United States Patent [19]

Kleppe et al.

[11] **3,870,081**

[45] **Mar. 11, 1975**

[54] **HEAT EXCHANGE CONDUIT**

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[22] Filed: **Feb. 9, 1973**

[21] Appl. No.: **331,248**

[30] **Foreign Application Priority Data**

Feb. 10, 1972 Norway 370/72

[52] **U.S. Cl.** **138/38,** 165/179

[51] **Int. Cl.** **F15d 1/04**

[58] **Field of Search** .... 138/38, 39, 42; 165/177, 165/179, 182, 183; 48/180 M

[56] **References Cited**

UNITED STATES PATENTS

1,343,352	6/1920	Costelloe et al.	165/179
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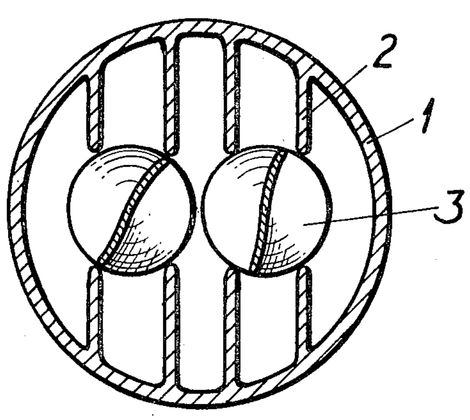
Primary Examiner—S. Clement Swisher
Assistant Examiner—Daniel M. Yasich

[57] **ABSTRACT**

A heat exchange conduit is disclosed by which there are achieved improved heat transmission conditions by the fact that a rotation of the flowing medium in the conduit is produced at the same time as said rotation is disturbed by means being in good heat conducting connection with the wall of the conduit. The heat exchange conduit comprises internal ribs extending parallel to the longitudinal axis of the conduit, and at least one additional element in the conduit for promoting the heat exchange, whereby at least one such additional element is constituted by a strip, each strip being twisted and its principal axis being parallel to the longitudinal axis of the conduit.

3 Claims, 5 Drawing Figures



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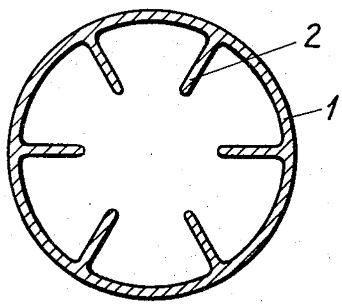

Fig.1
PRIOR ART

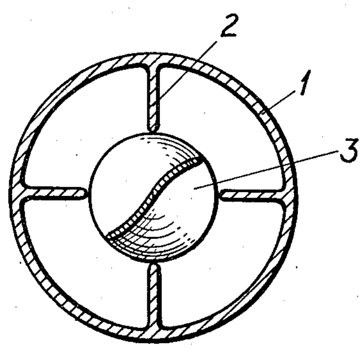

Fig.2

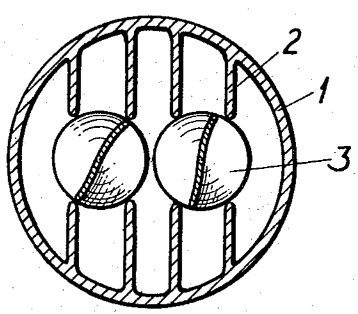

Fig.3

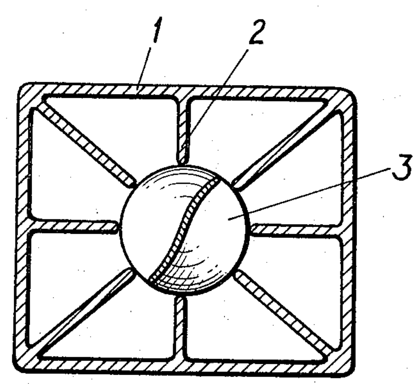

Fig.4

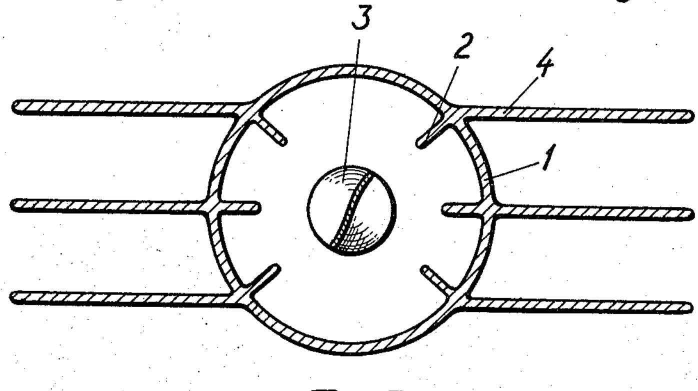

Fig.5

HEAT EXCHANGE CONDUIT

The present invention relates to a heat exchange conduit comprising internal ribs extending parallel with the longitudinal axis of the conduit, and at least one additional element disposed within the conduit in order to promote the heat exchange.

Such heat exchange conduits are utilized in heat exchangers wherein heat is to be transmitted from one medium to another through the wall of the conduit or tube. In order to increase the heat transmission inside such tubes, the flowing medium within the tube has a turbulent flow. This can be achieved by the combination of sufficiently large diameter and flow velocity, and sufficiently low viscosity for the flowing medium.

In many cases difficulties are encountered in achieving turbulence. It may be the case that a given viscosity may not be changed, or that the velocity may not be above a given limit. In order to have transmitted a certain amount of heat per unit of time, and with given temperatures, the solution in such cases generally is to increase the internal surface. For a given tube dimension the surface may, for example, be increased by means of internal ribs in the tubes. Such ribs also are assumed to have a favorable influence on the heat exchange because the ribs project towards the interior of the tube and come into contact with those portions of the flowing medium which have temperature differential with the outer layer. Measurements have shown that such ribs, in one case, increased the flow of heat through the tube wall approximately 14 percent in relation to tubes without ribs, under otherwise equal conditions.

Another known device whose purpose is to give an improved heat transmission, is one or more twisted strips within the tube. This is shown in U.S. Pat. No. 1,343,352 and Swiss Pat. No. 353,387. Such strips have the effect that the flowing medium circulates during the flow through the tubes, but the effect, with respect to the heat transmission, is not especially good. This is due to the fact that such circulation does not give any substantial overturn of the flowing liquid layers. The flow does not become turbulent for promoting heat transmission. Tests have shown that insertion of a twisted strip with a width equal to the tube diameter, in a special case increased the flow of heat through the tube wall with less than 1 percent.

An object of the present invention is to provide a heat exchange counduit in which there are achieved improved heattransmission conditions by the fact that there is produced a rotation of the flowing medium in the conduit, at the same time as this rotation is disturbed by means in good heat conducting connection with the wall of the conduit.

According to the invention, the above object is achieved by the provision of a heat exchange conduit of the type set forth above, and which is caracterized in that at least one such additional element is constituted by a strip, said strip being twisted and its principal axis being parallel with the longitudinal axis of the conduit.

The present invention constitutes a combination of the above mentioned constituents, namely internal ribs and at least one twisted strip. This combination has the surprising effect that the heat transmission through the wall of the conduit is increased substantially more than with the sum of the individual increases which are

caused by the ribs and twisted strip, respectively. Tests have shown that the disclosed combination is able to give more than a 20 percent increase of the flow of heat through the wall of the conduit in relation to a conduit with smooth walls and without twisted strips, under otherwise equal conditions.

The invention departs substantially from the prior art with respect to the use of ribs and twisted strips, respectively. The idea behind the invention is to create a rotation of the flow by means of at least one twisted strip, and to disturb this rotation by means of ribs which are in good heat conducting connection with the wall of the conduit, but without increasing the resistance to flow beyond a certain limit. The disturbance of the flow could be achieved by, for example, surfaces extending completely or partly transversely to the flow direction, but this would firstly give strongly increased resistance to flow, and secondly the production of such tubes would be complicated. The conduits or tubes, exclusive of strips, which are utilized according to the present invention, may be extruded integrally with the internal and possibly also external ribs. It is, however, no presupposition that the tubes are extruded. There is nothing to prevent the ribs from being produced separately and fixed to the tube, or the ribs being formed, for example, depressed or folded parts of the tube.

Further details of the invention will become apparant from the following description taken in connection with the accompanying drawings in which,

FIG. 1 shows a transverse section of a heat exchange tube according to a known embodiment,

FIGS. 2 – 4 show embodiments of heat exchange tubes according to the present invention, and

FIG. 5 shows a heat exchange tube according to the invention which is also provided with external ribs.

The tube 1 shown in FIG. 1 is of the previously known type discussed above, in which the internal surface of the tube is increased by means of internal ribs to which are formed integrally with or attached to the wall of the tube and project towards the center of the tube.

In FIGS. 2 – 4 are shown embodiments of tubes according to the invention. A tube 1 with ribs 2 has at least one internal twisted strip 3 which preferably extends along the whole length of the tube. The tube with ribs is preferably made of a material with good thermal conductivity, whereas this is not essential in the case of the strip, as the strip bears against the ribs only at certain points and consequently has little effect with respect to heat conduction. Therefore it is conceivable to make the strip of a non-metallic material, such as a plastic, when this is advisable in view of temperature, chemical influence from the flowing medium or in other regards.

The tube may have sections other than the circular form, and the ribs 2 need not necessarily project radially into the tube as shown in FIG. 2. As shown in FIG. 3 the ribs may be parallel, and as shown the tube may also contain more than one strip. The essential requirement is that each strip causes a rotation of the flow, and that the ribs disturb this rotation.

As previously mentioned, it is convenient but not necessary, that the tube with its internal ribs may be produced by extrusion. The material may be any metal or a metal alloy, preferably with good thermal conductivity. The internal and possibly the external ribs which are formed by the extrusion, will necessarily be parallel with the longitudinal axis of the tube.

The number of ribs is not decisive. The essential requirement is that there be a suitable distance between the ribs, in order that the flowing medium shall be able to move into and out of the spaces between the ribs.

A simple and cheap embodiment of the invention comprises a tube with a few internal ribs and one twisted strip centrally disposed in the tube, so that the edges of the strip bear against the ribs at certain points as shown in FIG. **2.** The ribs may project radially into the tube and be uniformly spaced around the wall of the tube. The strip may be sufficiently fixed by means of friction against the ribs, or possibly by fastening in other ways.

It is possible that the strips may have such a width that they do not bear against the ribs. This is shown in FIG. **5.** With a certain distance between strips and ribs, the produced rotation of the flowing medium will also be effective at the ribs. In such a case it is possible that the strip will be situated somewhat irregularly within the tube if it is not sufficiently fixed. It is convenient for the strip to be anchored and maintained fairly coaxial with the tube by placing it under tension or supporting it at certain points by means of auxiliary means (not shown) inside the tube.

A conduit or tube according to the invention may have external ribs of any type, in cases where this is appropriate in order to improve the heat transmission conditions outside the tube. An example of external ribs **4** is shown in FIG. **5.**

The invention may be utilized for all types of heat exchange whereby at least one medium flows through tubes, either for increasing the heat transmission inside the tube, or for maintaining a given transfer of heat in spite of reduced velocity of flow or increased viscosity. With a given flowing medium and given tube dimensions, the invention enables the velocity of flow, and thereby the loss of pressure, to be lowered with maintenance of a given heat transmission, as compared to known heat exchange tubes.

We claim:

1. A heat-exchange element comprising an elongated tube having inner and outer surfaces, internal, longitudinally extending ribs projecting inwardly from the inner surface of said tube and having inner edges, and at least one additional element disposed within said tube for promoting heat exchange, said additional element being constituted by a twisted strip extending longitudinally through the tube and having a principal axis parallel to the longitudinal axis of the tube, said additional element being so dimensioned and disposed in the tube to have longitudinal edges bearing at least at certain points against the inner edges of at least two internal ribs whereby said ribs and strips cooperate to produce flow disturbance of a fluid flowing in the tube to increase heat transmission between said fluid and the wall of the tube.

2. A heat-exchange element as claimed in claim **1** wherein said internal ribs project towards the center of the tube and a single one of said twisted strips is disposed between said inner edges of said ribs.

3. A heat-exchange element as claimed in claim **1,** wherein at least two of said twisted strips are disposed in said tube adjacent to one another and bear against said ribs at said certain points along their lengths.

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