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(54) CAPILLARY PUMPED DIPHASIC FLUID LOOP PASSIVE THERMAL CONTROL DEVICE WITH THERMAL CAPACITOR

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(57) **ABSTRACT**

The thermal control device comprises at least one capillary pumped diphasic fluid loop, comprising, in a known manner, an evaporator extracting the heat from a so-called hot source and connected via a vapour pipe to a condenser in which the condensation of the fluid vapour releases thermal energy transmitted to a so-called cold source, the condenser being connected via a liquid pipe to the evaporator, and the device moreover comprises at least one thermal capacitor in permanent heat exchange relationship with liquid phase fluid in said at least one diphasic fluid loop. Use in particular with space vehicles such as satellites.

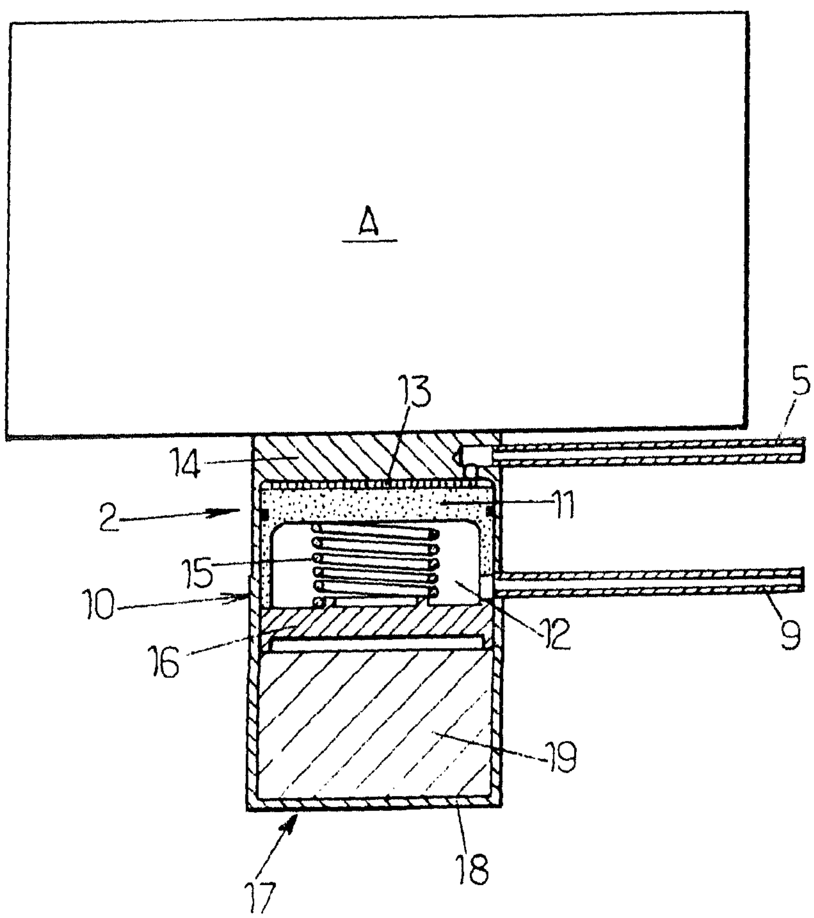
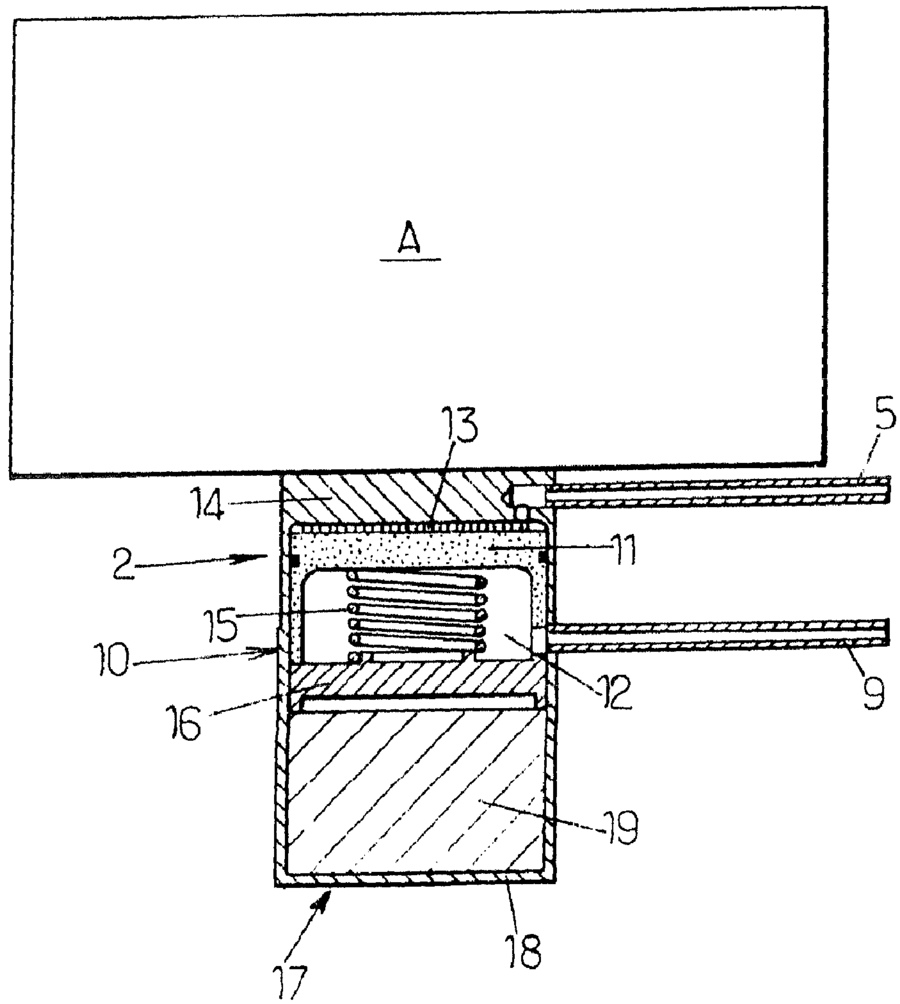


FIG.1.



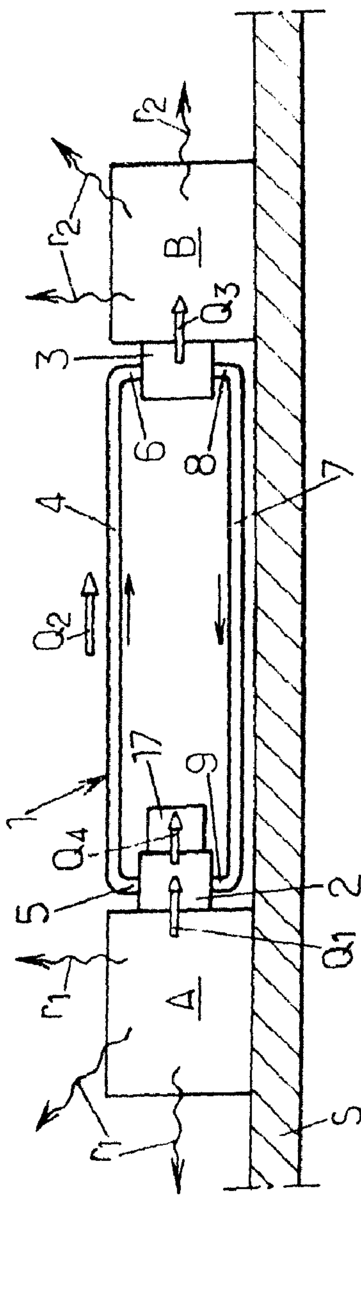


FIG.2a.

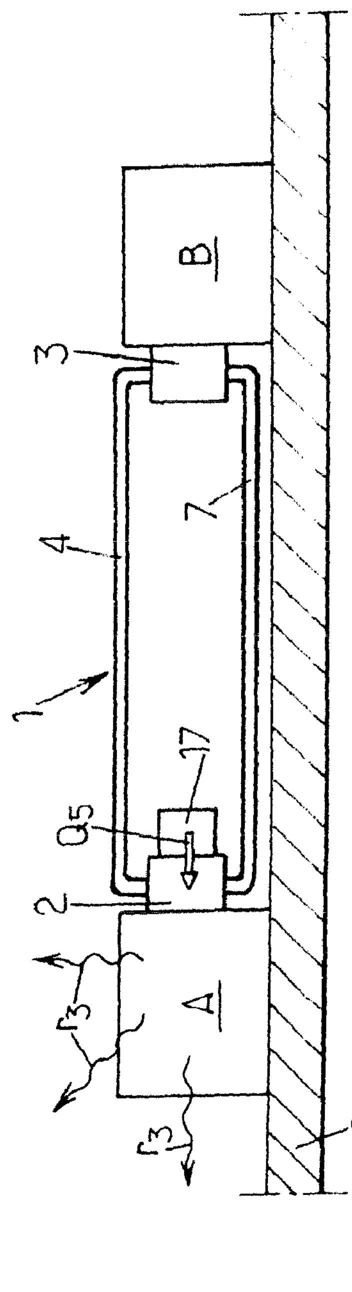


FIG.2b.

CAPILLARY PUMPED DIPHASIC FLUID LOOP PASSIVE THERMAL CONTROL DEVICE WITH THERMAL CAPACITOR

[0001] The present invention relates to a purely passive thermal control device, based on at least one fluid circulation heat transfer loop used for cooling sources dissipating thermal energy.

[0002] More specifically, the invention relates to a closed circuit fluid coolant circulation thermal control device, capable of transferring heat from at least one so-called hot source to at least one so-called cold source, and comprising at least one capillary pumped diphasic fluid loop.

[0003] According to the state of the art, such a loop, commonly known as a LHP (Loop Heat Pipe) is a heat transfer loop that comprises an evaporator, intended to be placed in heat exchange relationship with at least one so-called hot source, in order to extract heat from said hot source, and which is supplied, through a microporous mass connected to a reserve of diphasic fluid in liquid state, with liquid diphasic fluid intended to be vaporised in the evaporator. The evaporator is connected by a vapour pipe to a condenser, intended to be placed in heat exchange relationship with at least one so-called cold source, and thus intended to release the heat extracted from the hot source to the so-called cold source, to which the heat is transmitted by the condensation in the condenser of vapour phase fluid to liquid phase fluid, which is returned to the evaporator by a liquid pipe connecting the condenser to the evaporator.

[0004] Thus, the evaporator and the condenser are connected by looped piping in which a diphasic fluid circulates in a liquid state in the cold part of the loop or liquid pipe, and in a gaseous state in the hot part of the loop, or vapour pipe.

[0005] In this type of loop, the fluid is pumped by capillarity (capillary loop), by means of the microporous mass connected to the liquid state fluid reserve and ensures pumping of the liquid fluid into the evaporator by capillarity. Thus, the liquid fluid present in the evaporator reserve evaporates on contact with the hot source, and the gas thus created is discharged to the condenser, in heat exchange relationship with the cold source, and in which the gas condenses and returns in a liquid state to the evaporator to create a heat transfer cycle.

[0006] In such a loop, capillarity is used as the driving pressure, and the liquid-vapour phase change is used as a means of transporting energy.

[0007] The liquid fluid reserve, situated close to the hot source, generally on the rear face of the evaporator, is used to supply the loop with liquid according to the operating temperature or operating power.

[0008] One limitation of this type of capillary evaporator heat transfer loop arises from the fact that, when the external conditions significantly reduce the temperature of the cold source, or the temperature of the hot source, or both temperatures at once, without the temperature of the hot source becoming lower than the temperature of the cold source, the operation of such a loop according to the state of the art results in, in all cases, a further reduction of the temperature of the hot source, possibly below its normal operating range. In this case, and as is known in the state of the art, heaters are used to control the temperature of the hot source or the cold source, such heaters being installed in most cases in contact with said sources or on the wall of a tank associated with the evaporator containing the liquid diphasic fluid reserve. However, the use of heaters has the drawback of consuming electricity, which is always available in limited quantities and at very high cost on board space vehicles, in particular satellites. In some cases, furthermore, the use of heaters requires active control by temperature sensors, installed in particular on the aforementioned sources or the aforementioned tank, as well as a unit to control the heaters and process the signals from the temperature sensors, which makes the thermal control device more complex and more costly.

[0009] The aim of the present invention is to overcome these limitations, and to propose a capillary pumped diphasic fluid loop thermal control device of the type set out above, that better meets the various practical demands than the devices known in the state of the art and, in particular, provides other advantages, which will become apparent from the description below.

[0010] The idea behind the invention is based on the addition, to at least one loop as set out above, of at least one thermal capacitor which, during nominal operation of the thermal control device, when said loop receives thermal power to transport, accumulates heat by means of a thermal flux passing from the hot source through the liquid state diphasic fluid present in or near the evaporator, whilst the loop, in nominal operation, discharges the majority of the thermal power it receives to the condenser and the cold source, and which, when the thermal power to be dissipated decreases or reaches zero, or the temperature of the cold source decreases, releases thermal energy to the loop, in such a way that it is possible to control, or even stop, the operation of said loop, in a completely passive manner.

[0011] To this end, the invention proposes a thermal control device of the type set out above, comprising at least one capillary pumped diphasic fluid loop as also set out above, and which is characterised in that it also comprises at least one thermal capacitor, in permanent heat exchange relationship with liquid phase fluid in said at least one diphasic fluid loop.

[0012] In a first embodiment, said at least one thermal capacitor can comprise at least one thermal inertia mass, preferably large, in order to store substantial thermal power during nominal operation of the device, when the loop receives thermal power to transport, and in order to be able to release this stored thermal power to the loop, when the thermal power to be dissipated decreases or reaches zero, or when the temperature of the cold source decreases.

[0013] Such a device can also advantageously be used to store the energy dissipated in the inertia mass when the so-called cold source is temporarily hotter than the so-called hot source, and to release this energy when the so-called cold source once again becomes colder than the so-called hot source. The device thus allows for the so-called hot source to be kept at a temperature hotter than the average temperature of the environment, but colder than the extreme temperatures of the environment.

[0014] However, advantageously, and according to a second embodiment, said at least one thermal capacitor comprises at least one mass of at least one phase change material. In this case, the phase change material has, by absorption of the latent phase change heat, a large thermal storage capacity that improves the control capability of the thermal control device.

[0015] At least one phase change material can also be a liquid-gas phase change diphasic fluid, such diphasic fluid being able to be identical to the fluid in said at least one diphasic fluid loop of the control device, or different from the diphasic fluid in such loop. Advantageously however, at least one phase change material is a solid-liquid phase change material, which facilitates the production of the additional thermal capacitor and its incorporation into the evaporator on the diphasic fluid loop, and which also offers the advantage of facilitating the selection of the phase change material(s) of the additional thermal capacitor(s) to adjust the operating range of the corresponding diphasic fluid loop and the hot source.

[0016] Another advantage is that the phase change material (s) of the thermal capacitor(s) can be selected in such a way that the control device operates as a thermal switch, stopping the operation of said at least one diphasic fluid loop under given temperature conditions of the cold source and/or the hot source.

[0017] In any event, the thermal control device according to the invention allows for heat transfer between the thermal capacitor(s) and the liquid fluid reserve of said at least one diphasic fluid transfer loop, said at least one thermal capacitor being in heat exchange relationship principally with at least part of the liquid pipe of said at least one diphasic fluid loop, or, advantageously, said at least one thermal capacitor being in heat exchange relationship principally with said liquid fluid reserve of said at least one diphasic fluid loop.

[0018] This heat transfer between the thermal capacitor and the liquid fluid reserve of the transfer loop, either in the evaporator or in the liquid circulation piping, can take place directly, by conduction, in which case it is advantageous that said at least one thermal capacitor is in direct contact with the evaporator of said at least one diphasic fluid loop.

[0019] However, this heat transfer can also take place indirectly, in such a way that the thermal capacitor is remote from the liquid fluid reserve of the evaporator, in which case said thermal capacitor is in heat exchange relationship with said evaporator through at least one heat pipe and/or at least one intermediate heat transfer loop.

[0020] According to an embodiment that is advantageously simple to implement, said at least one thermal capacitor is fixed to or in a housing of said evaporator, which contains said liquid fluid reserve and said microporous mass of said at least one diphasic fluid loop, and close to a liquid fluid intake, originating from said corresponding liquid pipe, into said housing, on the side of the housing opposite a hot face of said evaporator, forming an interface with said hot source or intermediate heat transfer loop or with said heat pipe, and close to a vapour fluid outlet into said corresponding vapour pipe.

[0021] Advantageously in this case, to improve the cooperation between the evaporator and the microporous mass, at least one spring, preferably helical, pushing against a base of said housing adjacent to said thermal capacitor to push back said microporous mass towards said hot face of said evaporator, is arranged in said liquid fluid reserve.

[0022] To facilitate the production of the diphasic fluid loop, said housing of said evaporator is advantageously equipped with a liquid fluid intake tube originating from said liquid pipe and a vapour fluid outlet tube to said vapour pipe, and contains said microporous mass separating, in said housing, a fluid liquid reserve space, which communicates with said intake tube, from an evaporation space, which communicates with said outlet tube, and enclosed by said hot face arranged as a heat conducting interface plate with said hot source to be cooled.

[0023] Thus, during the operation of said at least one diphasic fluid loop of the thermal control device according to the invention, said at least one associated thermal capacitor will store some of the energy provided by the hot source, beyond a certain temperature (evaporating or melting temperature) when advantageously a phase change material (liquid-vapour or solid-liquid respectively) acts as a thermal capacitor. In the event that the temperature of the hot source drops, possibly below a temperature threshold (condensing or solidification temperature) if a phase change material (liquid-gas or solid-liquid respectively) acts as a thermal capacitor, this thermal capacitor returns all or part of the thermal energy stored to the fluid reserve with which it is in heat exchange relationship. A first effect is that the liquid diphasic fluid circulating in the loop or contained in the evaporator of this loop is thus heated. A second effect is that the thermal performance of the transfer loop, which is very sensitive to the temperature of the fluid in liquid state, is reduced in a completely passive manner. Such a diphasic fluid loop transports almost all of the thermal energy by phase change of the fluid, and requires in order to operate a few kilogram calories to keep the fluid circulating from the condenser to the evaporator in a liquid state. The heating of this liquid, according to the invention, by at least one additional thermal capacitor, allows for the heat transfer performance of the loop to be very significantly altered, and the loop thus operates as a thermal controller (non-zero thermal performance, low transfer) or even as a thermal switch (zero thermal performance, no transfer).

[0024] The thermal control device according to the invention is appropriate for a number of applications. Particular mention can be made of applications on board spacecraft, when such a spacecraft is subject to large thermal variations in its operating range, for example between phases in which it is directly lit by the sun, and phases of eclipse or in which it is no longer directly exposed to solar radiation.

[0025] On this type of spacecraft, the thermal power of the on-board dissipating equipment, in particular the electronic equipment, is dissipated, as known in the state of the art, by radiation by means of radiators in contact with the cold space, the size of these radiators being defined by the hot thermal environment of the spacecraft. In eclipse phase, for cold situations, and according to the state of the art, the radiators or dissipating equipment can be heated by means of heaters.

[0026] A further subject of the invention is therefore the application of a thermal control device specific to the invention, and as defined above, to the temperature control of a hot source, comprising at least one item of dissipating equipment on a spaceship, such as a satellite, with heat transfer to a cold source that is a heat sink comprising at least one radiator of said spaceship.

[0027] Further characteristics and advantages of the invention will become apparent from the non-limitative description given below of an embodiment described with reference to the attached drawings, in which:

[0028] FIG. **1** is a partial view, part cross-section and part side elevation, of a thermal control device according to the invention, in the end part of its capillary pumped diphasic fluid loop which comprises the evaporator and a thermal capacitor specific to the invention,

[0029] FIG. **2***a* is a diagrammatic side elevation view of the thermal control device partly shown in FIG. **1**, connecting a hot source to a cold source, to explain the operating principle of the diphasic fluid loop of the device, in the configuration in which the hot source is to be cooled, and

[0030] FIG. **2***b* is an analogous view to FIG. **2***a* to explain the operating principle of said loop when it is stopped.

[0031] The example of a purely passive thermal control device (or thermal controller) shown in FIGS. **1** to **2***b* comprises a single capillary pumped diphasic fluid loop, labelled **1** as a whole, inserted as a coolant circulation heat transfer loop between a so-called hot source A to be cooled, for example an item of heat dissipating electronic equipment on board a satellite, and a so-called cold source B, in this example a radiator supported on an external face of the satellite, the carrying structure of which is diagrammatically labelled S.

[0032] The loop **1** essentially comprises, at its two ends, an evaporator labelled **2** as a whole, which extracts heat from the dissipating equipment A during operation, and a condenser **3** that releases the heat to the radiator B. The loop **1** also comprises a first fluid pipe **4** connecting the outlet **5** of the evaporator **2** to the intake **6** of the condenser **3**, and through which the evaporator **2** supplies the condenser **3** with vapour phase diphasic fluid (for example ammonia with the formula NH_3), for which reason the pipe **4** is known as the vapour pipe, and a second fluid pipe **7** connecting the outlet **8** of the condenser **3** to the intake **9** of the evaporator **2**, through which the condenser **3** supplies the evaporator **2** with liquid phase diphasic fluid, for which reason the pipe **7** is known as the liquid pipe.

[0033] The evaporator **2** is able to absorb heat extracted from the dissipating equipment A by evaporation of the diphasic fluid circulating in the loop **1**, the gaseous fluid leaving the evaporator **2** being transferred by the vapour pipe **4** to the condenser **3**, which is able to release and discharge the heat to the radiator B by condensation of the vaporised fluid, the fluid in liquid state then returning by the liquid pipe **7** to the evaporator **2**, in such a way as to thus form a fluid heat transfer loop.

[0034] As shown in FIG. **1**, the evaporator **2** comprises a metal housing **10**, equipped with a liquid fluid intake tube **9** originating from the liquid pipe **7**, and a vapour fluid outlet pipe **5** to the vapour pipe **4**, and the housing **10** contains a microporous mass **11** that separates, inside the housing **10**, a liquid fluid reserve space **12** into which the intake tube **9** opens, from an evaporation space **13**, which communicates with the outlet tube **5**, and which is enclosed, on the opposite side to the microporous mass **11**, by a hot face **14** of the evaporator **2**, this hot face being kept a small distance away from the mass **11** by a mesh structure forming a spacer, and made up of a thick heat-conducting plate closing the housing **10** at one end and forming an interface plate with the dissipating equipment A to be cooled during operation, and by which plate **14** the evaporator **2** is held fixed against this equipment A.

[0035] The microporous mass **11** thus ensures the capillary pumping of the liquid fluid from the reserve **12** to the evaporation space **13**, in which the liquid fluid thus pumped is vaporised by the heat extracted from the dissipating equipment A through the hot face **14**, and the vaporised fluid escapes through the outlet tube **5** to the vapour pipe **4** and the condenser **3**, where it condenses and returns through the liquid pipe **7** to the evaporator **2** to create a heat transfer cycle.

[0036] To enhance the capillary pumping carried out by the microporous mass **11**, the latter is elastically pushed back into the housing **10** towards the conducting plate of the hot face **14** by a spring **15**, for example helical, arranged in the liquid fluid reserve **12** space, and held at one end against the microporous mass **11** by pushing, with its other end, against a base **16** enclosing the liquid fluid reserve **12** and made from a good heat-conducting metal or metal alloy.

[0037] According to the invention, a thermal capacitor **17** is associated with the loop **1** in such a way that it is in permanent heat exchange relationship with the liquid fluid in the reserve **12**.

[0038] This is advantageously obtained, as shown in FIG. **1**, by fixing the thermal capacitor **17** in direct contact with the evaporator **2**, in such a way that the heat exchange relationship between the liquid fluid in the reserve **12** and the thermal capacitor **17** takes place by conduction.

[0039] However, as a variant, the thermal capacitor **17** can be offset relative to the evaporator **2**, in which case the thermal capacitor **17** can be fixed in permanent heat exchange relationship with part of the liquid pipe **7**, and preferably with the intake tube **9**, which contains fluid in liquid state, or thermally coupled to the evaporator **2** by at least one heat pipe or at least one intermediate heat transfer loop.

[0040] In both cases, the thermal capacitor **17** can be made up of a large thermal inertia mass (metal block with good thermal conductivity) fixed for example to the base **16** of the liquid fluid reserve **12**, or mounted in the housing **10** of the evaporator **2**.

[0041] In the preferred embodiment, the thermal capacitor **17** comprises a tank **18**, which is fixed under the base **16** and/or to the housing **10**, continuing on from the latter, of the evaporator **2**, and contains a mass of a phase change material **19**, which can be a similar, or even identical, diphasic fluid to the fluid in the loop **1**, but which is preferably a solid-liquid phase change material **19**. The heat transfers between the thermal capacitor **17** and the liquid fluid reserve **12** are thus made possible directly by conduction through the base **16** and the housing **10**.

[0042] Inevitably, there is a parasitic, but small, thermal link between the hot source A (dissipating equipment) and the thermal capacitor **17**.

[0043] By arranging a phase change material **19** (either solid-liquid, through use of a paraffin for example, or a liquid-gas phase change material) as a thermal storage capacitor by absorption of the latent phase change heat, at the rear face of the evaporator **2**, that is, on the other side of the base **16** of the housing **10** relative to the liquid fluid reserve **12**, it is possible to use this thermal capacitor **17** to alter the performance when the loop **1** dissipates power, as shown in FIG. **2***a*. In this case, the dissipating equipment A radiates heat (radiation r**1**) and transfers a principal thermal flux Q**1** to the evaporator **2**, from where a thermal flux Q**2** is transferred by the fluid vaporised by the evaporator **2** and circulating in the vapour pipe **4** to the condenser **3**, transferring a thermal flux Q**3** to the radiator B, which radiates this heat into cold space (radiation r**2**) whilst a thermal flux Q**4** is transferred by the liquid fluid reserve **12** from the evaporator **2** to the thermal capacitor **17**. Thus, during nominal operation, when the loop **1** receives thermal power to transport to the condenser **3**, the phase change material **19** accumulates heat, by liquefaction or vaporisation of the material, due to the thermal flux Q**4** that passes through the evaporator **2**, whilst the loop **1**, which is in nominal operation, discharges the majority of the thermal power through the flux Q**2** to the evaporator **3** and the cold source B.

[0044] On the other hand, if the loop **1** is no longer operating to transport power, as described above with reference to FIG. **2***a*, but in temperature gradient mode (see FIG. **2***b*), that is, when the thermal power to be dissipated by the equipment A decreases until it reaches zero, or the temperature of the cold source B drops, tests have shown that it is sufficient to keep the liquid fluid reserve **12** of the evaporator **2** hotter than the hot face **14** of this evaporator **2**, in order to completely cancel out the operation of the loop **1**. This is obtained by the fact that the phase change material **19** releases thermal energy through the flux Q**5** to the liquid fluid reserve **12** of the evaporator **2**, by condensation or solidification of the phase change material **19**, so that by this means, it is possible to control and even stop the operation of the capillary pumped diphasic fluid loop **1**, in a completely passive manner.

[0045] In this case, no thermal flux is transported by the loop **1**, and the evaporator **2** heats the equipment A that radiates towards the inside of the satellite (radiation r_3).

[0046] A thermal switch is thus created with appropriate sizing of the thermal capacitor **17** (by adjustment of the mass (and nature) of the phase change material **19**) and it is thus possible to regulate/control the loop **1** over a very long period, all the more because the heat accumulation of the phase change material **19** of a thermal capacitor **17** mounted directly on the liquid fluid reserve **12** of a loop **1** is much faster than its thermal energy release.

[0047] To restart the loop **1**, all that is required is either to restart the operation of the dissipating equipment A, so that there is thermal power to be dissipated again, or for the temperature of the cold source B to increase again.

[0048] The use of a capillary transfer loop **1** the evaporator **2** of which is fitted with a thermal capacitor **17** based on the use of a phase change material **19** according to the invention allows, on the one hand, for efficient transfer of the thermal energy from the equipment A to the radiator B when the temperature of the equipment A is greater than the melting temperature of the material **19**, in the case of a solid-liquid phase change material **19**, whilst also heating the thermal capacitor **17** by means of the parasitic thermal flux passing through the evaporator **2**. When the temperature of the equipment A drops below a certain threshold, defined by the solidification temperature of the phase change material **19**, the thermal capacitor **17** releases heat to the liquid reserve **12** of the capillary loop **1**, which has the effect of heating the cold liquid coming from the condenser **3**, and reducing the thermal performance of the transfer loop **1**, in such a way that the equipment A will be kept passively within a limited temperature range preventing efficient heat transfer from the equipment A to the radiator B during this phase.

[0049] Mention can also be made of the application of the device to the passive temperature control of equipment A with variable heat dissipation (the cold source B being at a temperature assumed to be approximately constant). In this case, the use of the device according to the invention allows in the same way for the temperature variation range of the equipment A to be significantly reduced, in a completely passive manner. In this case, the thermal capacitor **17** absorbs some of the excess high-power energy, thus allowing for good heat transfer with the cold source B (strong coupling), and releases this energy to the liquid circulating to the low-power evaporator **2**, allowing for low heat transfer to the condenser **3**, and thus the low-power radiator B (weak coupling).

[0050] In a very general application, the device according to the invention is applied to a system subject to operating and environmental constraints such that, at the same time, the dissipation of the hot source A and the external thermal flux received by the cold source B vary. In all cases, the use of the device according to the invention allows for the passive limitation of the temperature excursions of the hot source A, by filtering the thermal interference of each end of the transfer loop, at the evaporator **2** and the condenser **3**.

[0051] In all of these examples of applications, it must be noted that the thermal control takes place in a completely passive manner, without the use of a thermistor, thermostat, heater, data acquisition and processing equipment, or any type of active or semi-active thermal control system using one or more of these elements.

[0052] Generally, it is possible to alter the behaviour of this thermal controller, by thermally insulating the thermal capacitor **17** from the environment and the transfer loop **1** to a greater or lesser extent, or through the selection of the phase change material **19**. The controller can thus be adjusted according to the operating temperature range.

1. A closed circuit fluid coolant circulation thermal control device, capable of transferring heat from at least one so-called hot source to at least one so-called cold source, and comprising at least one capillary pumped diphasic fluid loop, which comprises an evaporator, intended to be placed in heat exchange relationship with said at least one hot source and supplied, through a microporous mass, connected to a liquid state diphasic fluid reserve, with liquid diphasic fluid intended to be vaporized in the said evaporator, connected by a vapour pipe to a condenser, intended to be placed in heat exchange relationship with said at least one cold source, to which heat is transmitted by the condensation in said condenser of vapour phase fluid into liquid phase fluid, which is returned to said evaporator by a liquid pipe connecting said condenser to said evaporator, wherein the device also comprises at least one thermal capacitor, in permanent heat exchange relationship with liquid phase fluid in said at least one diphasic fluid loop.

2. The thermal control device according to claim **1**, wherein said at least one thermal capacitor comprises at least one thermal inertia mass.

3. The thermal control device according to claim **1** wherein said at least one thermal capacitor comprises at least one mass of at least one phase change material.

4. The thermal control device according to claim **3**, wherein said at least one phase change material is a liquid-gas phase change diphasic fluid.

5. The thermal control device according to claim **3**, wherein said at least one phase change material is a solid-liquid phase change material.

6. The thermal control device according to claim **3** wherein said at least one phase change material is selected to adjust an operating range of said at least one diphasic fluid loop and said hot source.

7. The thermal control device according to claim **3** wherein said at least one phase change material is selected so that the control device operates as a thermal switch, stopping the operation of said at least one diphasic fluid loop under given temperature conditions of at least one of said cold source and hot source.

8. The thermal control device according to claim **1** wherein said at least one thermal capacitor is in heat exchange relationship principally with at least a part of said liquid pipe of said at least one diphasic fluid loop.

9. The thermal control device according to claim **1** wherein said at least one thermal capacitor is in heat exchange relationship principally with said liquid fluid reserve of said at least one diphasic fluid loop.

10. The thermal control device according to claim **9**, wherein said at least one thermal capacitor is in direct contact with said evaporator of said at least one diphasic fluid loop.

11. The thermal control device according to claim **9**, wherein said at least one thermal capacitor is remote relative to said evaporator of said at least one diphasic fluid loop, and in heat exchange relationship with said evaporator by means of at least one of a heat pipe and an intermediate heat transfer loop.

12. The thermal control device according to claim **1** wherein said at least one thermal capacitor is fixed to or in a housing of said evaporator, which contains said liquid fluid reserve and said microporous mass of said at least one diphasic fluid loop, and close to a liquid fluid intake, originating from said corresponding liquid pipe, in said housing, on a side of said housing opposite a hot face of said evaporator, forming an interface with one of said hot source an intermediate heat transfer loop and a heat pipe, and close to a vapour fluid outlet communicating with said corresponding vapour pipe.

13. The thermal control device according to claim **12**, wherein at least one spring, for example helical, pushes against a base of said housing adjacent to said thermal capacitor to push back said microporous mass towards said hot face of said evaporator said spring being arranged in said liquid fluid reserve.

14. The thermal control device according to claim **12** wherein said housing of said evaporator is equipped with a liquid fluid intake tube originating from said liquid pipe and a vapour fluid outlet tube communicating with said vapour pipe, and contains said microporous mass separating, in said housing, a fluid liquid reserve space, which communicates with said intake tube, from an evaporation space, which communicates with said outlet tube, and which is enclosed by said hot face arranged as a heat conducting interface plate with said hot source to be cooled.

15. The thermal control device according to claim **1** for the temperature control of said hot source comprising at least one piece of dissipating equipment on a spaceship, with heat transfer to said cold source that is a heat sink comprising at least one radiator of said spaceship.

16. The thermal control device according to claim **4**, wherein said liquid-gas phase change diphasic fluid is identical to the fluid in said at least one diphasic fluid loop.

17. The thermal control device according to claim **4**, wherein said liquid-gas phase change diphasic fluid is different from the diphasic fluid in said loop.

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