United States Patent [19]
Weinhardt et al.

[11] **3,820,596**
[45] **June 28, 1974**

[54] **HEAT TRANSPORTING DEVICE**

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[22] Filed: **Jan. 17, 1972**

[21] Appl. No.: **218,174**

[30] **Foreign Application Priority Data**
Jan. 27, 1971 Netherlands........................ 7101035

[52] **U.S. Cl.**.................................. **165/105,** 267/113
[51] **Int. Cl.**.. **F28d 15/00**
[58] **Field of Search**...................... 165/105; 267/113

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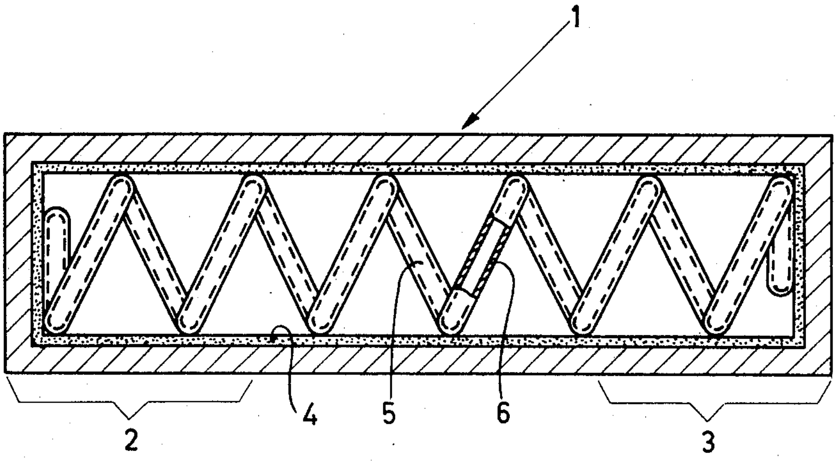
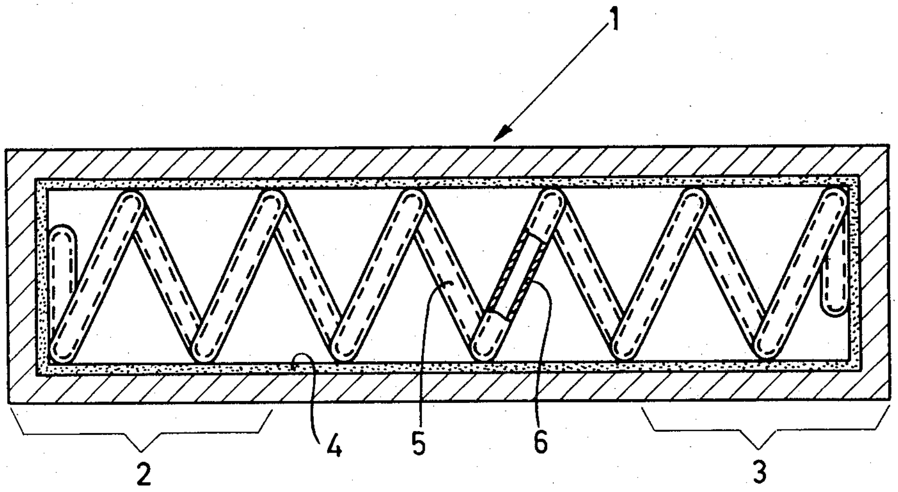
[57] **ABSTRACT**

In a heat pipe device having a porous mass through which heat transporting medium condensate can flow from the condenser to the evaporator by capillary action, this porous mass is kept in its place relative to the container by at least one resilient and hollow element. The cavity within the resilient element forms a closed space in which a filling medium is present, the pressure of which, at least at the operating temperature of the device, is higher than the pressure in the container, whereby the resilient element exerts a force on the porous mass due to both said resiliance and the influence of the pressure differential across these members.

2 Claims, 1 Drawing Figure

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HEAT TRANSPORTING DEVICE

BACKGROUND OF THE INVENTION

The invention relates to a heat transporting device comprising a closed container having at one end at least one first and at the other end at least one second heat transmission wall; the container comprises a heat transporting medium which absorbs thermal energy through the first heat-transmission wall while changing from the liquid phase into the vapor phase, and delivers thermal energy to the second heat transmission wall while changing from the vapor phase into the liquid phase. The container furthermore comprises a porous mass which communicates the first heat transmission wall with the second heat transmission wall in such manner that medium condensed through said mass on the second heat transmission wall can flow back to the first heat transmission wall by capillary action.

Devices of this type are known from the U. S. Pat. Nos. 3,229,759 and 3,402,767. With such devices, large amounts of thermal energy can be transported substantially without drop in temperature and without using a pumping device and without further moving components. Liquid heat transporting medium which evaporates near the first heat transmission wall moves in the vapor phase to the second heat transmission wall as a result of the lower vapor pressure prevailing there as a result of the slightly lower temperature at that area. The vapor then condenses on the second heat transmission wall while delivering the heat of evaporation to said wall, after which the condensate is returned via the porous mass by capillary action, while using the surface stress of the condensate, to the first heat transmission wall to be evaporated there again.

The porous mass ensures that condensate can flow back from the second to the first heat transmission wall in all circumstances, even against gravity or without the use of gravity. Porous masses often consist of ceramic materials, sintered metal powders, a composition of gauzes of wire-shaped or band-shaped material, arrangements of (glass) fibres or pipes or of combinations thereof the porous mass communicating the first heat transmission wall with the second heat transmission wall may cover the surface of the wall of the container entirely or only partly. In the latter case said mass may also be provided inside the container in such manner that it has direct contact only with the two heat transmission walls and is not in contact with the remaining walls of the container.

In order to hold the porous mass inside the container in its place, it is known from FIGS. 4 and 5 of the U. S. Pat. No. 3.503,438 for a container having a rigid wall and from FIG. 6 of "Mechanical Engineering", November, 1968, pp, 48–53 "Applications of the heat-pipe" for a container having a flexible wall, to arrange a helical spring within the container, said spring forcing the porous mass against the wall of the container as a resilient element. Such a construction exhibits several advantages. For example, when the porous mass consists of layers of gauze, said gauzes need not be welded to the wall of the container. Spot-welding on the inside of the container is difficult to perform, particularly in the case of small diameters. Moreover, at the points of welding, the gauze structure is damaged so that no transport of condensate can take place in those places. Furthermore, the helical spring can easily be mounted since it can be laid in curves or can easily be provided (wound) on a core which is provided in the container together with the spring, after which the core is removed.

A problem is, however, that, at the usually high operating temperatures of the heat transporting device, the resilience of the spring decreases under the influence of said high temperatures to such an extent and associated or not associated with plastic elongation, that the force of pressure becomes too low and the porous mass works loose from the wall of the container during operation. As a result of this a capillary structure of the porous mass can be damaged to such an extent that said mass is no longer useful for the return of condensate. The working loose may also result in an entire or partial blocking by the porous mass of the duct through which the transport of medium vapor takes place. The operation of the device is disturbed in both cases and boiling dry and consequently tearing of the heat transmission wall to which thermal energy is supplied may occur. When the porous mass also works loose from the last-mentioned wall, boiling dry may also occur there, because condensate does not reach said wall or, when condensate does reach said wall, because the wall is no longer uniformly wetted by the porous mass.

It is the object of the present invention to provide a heat transporting device in which the said drawback is avoided.

SUMMARY OF THE NEW INVENTION

The heat transporting device according to the invention comprises a closed container in which at least one resilient element is arranged which keeps the porous mass in its place relative to the container by resilience action. The resilient element is internally hollow and the cavity inside the element forms a closed space in which a filling medium is present, the pressure of which, at least at the operating temperature of the device, is higher than the pressure in the container; the resilient element exerts an extra force on the proous mass under the influence of the pressure differential across these for maintaining the place of the said mass within the container.

It is achieved in this manner that during operation of the device, when condensate should be transported through the porous mass, said mass remains in its place which in many cases means it remains pressed against the wall of the container. When the device is not in operation and is at room temperature, the pressure of the filling medium in the resilient element need not always be higher than the pressure which prevails in the container in that case, but it may be equal to or even lower than the pressure in the container. On the one hand the resilience of the resilient element at room temperature will often be sufficient to keep the porous mass in its place, on the other hand it is not always objectionable that the porous mass, for example gauze, is not rigidly pressed at room temperature, because transport of condensate does not take place all the same.

For the rest, the pressure in the container at room temperature is usually low, since the container is often evacuated so that the process of evaporation condensation of the transporting medium can be performed readily. The resilient element need not specially exert a pressure force on the porous mass (compression spring), but it is also possible that said mass is kept in its space in that a pulling force is exerted on it (tension spring). All this depends of course on the arrangement of the porous mass in the container.

In both cases the resilient element should be constructed and arranged, respectively, in such manner that a rise in pressure of the filling medium in the resilient element results in an increase of the compression and pulling force, respectively, on the porous mass. In the case of a helical spring, for example, a rise in pressure of the filling medium herein may result in an increase of the diameter of the spring and a decrease in the length of the spring. The increase in diameter may be used to increase the pressure force exerted on a porous mass, while the decrease in length may be used in the case in which the pulling force on a porous mass should be increased.

As filling media are to be considered all kinds of materials which may be solid, liquid or gaseous at room temperature, provided the vapor and gas pressures, respectively, of said materials, at any rate at the operating temperature of the device and possibly also at room temperature, are higher than the pressure in the container. For example, when sodium is present in a container as a heat transporting medium, which container is otherwise evacuated, potassium or caesium, for example, may be used as a filling medium.

In a favorable embodiment of the device according to the invention, the filling medium is an inert gas. This provides the advantage that, in the case of unexpected leakage of the resilient element, no chemical reactions occur between the heat transporting medium and the filling medium, so that the operation of the device is not disturbed and the device is not damaged.

In order that the invention may be readily carried into effect, one embodiment of the heat transporting device will now be described in greater detail, by way of example, with reference to the accompanying drawing which is not drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference numeral **1** denotes a closed container having at one end a first heat transmission wall **2** and at the other end a second heat transmission wall **3.** A porous mass **4** which has a capillary structure and in this case consists of layers of gauze is provided on the inner wall of the container.

The container comprises a suitably chosen quantity of sodium as a heat transporting medium and is otherwise evacuated. Furthermore, a helical spring **3** is arranged in the container as a resilient element which exerts a special force on the layers of gauze **4** by which said layers are pressed against the wall of the container. The helical spring **3** is internally hollow which is shown in detail in a broken-away part **6.** The cavity inside the spring constitutes a closed space in which a quantity of argon is present as a filling medium.

During operation, liquid sodium absorbs thermal energy through the first heat transmission wall **2** from a heat source, not shown, as a result of which said sodium evaporates. The vapor then flows to the second heat transmission wall **3** as a result of the lower vapor pressure prevailing there owing to the slightly lower temperature at the area and condenses on said wall while supplying the heat of evaporation absorbed near the first heat transmission wall **2.** The condensate flows through the porous mass **4** constructed as layers of gauze by capillary action and while using the surface tension of the condensate it flows back to the first heat transmission wall **2** to be evaporated there again. The return of condensate takes place irrespective of the position of the container so even against gravity or without the use of gravity.

For example, when the operating temperature of the heat transmission device is, for example, 1,100°K, the vapor pressure of the sodium in the evacuated container is 450 Torr (1 Torr = 1 mm mercury pressure). By a suitably chosen quantity of argon in the helical spring **5** it is achieved that at the said high temperature the argon pressure in the spring is higher than 450 Torr, for example 2 atm. When the resilience of the helical spring **5** at the operating temperature of 1,100°K is insufficient to ensure that the layers of gauze **4** remain engaging the walls of the container, the difference in pressure across the helical spring **5** ensures that the spring remains pressed positively against the layers of gauze all the same. Said layers remain engaging the walls of the container so that the problem mentioned in the preamble cannot occur. Should leakage of the helical spring **5** occur, the outflowing argon as an inert gas will not enter into chemical reaction with the sodium. The heat transporting device remains safeguarded against further damage.

What is claimed is:

1. A heat transporting device comprising a closed container having at one end at least one first and at the other end at least one second heat transmission wall, said container comprising a heat transporting medium which absorbs thermal energy through the first heat transmission wall while changing from the liquid phase into the vapor phase and delivers thermal energy to the second heat transmission wall while changing from the vapor phase into the liquid phase, the container comprising a porous mass which communicates the first heat transmission wall with the second heat transmission wall in such manner that medium condensed through said mass on the second heat transmission wall can flow back by capillary action to the first heat transmission wall, at least one resilient element being furthermore arranged in the container and keeping the porous mass in its place relative to the container by resilience action, characterized in that the resilient element is internally hollow and the cavity inside the element forms a closed space in which a filling medium is present the pressure of which, at least at the operating temperature of the device, is higher than the pressure in the container and the resilient elements exerts an extra force on the porous mass under the influence of the pressure differential across these for maintaining the place of the said mass within the container.

2. A heat transporting device as claimed in claim **1,** characterized in that the filling medium is an inert gas.

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