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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A23L	A2	(11) International Publication Number: **WO 99/20124**
		(43) International Publication Date: 29 April 1999 (29.04.99)

(21) International Application Number: PCT/US98/22036

(22) International Filing Date: 16 October 1998 (16.10.98)

(30) Priority Data:
08/954,644 20 October 1997 (20.10.97) US

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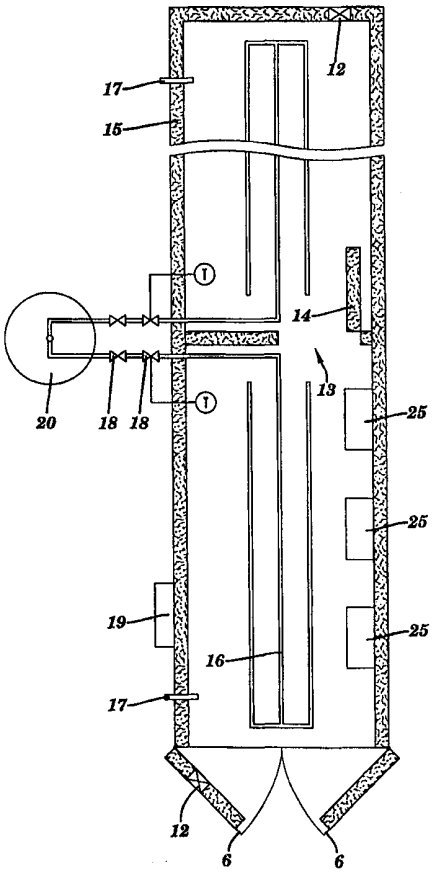
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: METHOD AND APPARATUS FOR SHIPPING SUPER FROZEN MATERIALS

(57) Abstract

A method and apparatus for freezing products or materials to a super–frozen state, storing them until shipment and shipping them in a super–frozen state. The apparatus consists of two self–contained, super–insulated containers. The first apparatus has at least two compartments, one for freezing and one for storage. The product or material to be frozen is placed in the freezing compartment and frozen to a super–frozen state and then transferred to the storage compartment where it is stored until shipment. The second apparatus is a self contained super–insulated shipping container. When shipment is to be effected, product or material is transferred from a storage compartment of the first apparatus in a super–frozen state to the second or shipping apparatus. The doors of the shipping apparatus are closed and the self–contained, super–insulated apparatus containing super–frozen product or material is shipped to a remote venue.



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Method and Apparatus for Shipping Super Frozen Materials

Background

Field of Invention

This invention relates to a method and apparatus for shipping, storing and freezing super frozen perishable materials in a self-contained shipping container which maintains the perishable material below -50° C and which is super insulated and has its own cryogenic-based refrigeration system.

Prior Art

Freezing and Storage

Super containers can be used also as a method for freezing and storing super frozen products. By using the containers for the three areas-- freezing, storing and shipping- there is a substantial cost savings over the current methods for all three areas. For freezing there are presently other cryogenic systems available, but they are difficult to ship and they are very expensive. Furthermore, they must be housed inside a building which can greatly increase the cost. The existing method is suitable for freezing but provides no place to store the products after freezing.

Thus, a large storage freezer must be built which again is associated with a substantial cost. Once built the separate freezing and storage systems are inflexible. In other words it cannot easily be picked up and moved to another part of the world. If the nature of the business changes, a large super freezer facility can become un-usable in that location and therefore of no value. The system of the present invention will retain it's value in that it can be easily shipped to another location and/or sold.

A variety of shipping, storing and freezing devices using CO_2 and N_2 have been used for perishable products. However these devices are designed to maintain product at about -20° C and are unable to maintain super frozen product at temperatures in the range of -50 to -60° C. These devices include Carbon Dioxide Refrigeration Systems (US Patent 3,695,056: Glynn; EP and Hsu; HL), Refrigeration system with carbon dioxide injector (US Patent 4,399,658: Nielsen;DM), Container CO_2 cooling system (US Patent 4,502,293: Franklin Jr.;PR), Liquid nitrogen freezer (US Patent 4,580,411: Orfitelli; JS), Portable self-contained cooler/freezer apparatus for use on common carrier type unrefrigerated truck lines and the like (US Patent 4,825,666: Saia, III; LP), Refrigerated container (US Patent 4,891,954: Thomsen; VE), Portable self-contained cooler/freezer apparatus for use on common carrier type unrefrigerated truck lines and the like

(US Patent 4,991,402: Saia, III; LP), Portable self-contained cooler/freezer apparatus for use on airplanes, common carrier type unrefrigerated truck lines and the like (US Patent 5,125,237: Saia, III; LP), Self-contained cooler/freezer apparatus (US Patent 5,262,670: Bartilucci; A), Portable self-contained cooler/freezer apparatus with nitrogen environment container (US Patent 5,598,713: Bartilucci; AR).

All of the above apparatus are characterized by the ability to cool or freeze perishable material down to about the temperature of approximately -20° C. This is adequate and even desirable for some applications. However, for materials that require super freezing at temperatures of approximately -60° C such apparatus are unable to fulfill the requirements. In addition, all of the above apparatus are characterized by a division into two compartments. The first of these compartments contains the perishable material, the second of these compartments contains the cooling agent (CO_2 or N_2). Cooling is accomplished by the cooling agent moving from the second to the first compartment via a venting system.

Shipping

Perishable products which require super frozen conditions for preservation previously have been shipped in special ships, known as super carrier vessels.

These super carrier vessels have bulk storage freezers which allow product to be held at a constant temperature of -60° C. In order to utilize this method of shipping in a super carrier vessel a minimum of 100 metric tons of product must be shipped. For many perishable products this is impractical. For smaller shippers it is also impractical. For many products which are in demand the time required for shipment on a super carrier vessel, often several months, further makes such a shipping method impractical.

Brief Description of the Drawings

Fig. 1 shows a roof section of a container with additional insulation, a vent door and a CO_2 distribution system.

Fig. 2 shows the wall section of a standard ISO shipping container with standard insulation value, and the additional insulation which, when added, will create the super insulated container's insulative value. Standard r-value of a shipping container is in the range of 15 to 20. The super container shown in this figure has r-values of 30 or more.

Fig. 3 shows a section of a super freezer/storage container with super insulated walls, a freezer section and a storage section, a cryogenic liquid supply tank, thermostatic valves for the temperature controlled flow of the cryogenic liquid, an electric control panel to turn the system on and off and set the desired interior air temperature, fans 25 for increased heat transfer during the freezing process and temperature probes to read the air temperature inside the two sections.

Preferred Embodiment

Description

Herein we describe a specific embodiment which is the preferred embodiment. While the invention is susceptible to various modifications and alternative forms, this specific and preferred embodiment is shown by way of the drawings and the detailed description herein described. It should be understood, however, that there is no intent to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

Referring to Figure 1, the invention is constructed beginning with a commercially available insulated ISO shipping container built with or designed to support a mechanical refrigeration unit. The refrigeration unit was removed from the nose **1**. The nose **1** was closed and insulated with 8" to 10" of polyurethane insulation foam **2**. Four inches of polyurethane foam insulation was added to the bottom side **3** of the container, between and around the cross members, the walls and ceiling **4** on the inside of the container and the doors **5** of the container. Additional closure gaskets were added around the seal of the doors **6** after the insulation was added to insure a proper seal. A hinged vent door **7** which automatically opens when the pressure inside the container increases. The vent door **7** releases the pressure as the cryogenic liquid is added and as the cryogenic liquid sublimates. This was installed in the nose **1** of the container about one inch down from the top of the container box. A cryogenic liquid spray header was installed. The spray head is known as a Transnow CO_2 sprayhead **8** and is the subject of US Patent 4,640,460. The sprayhead was installed in the roof of the super insulated container and connected to a valve **9** on the outside of the container where the liquid CO_2 line **10** is connected. The said Transnow CO_2 spray head has properties and advantages such that it provides the greatest ration of liquid CO_2 to solid CO_2 product, thus operating at highest available efficiency and reducing the refrigeration cost. It should be understood that there is no intention to limit the scope of the invention

to use with a Transnow CO_2 spray head, any cryogenic liquid distribution system or solid dry ice could be used as well.

A key feature of the invention is increasing the r-value of the container walls. Figure 2 is a cross section of the container wall showing the additional insulation **11**.

Figure three shows a cross-section and key features of the freezing and storage container. This container is a standard ISO insulated container to which has been added a vent door **12**, at least one interior wall **13** and connecting door **14** and foam insulation **15** is added to all walls and doors such to form super-insulated walls and doors increasing the r-value. A cryogenic temperature control system is added consisting of refrigerant piping **16,** temperature probes **17**, thermostatic valves **18**, an electric control panel **19**, and cryogenic storage facility **20**.

Operation

The product or material to be frozen is loaded into a freezing section of the freezing and storage super-insulated container which has been pre-cooled to -60° C. It is

allowed to cool to ambient temperature and is thus transformed into the super-frozen state. The super-frozen product or material is then transferred to a storage section of the container to await transfer.

The product or material to be shipped is pre-frozen in the super-frozen state is transferred from the storage container and loaded into the super insulated container which has been pre-cooled to -60° C. The loading proceeds in the same manner in that they are loaded into a standard shipping container. In most cases the products are bulk loaded by hand, one on top of the other. The amount of product that should be loaded is also a factor of how long the shipping time will be and the amount of CO_2 solid is needed. However, once the pre-frozen product or material has been loaded into the suer insulated container, this super insulated container provides an atmosphere in which the CO_2 is distributed and surrounds the frozen products inside the super insulated container. As the CO_2 is being distributed a large amount of pressure is being blown into the container box. The effect is something like a blizzard with very high winds. Thus the CO_2 snow will fill air pockets and crevices, although the majority of the snow will be piled on top of the products. Once the product is loaded into the super insulated container and injected with the CO_2, the super insulated container will be handled the same way

all other dry cargo shipping containers are handled. This is in distinction to frozen shipping containers which require monitoring and electrical power hookups. Before injecting the CO_2, a calculation is performed to determine the amount of CO_2 that will be required to maintain the super frozen state of the product or material until it arrives at its destination or until additional CO_2 can be added to the super insulated container. This calculation is based upon the insulative value of the super insulated container, the amount (weight) of pre-frozen products or materials which will be loaded, the relative heat factor of the products or materials and the amount of time the product will be in transit. The super insulated container can be loaded onto a truck chassis and transported to the point of departure such as a ship port, rail yard or other transportation depot. It is then taken off of the truck and put into a holding area awaiting loading onto the ship, train or other conveyance. From the moment the super insulated container is loaded onto the conveyance until its arrival at the destination, no special monitoring or handling is required by the shipper or the shipping line.

When the container arrives at its destination, the interior temperature of the super insulated container can be tested and, if necessary, additional CO_2 can be added to provide extra storage time. The products can also be unloaded at this point and placed in cold storage at the destination.

Other Embodiments

This system can be used also with standard frozen products, for example in areas where there is currently no refrigerated shipping service available, but dry container service is available. Further, shipping costs can be often reduced by shipping the container of the subject invention at the dry shipping rate whereas other types of frozen shipping containers require frozen shipping rates.

There are a variety of insulation types which could be used in place of or in addition to polyurethane foam. Any insulation system which raises the r-value of the container above the 15-20 range constituents an additional embodiment of the invention.

Finally, the shipping container could also be used for storage, the storage and freezing container could be also used for shipping and a system comprising a combination of the storage and freezing container and the shipping container are all additional embodiments of the invention.

Example 1

Freezing and Storage Container

To the system of example 1 were added five 1 hp fans were added to the rear area and the spray header was separated into two sections. Two temperature probes were added (one in each compartment) to monitor the air temperature. The temperature probes were connected to an electric switch box which allows the desired air temperature to be set inside each compartment. The switches and probes are connected to valves which open and close based on desired temperature setting and the actual air temperature inside each compartment.

Fresh tuna fish were loaded onto racks and the racks were placed inside the freezing section of the container. The doors were closed and the fans and nitrogen supply switches were turned on. Wire temperature probes were placed inside the core meat of the fish. When core temperature reaches around -50° C everything is turned off and the doors of the container were opened and nitrogen gas was allowed to escape. The fish were taken off the racks and glazed by dipping in water for a few seconds. The glazed fish were then loaded into the super insulated storage area. The container is then shipped as described above.

Example 2

Shipping container

A super insulated shipping container was constructed and pre-frozen tuna were shipped in it from Italy to Japan, arriving in Japan in perfect super frozen state. Details of this example follow.

A standard 40 foot insulated shipping ISO container was purchased from Transnow CO_2. The container was modified by building a standard two by four stud wall with a plywood exterior and poly-foam was injected through the plywood and between the two by fours The ceiling and undercarriage was then sprayed with poly-foam adding about 4 inches to all surfaces. The container was then shipped to Italy. There the container was used for freezing and storing tuna during a two month production and gathering period. About 5 metric tons of tuna loins were produced and frozen during that time. The air temperature and the core temperature of the fish was monitored each day. As the temperature rose above -60° C more CO_2 was added, such that product was consistently below -50° C. Optimal results were achieved by periodic additions of large amounts of CO_2. When the container was fully loaded with tuna loins and ready to ship approximately 22 Metric Tons of liquid CO_2 was added and the whole container was shipped to Japan on the NYK Line, bill of lading number NYKS577080998, on the vessel Osaka Bay. Transit time was

28 days. The overall time between the last injection of CO_2 until opening the door of the container in Japan was 36 days. When the center door leading to the super insulated storage compartment was opened there was a large block of frozen CO_2 snow inside the compartment. The temperature of that snow was found to be -85° C. The fish had a core temperature of -60° C.

Conclusions, Ramifications, and Scope

Accordingly it can be seen that the instant invention provides a method and apparatus for freezing, storing and shipping super frozen materials or products such as tuna fish in a self contained system that maintains the material or product in a super frozen state for long periods of time.

Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Various other embodiments and ramifications are possible within it's scope.

Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.

What is claimed is:

1. An apparatus for shipping super-frozen products or materials which is fully self-contained.

2. The apparatus of claim 1 which is a commercially available insulated shipping container to which is added additional insulation, and a cryogenic dispersal system.

3. The apparatus of claim 1 which is a commercially available insulated shipping container to which poly-foam insulation is added to increase the r-value of the container, a CO_2 sprayhead, a liquid CO_2 dispersal system and door seals are added such that materials or products contained within can be maintained at or below -50° C.

4. The apparatus of claim 3 which further contains multiple CO_2 sprayheads and a temperature regulation system comprising one or more temperature probes connected to switches and valves which control the dispersal of freezing agent.

5. A method for shipping super frozen products or materials in a self contained apparatus.

6. The method of claim 5 comprising:

a self contained shipping container comprises a commercially available insulated container with additional insulation and a cryogenic dispersal system;

placing super-frozen product or material to be shipped in the self contained container;

shipping self-contained shipping container with super-frozen product or material to a remote venue.

7. The method of claim 6 in which the super frozen product or material is glazed with water prior to shipment.

8. An apparatus for freezing products or materials to a super-frozen state and then storing them in that state.

9. The apparatus of claim 8 where the apparatus is a commercially available insulated shipping container which is divided into at least two sections to which is added additional insulation and a cryogenic dispersal system.

10. The apparatus of claim 9 where the insulation material is poly-foam for the

purpose of increasing the r-value, where fans are added to disperse the cooling gas and where a control system is added to regulate the temperature during the freezing and during the storing processes.

11. A method for freezing products or materials to a super-frozen state and storing them in that state in a self contained apparatus.

12. The method of claim 11 comprising:

a self contained apparatus comprises a commercially available insulated container which has been divided into at least two sections where additional insulation and a cryogenic dispersal system has been added.

placing products or materials into a first section for freezing and freezing to a super-frozen state;

transfer of super-frozen products or materials to a second section for storage in the super-frozen state.

13. The method of claim 11 comprising:

a super insulated container which has been divided into at least two sections where additional insulation, a cryogenic dispersal system including fans for dispersal of cold gases and a temperature monitoring and control

system;

placing products or materials into a first section for freezing and freezing to a super-frozen state;

transfer of super-frozen products or materials to a second section for storage in the super frozen state.

14. The method of claim 11 in which product or material is super- frozen in a freezing compartment of the apparatus, glazed with water and then stored in a super -frozen state in a storage compartment of the apparatus.

15. A method and apparatus (system) for freezing and storing product or material to a super-frozen state in a first self contained super-insulated container, transfer of super-frozen product or material to a second self contained super-insulated container for shipment to a remote venue and shipment of the second self container.

16. The system of claim 15 comprising:

an apparatus for freezing products or materials to a super-frozen state in a first compartment and then storing them in that state a second compartment in which cold gases are dispersed by fans linked to a

temperature a monitoring and control system;

placing products or materials in the first freezing compartment and freezing product or materials to a super-frozen state in a first compartment;

transfer of super-frozen product or material to a second compartment for storage;

an apparatus for shipping super-frozen products or materials which is fully self contained;

transfer of super-frozen product or materials from the first self contained freezing and storage container to the second self contained shipping container;

shipment of self contained shipping container containing super-frozen product or material to a remote venue.

17. The system of claim 15 comprising:

an apparatus for freezing products or materials to a super-frozen state and then storing them where the apparatus is a commercially available insulated shipping container which is divided into at least two sections to which is added additional poly-foam for the purpose of increasing the r-value and a temperature monitoring and regulating system disperses cryogenic materials;

placing products or materials in the first freezing compartment and freezing the products or materials to a super-frozen state;

transfer of the super-frozen products or materials to a second storage compartment;

an apparatus for shipping super-frozen products which is a commercially available insulated shipping container to which poly-foam insulation is added to increase the r-value of the container, a cryogenic dispersal system and door seals are added such that materials or products contained within can be maintained at or below -50°;

transfer of super-frozen products or materials from first self-contained freezing and storing apparatus to second self-contained shipping apparatus;

shipment of self-contained shipping apparatus containing super-frozen products or materials to a remote venue.

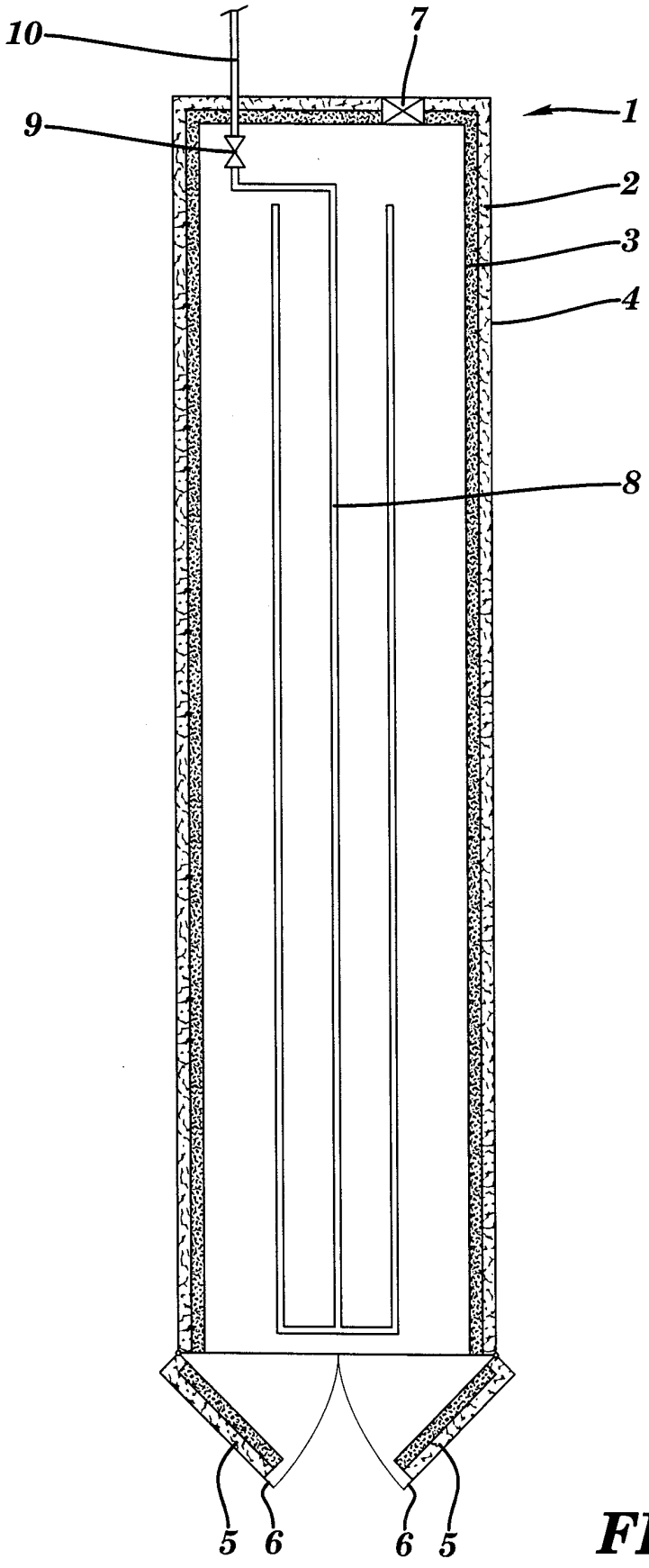

FIG. 1

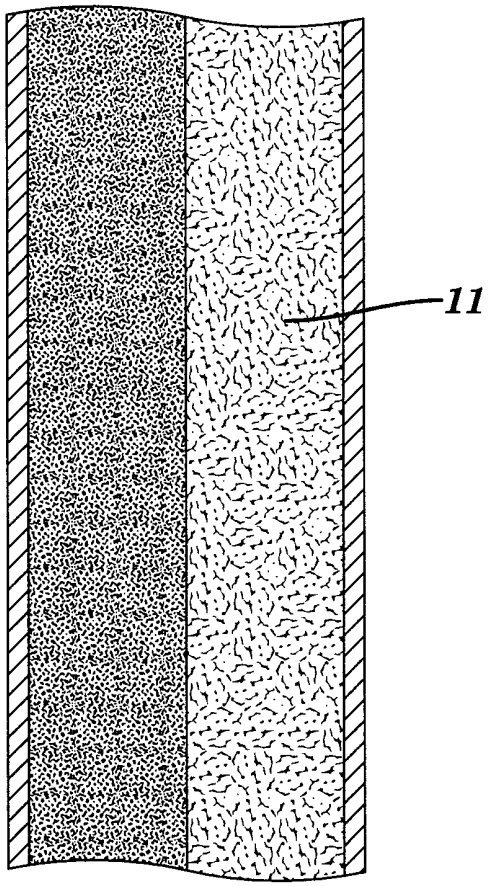

FIG. 2

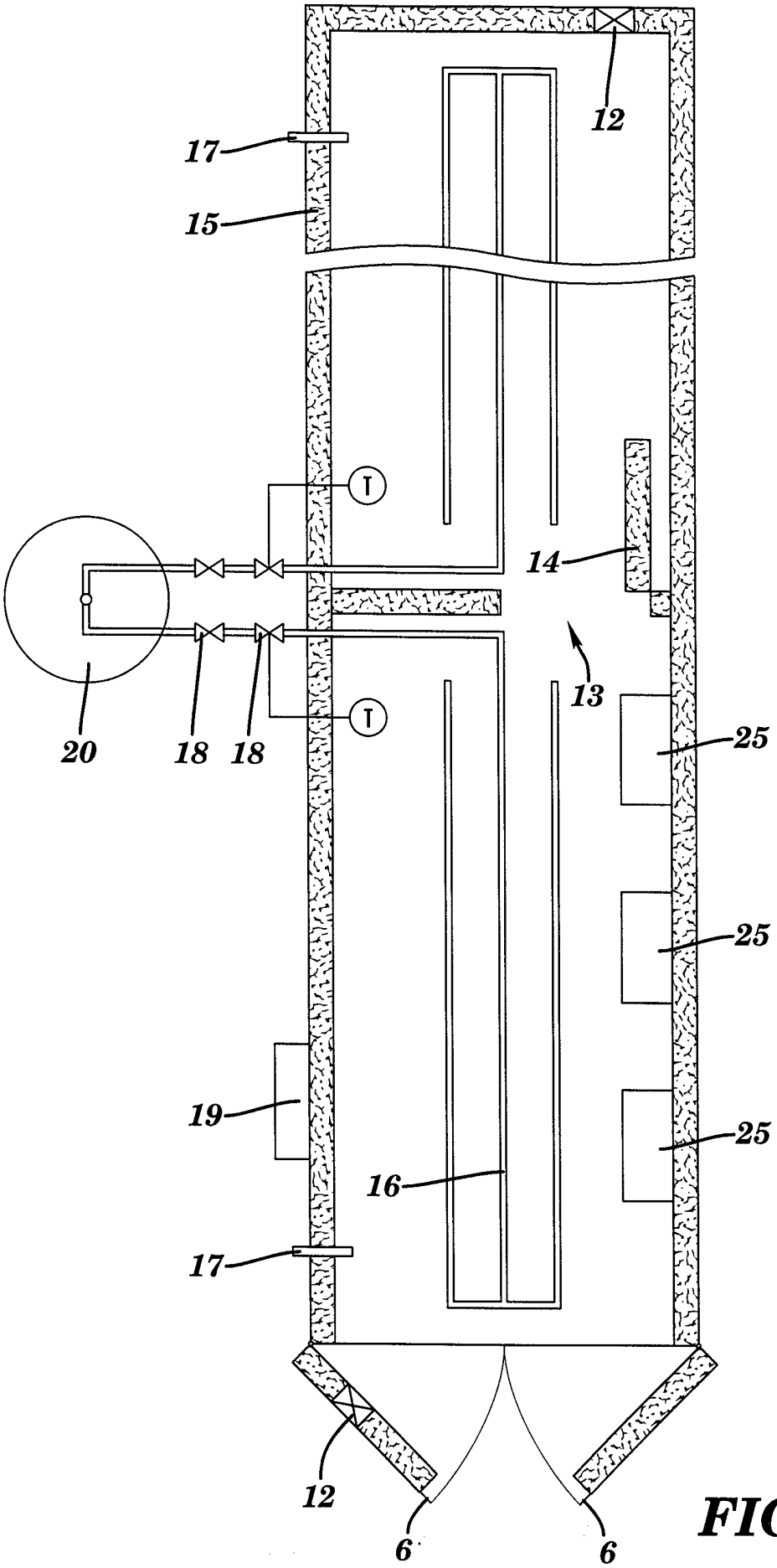

FIG. 3