

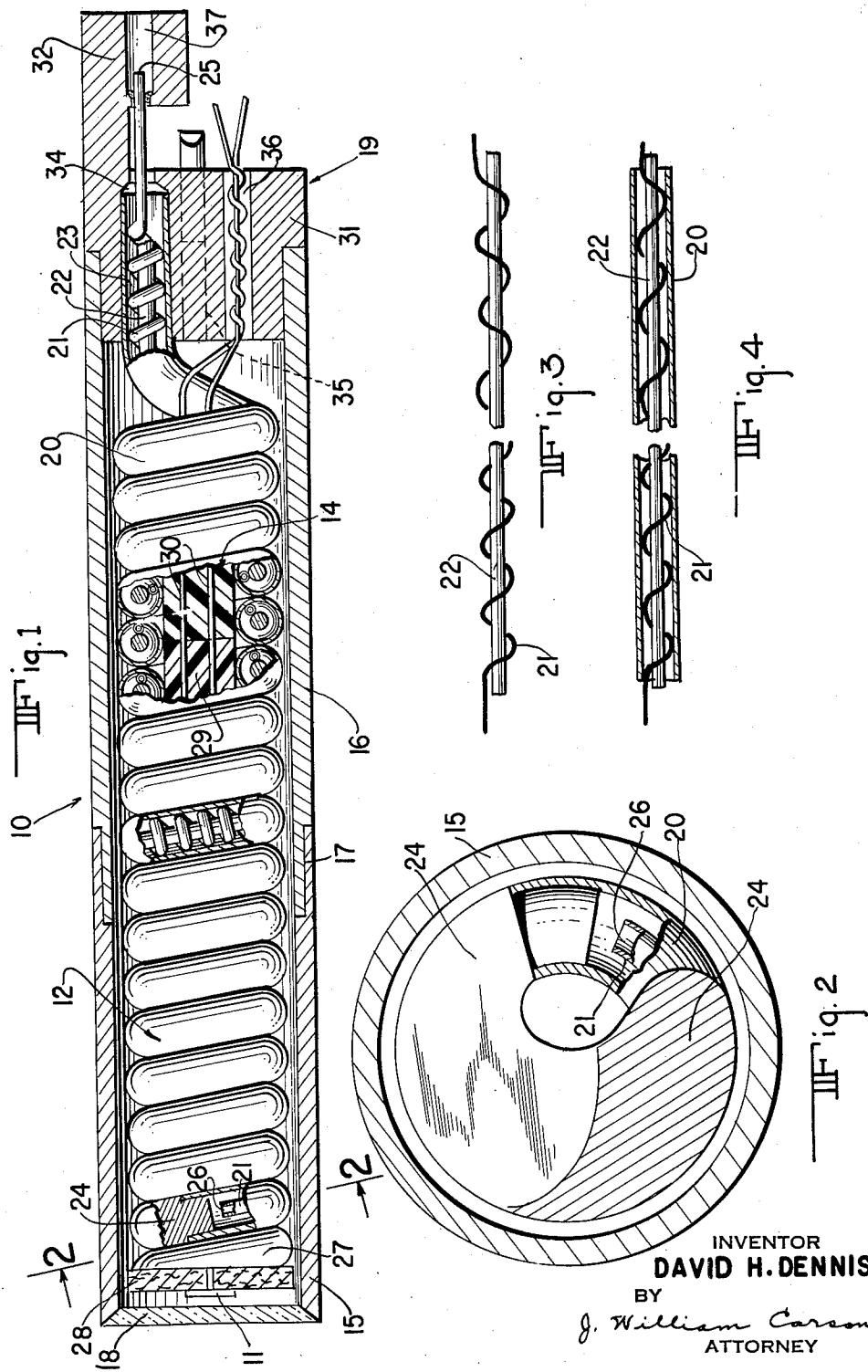
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COOLING DEVICE EMPLOYING THE JOULE-THOMSON EFFECT

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COOLING DEVICE EMPLOYING THE JOULE-THOMSON EFFECT

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5 Claims. (Cl. 62-440)

The present invention relates to refrigeration, and, more particularly, to improved apparatus for maintaining an element at a much lower temperature than the ambient temperature which apparatus utilizes a gaseous refrigerant capable of remaining in fluid state at extremely low temperatures.

Heretofore, it has been found that, by cooling elements such as infrared cells and the like to a temperature of about -100 F. or lower, the sensitivity of the cell is increased and the noise to signal ratio of the cell is greatly decreased. This can be accomplished by expanding a gaseous refrigerant under pressure in the vicinity of the cell and returning the cool expanded refrigerant in regenerative or counterflow heat exchange with the incoming refrigerant to cool the refrigerant before expansion and thereby attain a greater Joule-Thomson effect.

Accordingly, an object of the present invention is to provide apparatus of the foregoing type which is simple and compact in construction and is highly efficient in operation.

Another object is to provide such apparatus wherein a heat exchanger is utilized which can be fabricated from small parts in a practical and economical manner.

Another object is to provide such apparatus which can be so constructed of metallic parts that the apparatus will resist vibrations.

A further object is to provide such apparatus wherein maximum and uniform cooling of the cell element is effected.

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawing, forming a part of the specification, wherein:

FIG. 1 is a longitudinal sectional view, partly in elevation, of apparatus in accordance with the present invention.

FIG. 2 is an enlarged sectional view taken along the line 2-2 on FIG. 1.

FIG. 3 is a fragmentary schematic view illustrating a step in the manufacture of the heat exchanger.

FIG. 4 is a fragmentary schematic view illustrating another step in the manufacture of the heat exchanger.

Referring now more particularly to FIGS. 1 and 2 of the drawing, there is shown cooling apparatus which generally comprises an envelope 10, an infrared cell 11 to be cooled within the envelope at one end thereof, a heat exchange assembly 12 having one end in heat conductive connection with the cell, and a core 14 extending through the heat exchanger.

The envelope 10 comprises two tubular metallic members 15 and 16 secured together by a joint 17, a window 18 for the cell 11, sealed to the outer end of the member 15, and a header 19 at the outer end of the member 16.

The heat exchange assembly 12 comprises a metallic tube 20 in the form of a coil having adjacent convolutions in contact with each other, and capillary tubing 21 wound on a mandrel wire 22 and having spaced adjacent convolutions disposed within the tube 20 with the capillary tubing convolutions fitted against the inner wall of the tube 20 to rigidly mount the same and provide a spiral return flow path 23 between adjacent convolutions.

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One end of the tube 20 is open and is fitted into the header 19 as described hereinafter and the other end thereof is closed by a metallic plug 24. The capillary tubing has an inlet 25 at one end mounted in the header 19 for connection to a source of refrigerant and has an outlet or nozzle 26 at its other end adjacently spaced from the inner end of the plug 24. In this manner, refrigerant under pressure enters the inlet 25, flows through the capillary tube, is expanded at the nozzle 26 to lower the temperature thereof and cool the plug 24, returns by way of the path 23 while in heat exchange relation to cool the incoming refrigerant, and exits at the open end of the tube 20.

A metallic pedestal or mass 27 is secured to the plug 24 and to the cell 11 in heat conducting relation so as to cause the cell to be cooled. If desired, a shock absorbing disc 28 may be disposed between the cell and the mass 27.

The core 14 comprises a plurality of apertured beads 29 formed of nylon through which the lead wires 30 of the cell are strung to rigidly support the same.

The header 19 comprises a plug portion 31 sealed into the outer end of the envelope member 16, and an extension 32 on the plug portion disposed exteriorly of the envelope.

The plug portion 31 is formed with a bore 34 for receiving the open end of the tube 20 and providing an exit for the spent refrigerant and an inlet for the capillary tubing 21, a bore 35 adapted to be sealed off after evacuating the envelope 10, and a bore 36 for the lead wires 30 of the cell which is adapted to be sealed after threading the wires therethrough.

The extension 32 is spaced outwardly of the plug portion 31 to expose the gas outlet bore 34 to atmosphere and is formed with a bore 37 facing the bore 34 in which the inlet end of the capillary tubing 21 is sealed and which serves to connect the inlet 25 of the tube 24 to a source of refrigerant (not shown).

As shown in FIGS. 3 and 4, the heat exchanger assembly 12 is fabricated by winding the capillary tube 21 on the mandrel wire 22 (or winding the mandrel wire 22 on the tube 21, if a lesser degree of heat exchange is desired), inserting the tube 21 and the wire 22 into the tube 20 (FIG. 4), and winding the tube 20 and its contents about a form to shape shown on FIG. 1.

It was found that a highly efficient heat exchange assembly utilizing dry nitrogen at 1800 p.s.i.g. as the refrigerant could be provided by elements having the following approximate dimensions and characteristics:

Tube 20:	
Inner diameter.....inches..	0.047
Coil formed from tube:	
Length on core 14.....do....	1.5
Developed length.....do....	6
Outer diameter.....do....	.25
Capillary tube 21:	
Material.....	Stainless steel
Inner diameter.....inches..	0.005
Wall thickness.....inches..	0.003-0.006
Convolution per inch.....	8
Developed length.....inches..	13
Space between convolutions.....do....	.100
Mandrel wire: diameter.....do....	.014
Pedestal 27:	
Material.....	Stainless steel
Weight.....pounds..	.005

In practice it was found that the foregoing described apparatus could maintain the cell 11 at a temperature of about minus 300° F. with dry nitrogen under a pressure

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of about 1800 p.s.i.g. at 70° F. having a flow rate of about 0.110 cubic feet per minute.

From the foregoing description it will be seen that the present invention provides extremely compact and lightweight cooling apparatus which can withstand such rough usage to which it normally may be subjected.

As various changes may be made in the form, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

I claim:

1. In cooling apparatus, the combination of a tubular shell having an element to be cooled adjacent one end thereof, a heat conductive mass engaging said element; and an assembly within said shell comprising a heat conductive spiral tube having a convolution at one end in engagement with said mass and having a heat conductive plug for closing that end of said tube and being in engagement with said mass, and a capillary tubing member extending through said tube having an inlet at the end opposite said mass for refrigerant under pressure and having an outlet at the closed end of said tube for expanding the refrigerant within said tube at said plug, said mass having a configuration to be disposed between said element to be cooled and said plug and the end of said tube closed by said plug, whereby the expanded refrigerant cools said mass and returns through said tube to cool the refrigerant flowing towards said outlet.

2. In cooling apparatus, the combination of a tubular shell having an element to be cooled adjacent one end thereof, a heat conductive mass engaging said element; and an assembly within said shell comprising a heat conductive tube having a closed end in engagement with said

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mass, a capillary tubing member extending through said tube having an inlet at the end of said tube opposite its closed end for refrigerant under pressure and having an outlet at the closed end of said tube for expanding the refrigerant within said tube at its closed end whereby the expanded refrigerant cools said mass, and a wire member, one of said members being spirally wound about the other with spaced apart adjacent convolutions, the spaces between convolutions, the inner wall of said tube, said tubing member and said wire member providing a spiral return flow passageway through said tube for expanded refrigerant to cool the refrigerant flowing in said capillary tubing member towards its outlet.

3. In cooling apparatus according to claim 2, wherein said tubing member is wound about said wire member.

4. In cooling apparatus, the combination of a spiral tube having a bore closed at one end, a capillary tubing member having an outlet adjacent the closed end of said tube and an inlet at its other end for refrigerant under pressure adapted to be expanded at said outlet, and a wire member, one of said members being spirally wound about the other with spaced apart adjacent convolutions and said members being arranged in said tube, whereby the space between convolutions, the inner wall of said tube, said tubing member and said wire member provide a spiral return flow passageway through the bore of said tube for expanded refrigerant.

5. In cooling apparatus according to claim 4, wherein said tubing member is wound about said wire member.

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