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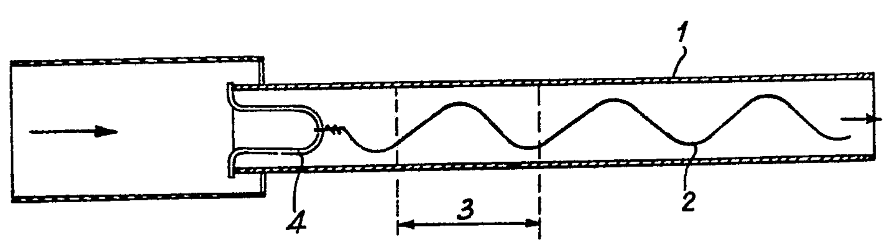
(71) Applicant
Elf France
137 Rue de l'Université
75007 Paris
France
(72) Inventors
Patrick Estienne
Alain Sanson
(74) Agents
Withers & Rogers
4 Dyer's Buildings
Holborn
London EC1N 2JT

(54) A system for cleaning tube-type heat exchangers automatically during operation

(57) A tube assembly through which a fluid is to flow and containing a device for cleaning the tube and/or preventing the accumulation of deposits therein, the device consisting of a helix 2 of a material which is resistant to corrosion and abrasion, which can be constantly agitated and thus repeatedly brought into contact with the internal walls of the tube 1 under the effect of the fluid stream, the helix 2 being held in position against longitudinal movement by a hook 4 disposed at the upstream end of the helix 2 which hook permits rotation of the helix 2 within the tube 1.

Fig. 2



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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Fig:1

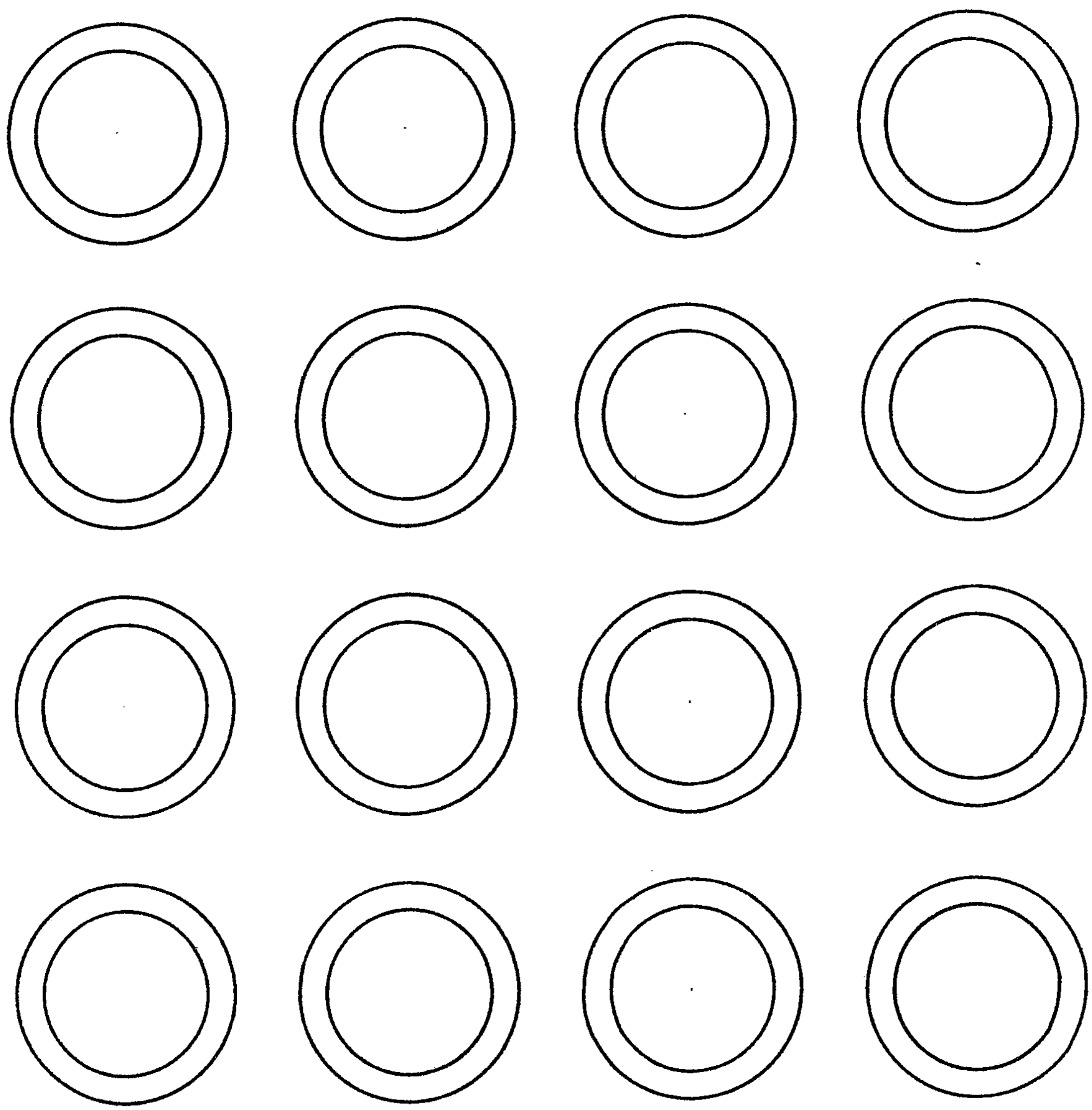


Fig: 2

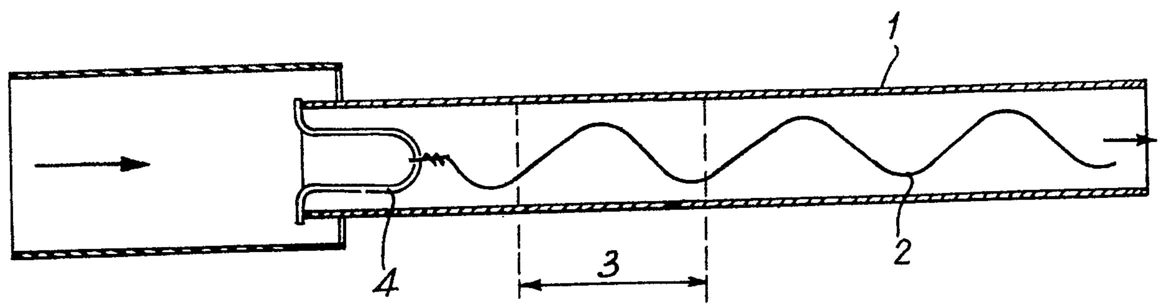
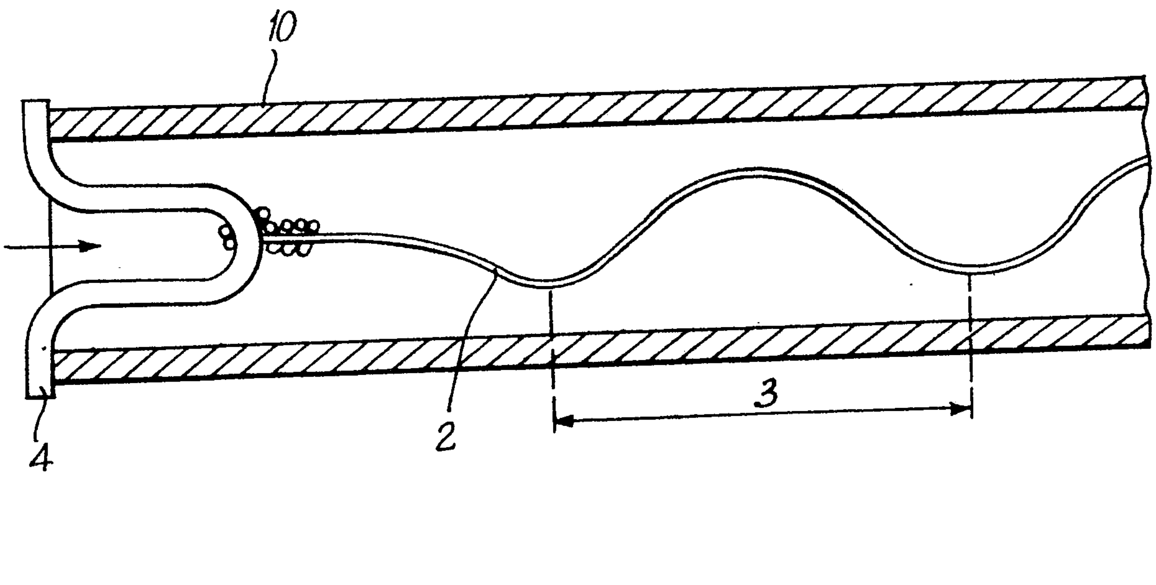


Fig: 3



SPECIFICATION

A system for cleaning tube-type heat exchangers automatically during operation

The accumulation of dirt and the like in a heat exchanger, for example in oil refineries, entails various drawbacks, such as:

—a progressive fall in thermal exchange performance, giving rise to a greater consumption of energy,

—a progressive increase in the loss of pressure, and sometimes a limitation on throughput,

—the necessity of stopping a plant in order to clean one of its exchangers if it is not fitted with a bypass, which involves a production loss which has to be made up and various expenses inherent in all stopping and restarting operations, such as the expense of fuel, flaring, etc.

Investment in the provision of a bypass involves other expenses, e.g. those of installing isolating valves for the bypass and its valve, as well as those related to the loss of heat during the period when the bypassed exchanger is being cleaned.

In any case, the cleaning of the assembly of heat exchanger tubes is laborious and the dirty tubes are sometimes found to be corroded under the deposit of dirt.

The subject of the invention is a simple, relatively inexpensive device for providing permanent automatic cleaning of the inside of tubes when the exchanger is in use. This device is placed in each tube in the apparatus.

According to one aspect of the invention there is provided a tube assembly through which a fluid is to flow and containing a device for cleaning the tube and/or preventing the accumulation of deposits therein, the device consisting of a helix of a material which is resistant to corrosion and abrasion, which can be constantly agitated and thus repeatedly brought into contact with the internal walls of the tubes under the effect of the fluid stream the helix being held in position against longitudinal movement by a hooking means disposed at the upstream end of the helix, which permits rotation of the helix within the tube.

According to another aspect of the invention there is provided a device for installation within a tube through which a fluid is to flow to clean the tube or to prevent the accumulation of deposits within the tube, the device comprising a helix of corrosion and abrasion resistant wire having means enabling it to be attached to the tube to prevent longitudinal movement but to allow rotation, relative to the tube.

According to a first embodiment, a metal wire in an elongated spiral shape, having a specific pitch varying from 1 to 7 times the diameter of the tube and possibly obtained by stretching a helical spring, is threaded by suction, for example, into a slightly longer tube, to allow for the lengthening of the helical wire during use.

The helix is formed from a metal wire with a diameter of from 0.3 to 1 mm which is resistant to corrosion and abrasion, such as a spring wire made of a suitable metal or alloy such as cold-rolled titanium, for example, or any other suitable material. The choice of the characteristics of the helix—its pitch, diameter, elasticity, the diameter of the wire from which the helix is formed, and the construction material—is basically determined by the vibration frequency desired under the operating conditions of the exchanger.

The elongated helix is bounded by an imaginary cylinder with a diameter which is equal to at least half the diameter of the tube, and it is preferably bounded by an imaginary cylinder with a diameter of between 0.50 and 0.90 times the internal diameter of the tube.

The helix is fixed in the tube in a flexible manner by one of its ends, on the upstream side relative to the flow of fluid, via a hooking system which may be of the same kind as the spring, or of a different kind. Thus this hooking system may be an inserted part, such as a metal hook in the shape of a "U" made of the same material as the spring or any other material which is resistant to corrosion and abrasion. Again, it may be formed by the interlocking connection of the ends of two adjacent wires.

Under the effect of a turbulent stream of fluid, the helix is permanently agitated; it regularly strikes and rubs all the points of the internal wall of the tube as it turns, thus providing repeated contact with the internal wall. A variation in the throughput of the conducted fluid brings about a variation in the length of the arrangement and consequently changes the striking and rubbing points on the interior of the tube.

The invention is illustrated by the following drawings and Examples which are given as an indication, but are not limitative.

Figure 1 shows part of a plate in which the heat exchanger tubes are inserted, shown by their cross-section.

Figure 2 shows a section through the layout of the laboratory test arrangement.

Figure 3 is a schematic section through a heat exchanger in a plant.

Example 1

As shown in Fig. 2, the test was carried out in the laboratory on a glass tube 1 with an internal diameter of 15 mm. The helix 2 is formed from a titanium wire with a diameter of 0.5 mm to avoid any risk of corrosion in use. The pitch 3 of the helix is 30 mm.

The diameter of the helix is 11 mm, and it is attached by a hook 4 to the upstream end of the tube.

The fluid chosen is water, so as to enable the behaviour of the stretched spring to be observed in a transparent medium, and it is circulating in the direction indicated by the arrows.

It was thus possible to confirm that at a flow speed of 20 l/minute, analogous to that of the crude oil in the tubes of a specific heat exchanger which regularly becomes soiled, the metal wire is endowed with a permanent agitation motion which brings it into contact with the walls of the tube.

Example 2

An industrial test on a hundred tubes 10 arranged as shown in Fig. 1, with an internal diameter of 15 mm, was carried out with a spiralled titanium wire with a diameter of 0.5 mm. The diameter of the helix was 8 mm, and its pitch was 30 mm. These wires were attached at one end either by a hook or by twisting them together in pairs. The crude petroleum circulates at a flow speed of approximately 0.40 m/sec in the tubes.

After operating for approximately 240 days, some of the tubes equipped with helical wires and some other tubes which were not so equipped were removed.

After having cut a certain number of these tubes in half lengthwise, it was possible to observe that the tubes which were equipped with a helix displayed a clean internal wall, while the other tubes were soiled internally.

Example 3

An industrial test on a complete heat exchanger with 2 sets of tubes with an internal diameter of 15 mm was carried out with helical titanium wire with a wire diameter of 0.6 mm, a helix diameter of 8 mm and pitch of 30 mm. These wires were attached at the end where the petroleum enters, by a hook, also made of titanium. The crude petroleum circulates in the tubes at a flow speed of approximately 0.40 m/sec.

After an operating time of approximately 140 days, the soiling in the tubes of this exchanger was compared with that in an identical exchanger with the same use. The tubes of the exchanger which was not equipped displayed marked internal soiling. A series of comparative measurements of the levels of heat transfer of these two exchangers shows the advantage of the helical device.

It was confirmed that the thermal exchanger equipped with the automatic cleaning device according to the invention maintained its thermal performance, while the exchanger without the arrangement displayed a progressive reduction in its performance, due to progressive soiling.

The device according to the invention therefore makes it possible to avoid the loss of calorific energy and to maintain a maximum and constant level of thermal transfer over a period of time. Another economic advantage is afforded by the fact that the price of supplying and fitting the device is of the same order of magnitude as the cost of cleaning the exchanger, and the investment may be recouped very rapidly by savings in energy and the elimination of cleaning costs.

CLAIMS

1. A tube assembly through which a fluid is to flow and containing a device for cleaning the tube and/or preventing the accumulation of deposits therein, the device consisting of a helix of a material which is resistant to corrosion and abrasion, which can be constantly agitated and thus repeatedly brought into contact with the internal walls of the tube under the effect of the fluid stream, the helix being held in position against longitudinal movement by a hooking means disposed at the upstream end of the helix, which means permits rotation of the helix within the tube.

2. A tube assembly according to Claim 1, wherein the helix is bounded by a notional cylinder with a diameter lying from 50 to 90 percent of the internal diameter of the tube.

3. A tube assembly according to Claim 1, wherein the helix is formed of a metal wire which is resistant to corrosion and abrasion.

4. A tube assembly according to Claim 3, wherein the wire is spring wire of cold-rolled titanium.

5. A tube assembly according to any preceding claim wherein the hooking means is a U-shaped hook.

6. A heat exchanger, including tube assemblies according to any preceding claim.

7. A device for installation within a tube through which a fluid is to flow to clean the tube or to prevent the accumulation of deposits within the tube, the device comprising a helix of corrosion and abrasion resistant wire having means enabling it to be attached to the tube to prevent longitudinal movement but to allow rotation, relative to the tube.

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