Sept. 24, 1968 J. BOHDANSKY ET AL 3,402,767

HEAT PIPES

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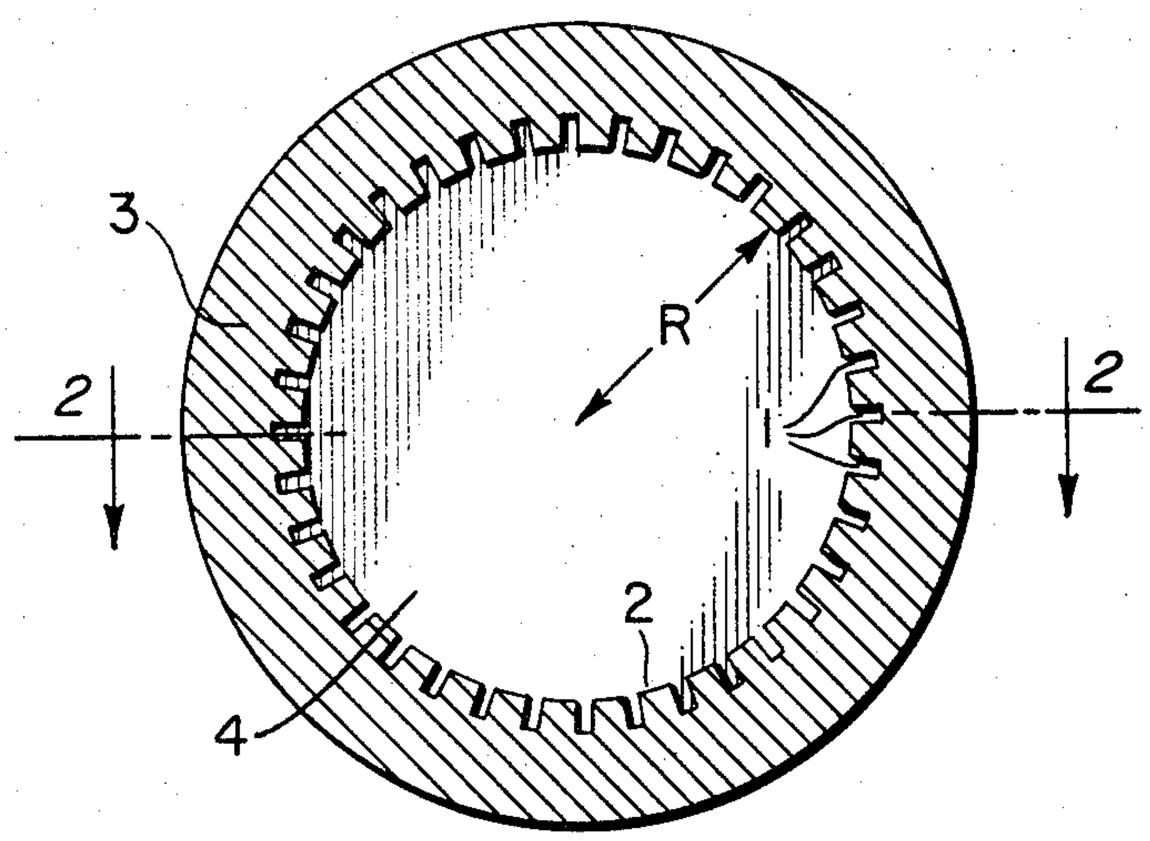
FIG. 1



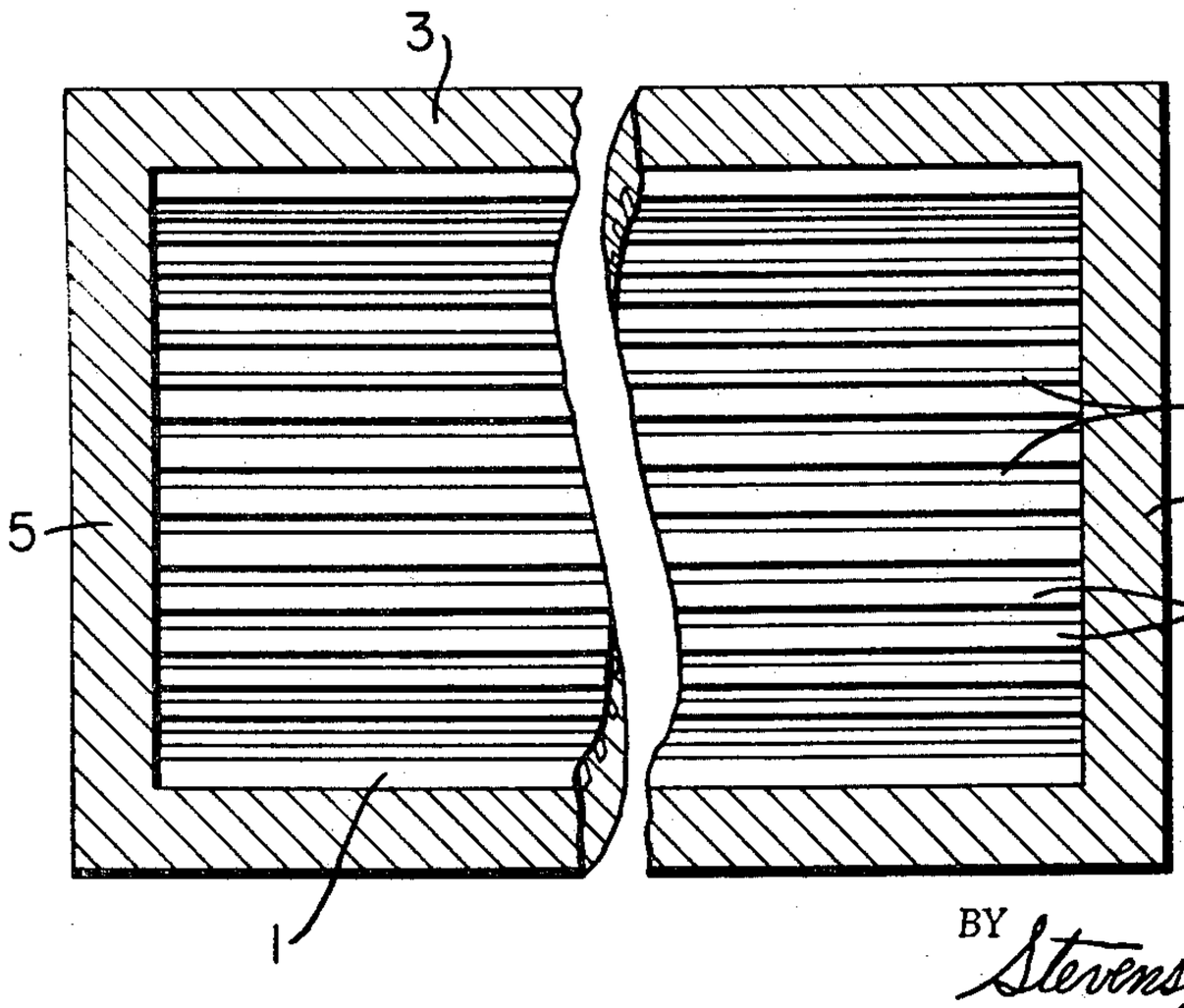


FIG. 2

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HEAT PIPES

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3 Claims. (Cl. 165—105)

ABSTRACT OF THE DISCLOSURE

A closed tubular container of heat resistant material for vaporizing a small quantity of a heat transfer liquid contained in the container. A condensing zone and an evaporation zone are defined in the container and capillary means are disposed therein for transporting condensed liquid from said condensing zone to the evaporation zone. The capillary means are constituted by parallel grooves of capillary diameter formed in the inside wall of the container.

The invention relates to devices known as, and hereinafter referred to as "heat pipes."

Heat pipes are disclosed in the "Journal of Applied Physics," 35, pages 1990/91, June 1964, and provide a means for transfer of heat. A heat pipe consists essentially of a closed tubular container of heat resistant material, condensable vapour and capillary means disposed within the container. The operation of such a heat pipe depends on the fact that when one of its ends is heated a closed circuit fluid flow arises in the pipe. Vapour flows from the heated end of the pipe to the unheated end and there condenses. The return of the condensate is effected by the capillary means. In heat pipes as at present constructed the capillary means are a separate structure (e.g. a porous ceramic insert or a fine-mesh wire coil) and it has been found that the mechanical insertion of such a separate structure into the container is a source of difficulty as regards satisfactory operation of the heat pipe. The capillary insert may, for example, be deformed with respect to the tube due to the different materials used and the varying thermal stress. As a result the thermal capacity and the heat transfer of the tube is strictly limited. Moreover, drying out of the capillaries and destruction of the tube may occur possibly due to such deformation.

The object of the invention is to provide a heat pipe in which the aforementioned defect is avoided or reduced and therefore works more reliably.

The heat pipe according to the invention is characterized in that the capillary passages are formed directly in the inside wall of the container. The capillaries are, preferably, channels or grooves parallel to the axis or slightly helical.

The optimum width of a capillary passage for use in the invention depends upon a number of factors, more especially the pipe radius R, the operating pressure, and material of the heat carrier or condensable vapour. There follows a table of values of the ratio R/*r* for a tube of 2 cm. diameter and 50 cm. long at an operating pressure of 1 atmosphere, for various heat carriers. The values are for optimum heat flow and are calculated for an operating temperature at which the vapour phase flows with a velocity below the velocity of sound.

Material	Cs	Rb	Na	Li	Bi	Pb	Ag
Heat flow, kw	3.3	5.6	33	95	22	29	63
Maximum temperature, ° C	450	470	820	1,300	1,600	1,800	2,000
Optimum tube to passage ratio R/r	9	12	15	17	18	16	25

The symbol "*r*" means the effective capillary radius; in other terms the width of the capillary passage is 2*r*. The depth of the passage is again twice the width.

The capillary structure according to the invention makes a separate capillary insert unnecessary.

The capillaries follow all movements of the tube and stress defects are obviated.

The capillary passages may be either made in the finished container or formed when the tube to form the container is drawn, for example by using a suitably shaped draw mandrel. The capillaries may also be made by milling, stamping, folding, etching, shock deformation or the like. Attention is finally drawn to the drawings, in which FIG. 1 is a transverse cross-sectional view of a heat pipe according to the present invention, and FIG. 2 is a cross section taken along the line **2—2** of FIG. 1.

As shown, a heat tube **3** is provided which is formed with a pair of end walls **4**. A plurality of capillaries **1** are formed in the inside wall **2** of the tube **3** in the axial direction, or are slightly helical. Advantageously, the capillaries are of rectangular cross section, the depth of each capillary being made twice the width.

We claim:

1. A tubular container of heat resistant material containing a small quantity of a heat transfer liquid, said container being closed at each end, and one end of said container being at a higher temperature than the other end thereof to define an evaporation zone and a condensing zone adjacent said ends, said container having a plurality of parallel, substantially longitudinal grooves of capillary diameter formed in the inside wall thereof of a depth substantially more than the width thereof for transporting condensed liquid from said condensing zone to said evaporation zone.

2. A tubular container according to claim **1**, wherein said grooves are of a rectangular shape.

3. A tubular container according to claim **1**, wherein said grooves extend helically with respect to the axis of said container.

References Cited

UNITED STATES PATENTS

2,279,548	4/1942	Bailey.	
2,840,351	6/1958	Holm	165—105 X
2,978,797	4/1961	Ekelund	165—179 X
3,217,799	11/1965	Rodgers	138—38 X
3,273,599	9/1966	Heeren	165—179 X

FOREIGN PATENTS

D. 15,545	10/1955	Germany.

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