve arrangement shown in Figure 1.

The Figs. 4 and 5 represent schematically an arrangement of a plurality of heat exchange tubes such as are shown in Figs. 1 or 2 with the intake and outlet tubes 13 and 14, with the steam-chest 18 the circulating pump 19 and the corresponding connecting piping 25.

In the arrangement shown in Fig. 6, two series of tubes 1 and 21 are employed provided with a double chamber 20, common to both series of tubes. One series thereof, e. g. the system 21 having no cores or no helical surface according to Fig. 2.

In the tube systems serving for cooling a given medium or for superheating of steam, the tubes 1 are pressed in on both its ends not to the headers, but to the plates, and the cores are fixed at one end to a parallel plate, which is fixed at certain points to the plate into which the tubes are adjusted, and which replaces the cover 6 and the headers 3 according to Fig. 1. On the other end, where the extremities of the tubes 1 may freely move with respect to the ends of the cores 2, the covers 11 of the headers 4 are replaced again by a plate, which is connected by means of screws to another plate to which the ends of the tubes 1 are pressed in. The hollow spaces 24 are here replaced by small cylinders, one for every individual core, the said cylinders being connected to the plate, which replace the covers 11.

The whole arrangement may be employed in tubular systems of any design serving to evaporate, heat, cool or condense any kind of steam or vapours, and to use any required heating or heated media.

The core 2 may be replaced, in certain cases by guiding spiral surfaces, which serve to change the direction of the flowing medium towards the inner surface of the tube 1. Also the number of helices located on the core may be chosen freely and the angle of the helical curves need not remain invariable along the whole core; this angle may preferably be increased particularly at both ends of the tubes. Instead of using a choking ring 10 it is also possible to reduce the diameter of the end of pipe 1 adjacent to this ring, or to provide this end of said pipe with a conical extension, similar to ring 10.

What we claim is:—

1. In a tube system for liquid evaporators, a plurality of tubes, means for passing a fluid medium through said tubes, a core member positioned centrally in each of said tubes, means for fixing one end of each of said core members with respect to its tube, means positioned on each of said core members for dividing the space between the core and tube into a helical path and means positioned at the free end of each of said core members for controlling the flow of said fluid medium through its tube in accordance with the difference of expansion of the tube and core.

2. In a tube system for liquid evaporators, a plurality of tubes, adapted to be externally heated, means for passing a liquid through said tubes, means for dividing the passage through each of said tubes into a continuous helical path for imparting a high velocity, rotary motion to said liquid sufficient to separate said liquid from the vapor formed therein and sufficient to force said liquid outward into intimate contact with the hot inner surfaces of each of said tubes as said liquid is passed through said tubes.

3. A tube system for liquid evaporators, comprising a plurality of elongated tubes, headers connected to the ends of said tubes, said tubes being adapted for heating on the outside, core members positioned inside of said tubes, one end of each of said core members being attached to one of said headers, helical members positioned on said core members for dividing the space between each of said core members and the inner surface of its tube into a continuous helical path, the angle of said helical path with respect to said core member being sufficient to impart a rotary motion to the liquid flowing through said tube to separate vapor from said liquid and to force the liquid against the hot inner surfaces of said tubes.

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