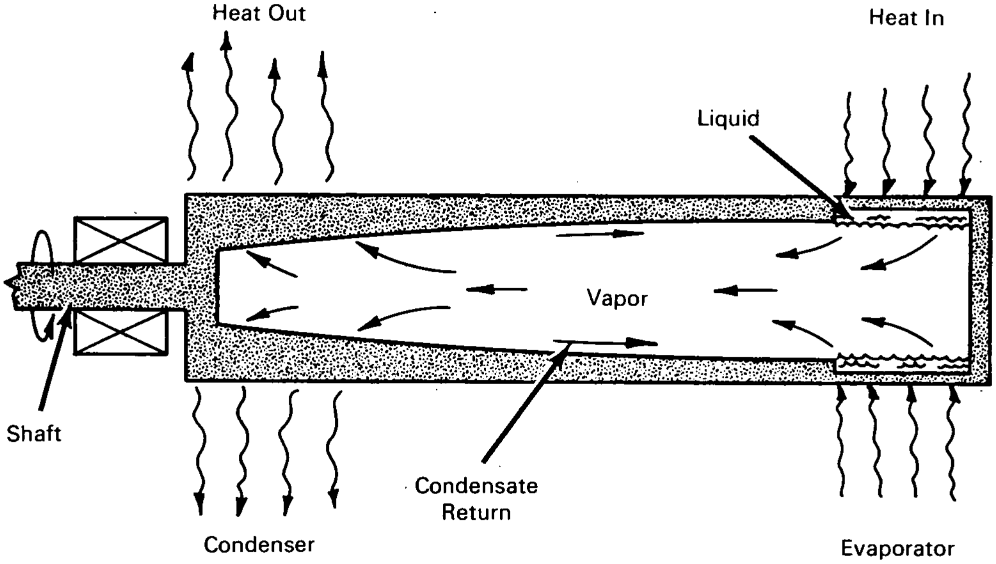
NASA TECH BRIEF

A Rotating, Noncapillary Heat Pipe



Schematic Diagram of Rotating Heat Pipe

The problem:

To utilize rotational accelerations for transferring heat very rapidly and efficiently.

The solution:

A hollow shaft that operates like a heat pipe, with a small, sealed-in inventory of fluid that transfers heat by vaporizing at the hot end and condensing at the cold end. Whereas present heat pipes use capillaries to pump the condensed fluid back to the evaporator end, this rotating heat pipe pumps with centrifugal forces. Consequently, the rotating heat pipe overcomes the limitations of capillary heat pipes, specifically, their relatively low levels of heat flux and their poor performance when pumping against gravity. These shortcomings result from the very low pressure heads that can be generated in capillaries by liquid surface-tension forces. The rotating heat pipe, however, makes use of large centrifugal forces for pumping the condensate, and also utilizes rotation to forcibly separate vapor from liquid in the evaporator and the condenser regions. These capabilities improve the overall thermal efficiency.

How it's done:

The hollow shaft has a slight internal taper from one end to the other. The heated end (evaporator) has the larger inside diameter, and the cooled end (condenser) is slightly smaller in inside diameter. The liquid inventory rotates with the heat pipe and collects as an annulus at the larger end. Heat transferred through the wall evaporates or boils some of the liquid, gene-

(continued overleaf)

rating vapor that flows toward the center of rotation and axially toward the cooled end of the heat pipe. Here, the vapor condenses on the cooled walls and the liquid condensate is centrifuged back to the evaporator end along the diverging inside walls. Heat is thereby transferred from end to end by virtue of the heat of vaporization with very small overall temperature drop. Heat fluxes are attainable in order of magnitude greater than in comparable capillary heat pipes.

Notes:

1. The principles of the rotating heat pipe can be applied to a variety of shapes other than hollow shafts, such as hollow discs, toroids and cylinders with concave ends.
2. Applications abound for both internal heating and cooling of rotating parts: for example, cooling of high speed drills and saws; cooling of brakes, tires, bearings, gears, and rollers; heating of immersed elements and circulating blades; abstracting heat from reactors, furnaces and combustion chambers; cooling of motor rotors, gas-turbine blades, air-conditioners, etc.
3. This device is relatively insensitive to gravity and random accelerations, and thus can be applied on earth, in space, or in vehicles and machines where motion and orientation may vary.
4. Requests for further documentation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B69-10684

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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