NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

(NASA-Case-NPO-11120-1) HEAT TRANSFER DEVICE Patent (NASA) 4 p CSCL 20M

N74-18552

Unclas
00/33 30284

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,789,920

Government or Corporate Employee : Westinghouse Corp. Pittsburgh, PA

Supplementary Corporate Source (if applicable) : ——

NASA Patent Case No. : NPO-11,120-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

YES /X/ NO /__/

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "...with respect to an invention of ..."

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Enclosure

United States Patent [19]
Low et al.

[11] **3,789,920**
[45] **Feb. 5, 1974**

[54] **HEAT TRANSFER DEVICE**

[76] Inventors: **George M. Low**, Deputy Administrator of the National Aeronautics and Space Administration in respect to an invention of; **Ralph W. Kalkbrenner**, P.O. Box 10864, Pittsburgh, Pa. 15236

[22] Filed: **May 21, 1970**

[21] Appl. No.: **39,343**

[52] **U.S. Cl.**............. **165/105,** 29/157.3 R, 267/166
[51] **Int. Cl.**.. **F28d 15/00**
[58] **Field of Search**..... 165/105; 29/157.3; 267/166

[56] **References Cited**

UNITED STATES PATENTS

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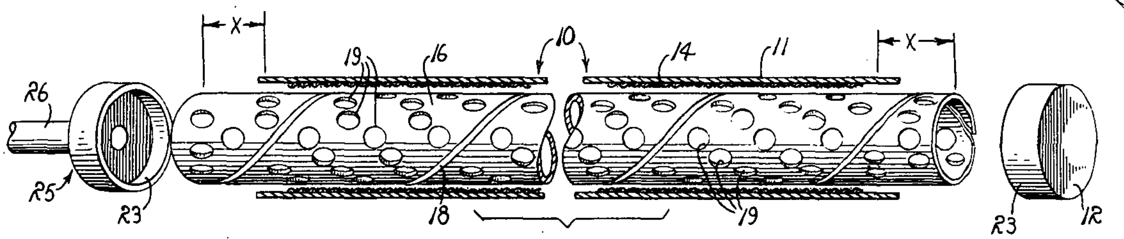
[57] **ABSTRACT**

A heat transfer device characterized by an hermetically sealed tubular housing including a tubular shell terminating in spaced end plates, and a tubular mesh wick concentrically arranged and operatively supported within said housing. A feature of the invention resides in the provision of an improved wicking restraint formed as an elongated and radially expanded tubular helix concentrically related to the wick and adapted to be axially foreshortened and radially expanded into engagement with the wick in response to an axially applied compressive load, whereby the wick continuously is supported in a contiguous relationship with the internal surfaces of the shell.

1 Claim, 3 Drawing Figures



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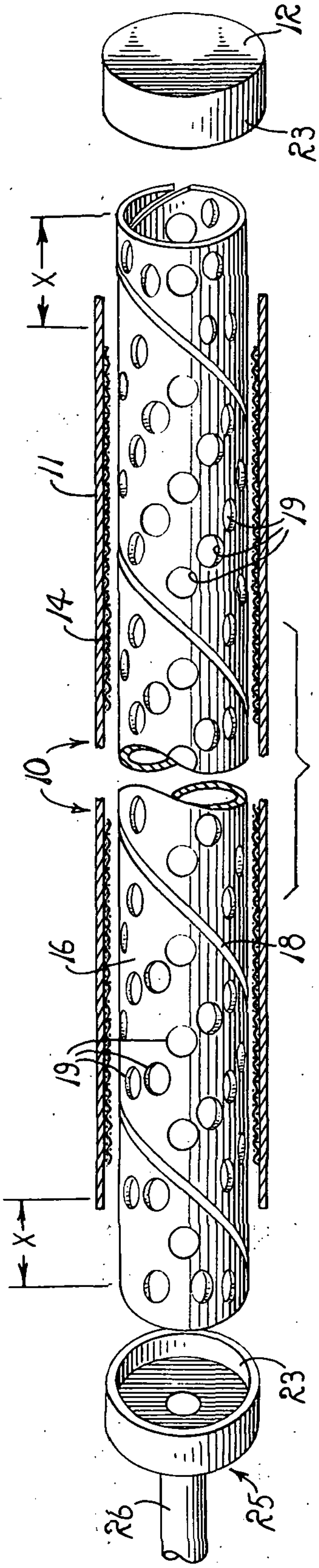

FIG. 1.

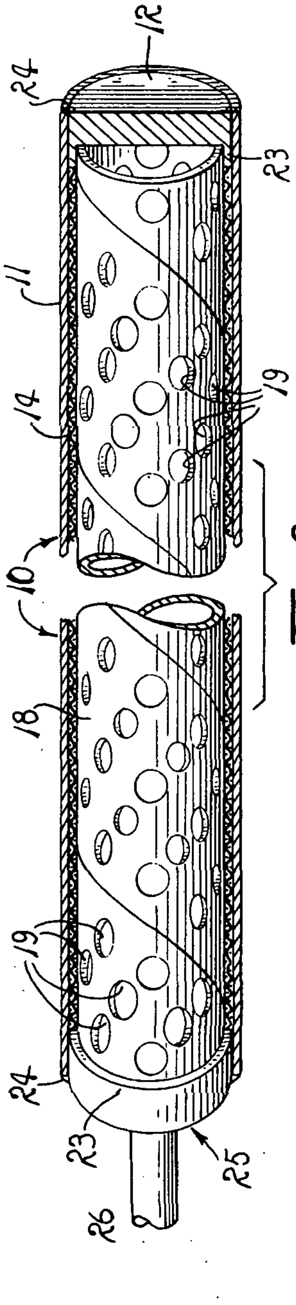

FIG. 2.

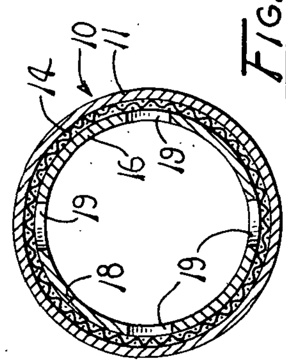

FIG. 3.

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HEAT TRANSFER DEVICE

ORIGIN OF INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to heat transfer devices of the type generally disclosed in U.S. Pat. No. 3,229,759, and more particularly to an improved heat transfer device having a tubular wick concentrically arranged within a tubular shell and an expanded helix functioning as a wicking restraint for continuously supporting the wick in an operative disposition relative to the internal surfaces of the shell.

2. Description of the Prior Art

The prior art is replete with heat transfer devices which employ a wick of the type commonly employed in the so-called heat pipe. In such devices, the wick is supported in a seated disposition, relative to an adjacent circumscribing wall of a shell which defines a sealed chamber. One technique heretofore employed in supporting such a wick requires that a srping-loaded retainer be utilized for urging the wick into engagement with the adjacent wall of the shell. However, due to the fact that working fluids frequently require operative temperatures of magnitudes which tend to have deleterious effects on springs, the spring-loaded retainers thus employed often fail under prolonged use. Consequently, the overall efficiency of the device is reduced.

Another technique often employed in mounting a wick within a shell of a heat transfer device requires that a tubular shell be integrated with a tubular wick through a swaging process. However, mutual withdrawal or "springback" of the thus integrated wick and shell tends to affect the interface established between the wick and the adjacent surface of the wall of the shell. Since it is desirable to accurately control pressures established at the interface between a wick and its associated shell, this technique frequently fails to satisfy existing needs.

OBJECTS AND SUMMARY OF THE INVENTION

It therefore is an object of the instant invention to provide an improved heat transfer device adapted to be employed over extended periods of use.

It is another object to provide a heat transfer device having a wick maintained in an operative disposition through an application of a constantly applied pressure.

It is another object to provide an improved heat transfer device having a retainer adapted operatively to be seated within a tubular mesh wick and apply a radially directed, uniform pressure to the internal surfaces of the wick as it is subjected to an axially applied, compressive force.

It is another object of the instant invention to provide an improved, readily fabricated heat transfer device which may be employed over prolonged periods at elevated temperatures.

It is another object to provide a novel wick retainer for a heat transfer device of the type commonly called a heat pipe.

These and other objects and advantages are achieved through a simplified heat transfer device having provided therein a retainer comprising an elongated helix adapted to be axially foreshortened and radially expanded in the presence of axially applied compressive loads and employed for supporting a tubular mesh wick in an operative disposition relative to the inner surface of a tubular shell.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded, partially sectioned elevation of a heat transfer device embodying the principles of the present invention.

FIG. 2 is a partially sectioned perspective view illustrating the heat transfer device of FIG. 1 in an assembled configuration.

FIG. 3 is a cross-sectional end view of the heat transfer device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1, in an exploded, perspective view, a heat transfer device **10** which embodies the principles of the instant invention.

The heat transfer devie **10** is provided with an elongated housing including a tubular shell **11** and a pair of end plates **12** which serve to establish an hermetically sealed working chamber **13.** Within the chamber **13,** in concentric relationship with the shell **11,** there is disposed a tubular wick **14** of any suitable design. As a practical matter, the wick **14** preferably is formed from suitable stainless steel mesh stock having a predetermined resiliency which accommodates a radial expansion of the wick.

It is to be understood that the wick **14** is employed in conveying liquid working fluids, not shown, from a "cool region" to a "hot region," along a cylindrical path, whereupon the working fluid is vaporized and subsequently returned along a concentric axial path to the "cool region," whereupon condensation is achieved. The particular fluid employed varies in accordance with the uses and temperatures operatively encountered. Since the use of such fluids is well known, a detailed description is omitted.

An elongated wick retainer **16** is arranged in a concentric relationship with the wick **14** and serves to support the wick in an operative disposition relative to the adjacent wall of the shell **11.** In practice, the retainer **16** is of a configuration conforming to a tubular helix, which, when axially compressed, is foreshortened and radially expanded. The helix is so configured that a radially directed, predetermined pressure is developed and applied along the internal surfaces of the tubular wick **14** as the helix axially is compressed. Pressure thus developed is employed in urging the wick into a seated relationship with the internal surface of the shell **12.** The helix which serves as the retainer **16** is fabricated in any suitable manner from a tubular metal stock of a material such as a high grade of stainless steel. Where preferred, a stainless steel tube of a suitable diameter and wall thickness is machined or milled to include a helical kerf **18** extending throughout the length of the tube, whereby the helix is formed.

The width of the thus formed kerf **18**, as well as its spiral lead, is employed in determining the radial expansion of the retainer **16** as it is foreshortened through an axially applied compressive force. It should readily be apparent that the material from which the retainer is fabricated and the width of the helical kerf **18**, as well as the lead thereof, and the thickness of the wall of the tube serve to dictate the limits of radial expansion which are experienced as the retainer is foreshortened under forces of compression. Therefore, in practice, the width and lead of the kerf **18** are compatible with the stock material employed in fabricating the retainer **16**. As a practical matter, the wall of the retainer **16** is provided with suitable perforations **19** which accommodate a passage of fluid therethrough in order to enhance the flow of the working fluid. Hence, the strength and resiliency of the retainer are affected by the size and number of such openings.

The end plates **12** are fabricated from a suitable material compatible with the high grade stainless steel of the shell **11** and the retainer **16**. As best illustrated in FIG. **2**, each of the plates includes a circumscribing skirt **23** which is inserted into an end of the shell **12** in a manner such that the plates are arranged in a coaxial relationship with the retainer **16**. Preferably, the skirts **23** abut the ends of the wick **14** and circumscribe the ends of the retainer as they are inserted into the ends of the shell **11**. The plates are then welded at beads **24**, or otherwise are secured to the shell **11** in order to establish the working chamber **13**.

It is important to note that during the assembly of the heat transfer device **10**, the wick **14** is inserted into the outer shell **11**, and then the retainer **16**, in its relaxed state, is inserted through the wick **14** in a manner such that its opposite ends extend a distance X, FIG. **1**, from the opposite ends of the shell **11**. The end plates **12** now are positioned in a coaxial relationship with the retainer **16** and compressively are displaced towards each other so that the ends of the retainer **16** engage the end plates **12** and become seated within the skirt **23**. Continued mutual displacement of the end plates serves to impose an axial loading on the retainer **16** for causing the retainer to become foreshortened, through the distances X. As the retainer is foreshortened, it becomes radially expanded and applies a radially directed pressure to the adjacent surface of the wick **14**. Once the plates are fully seated within the opposite ends of the shell **11**, they are welded in place at weld beads **24**, formed in any suitable manner compatible with conventional stainless steel welding techniques. The wick **14** of the device **10** thus assembled is supported with a determinable pressure being applied by the retainer **16** maintained in its radially expanded state by the end plates **12**.

As a matter of convenience, it is preferred that one of the end plates **12** be provided with a vent **25** through which communication with the chamber **13** can be established. This vent includes a tubular conduit **26** which axially extends through the plate. During assembly of the device **10** the conduit **26** is employed in flushing and delivering the working fluid to the chamber. Once the end plates **12** are secured to the shell **11**, a selected working fluid is deposited in place and a vacuum is drawn through the conduit **26** whereupon the conduit is "pinched" or otherwise hermetically sealed.

With the heat transfer device **10** thus assembled, it is readied for employment in a known manner consistent with the employment of heat pipes.

It should readily be apparent that the heat transfer device **10**, as heretofore disclosed, is assembled employing relatively simple and economical techniques, while a sustained and predictable restraint of the wick **14** is achieved, even when the device is employed at elevated temperatures over prolonged operative periods.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the illustrative details disclosed.

What is claimed is:

1. An improved heat transfer device comprising:

A. an elongated shell of a tubular configuration;

B. a tubular wick concentrically related to said shell and seated therein;

C. means for supporting said wick in contiguous engagement with the internal surfaces of said shell including,

  1. a perforated body of a tubular configuration,
  2. means for facilitating radial expansion of said body, including means defining a helical kerf extended along the body, whereby the body is adapted to be readily deformed in response to axially applied compressive stress, and
  3. means for axially applying compressive stress to said body, including a pair of end plates integrally connected to said shell at the opposite ends thereof in contiguous engagement with the opposite ends of said perforated body; and

D. a working fluid confined within said shell.

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