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NASA TECH BRIEF

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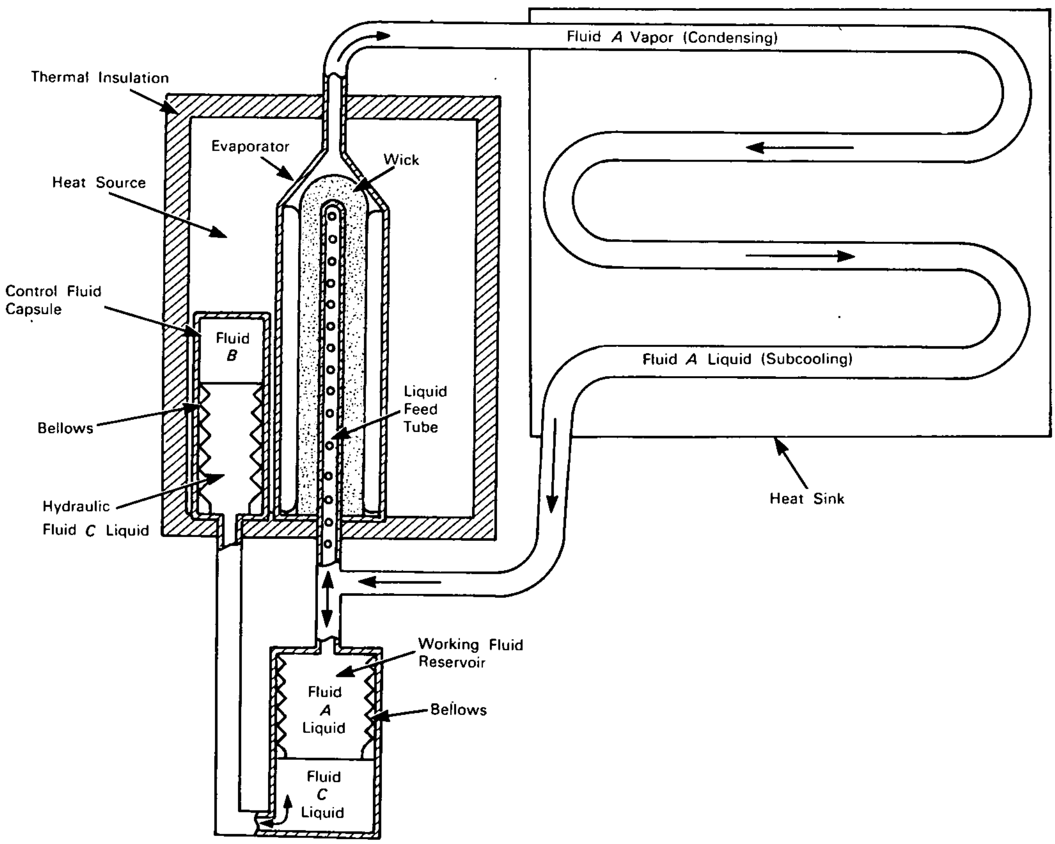
Closed Fluid System Without Moving Parts Controls Temperature



The problem: To provide a reliable, lightweight system that will maintain a constant temperature in an insulated region, without requiring the use of mechanical pumps, thermostatic control valves, sliding or rotating seals, or a source of electrical power.

The solution: A closed fluid system in which the energy for thermodynamic cycling of two-phase heat transfer fluids and a hydraulic (one-phase) fluid is entirely supplied by the heat generated in a thermally insulated region to be maintained at a constant temperature.

How it's done: The system incorporates a capillary pumped heat transfer loop containing (1) a fluid reservoir with a bellows (expandable bladder) to separate working fluid *A* from hydraulic fluid *C*, and

(continued overleaf)

(2) a control fluid *B* capsule with a bellows to separate fluid *B* from fluid *C*. The evaporator portion of the capillary pumped heat transfer loop (containing wick material) is enclosed in the insulated region to be maintained at constant temperature.

The curve representing a plot of the saturated vapor pressure of fluid *A* versus temperature must have a sharper slope than the corresponding curve for fluid *B*. The control-temperature band of this system will then lie within a few degrees above the crossover temperature (the point of intersection between the saturated vapor pressure/temperature curves of fluids *A* and *B*). Water and one of the halogenated hydrocarbons are examples of fluids which have crossover characteristics required of fluids *A* and *B*, respectively. The hydraulic fluid *C* transfers the volume changes between fluids *A* and *B* and must have a relatively low vapor pressure in the vicinity of the crossover point.

In operation of the system, the evaporator absorbs heat generated in the insulated region and vaporizes fluid *A* from the surface of the evaporator wick. The resultant vapor passes into an external condenser where it gives up its latent heat to the surrounding heat sink. The condensate (fluid *A* liquid) flows from the condenser into the inner feed tube of the evaporator and is pumped by capillary action to the surface of the wick, from which it evaporates to begin a new heat transfer cycle.

Under the conditions of dynamic equilibrium within the system, the pressure of the fluid at the junction of the fluid *A* reservoir and the liquid feed tube will tend to be equal to the pressure in the fluid *B* capsule, and the temperature of this capsule will approach the temperature of the evaporator walls. These pressure and temperature requirements can be simultaneously satisfied only when the temperature of the evaporator and fluid *B* capsule is a few degrees above the crossover temperature. The system will automatically seek and maintain a temperature (within the temperature-control band at the crossover point) that will satisfy both the dynamic heat rejection and internal pressure requirements.

Notes:

1. The bellows used to separate the fluids and provide for volume changes must have a negligible pressure resistance to volume change.
2. The control fluid may be a mixture of two or more fluids (used in conjunction with appropriate working and hydraulic fluids) to permit the system to adjust to any desired operating temperature within a wide range of temperatures.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
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   Reference: B65-10331

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546

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