Sept. 13, 1966 E. BERNER 3,271,970

INSULATED COLD STORAGE ROOMS OR SIMILAR ENCLOSURES

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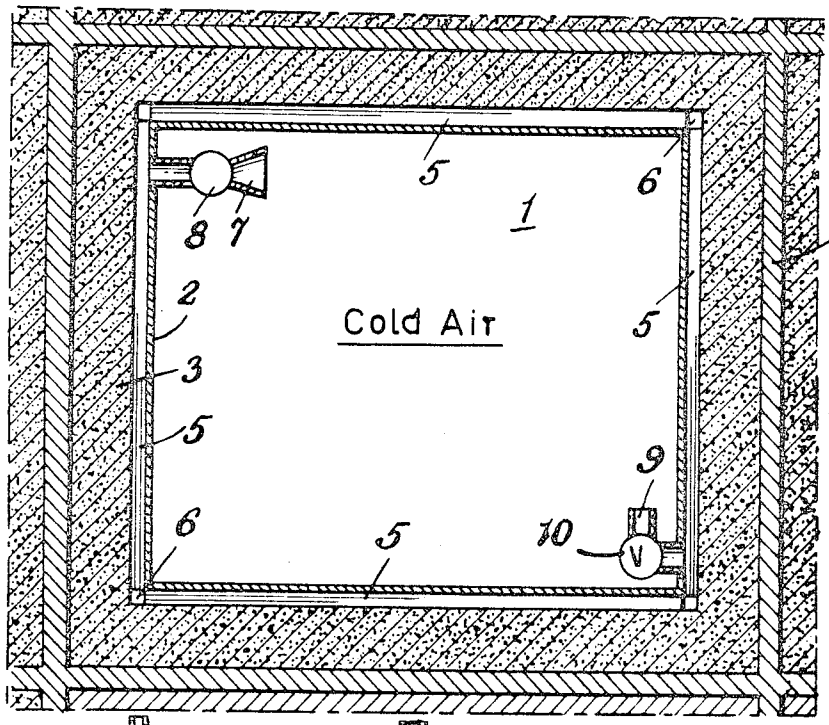


FIG. 1.

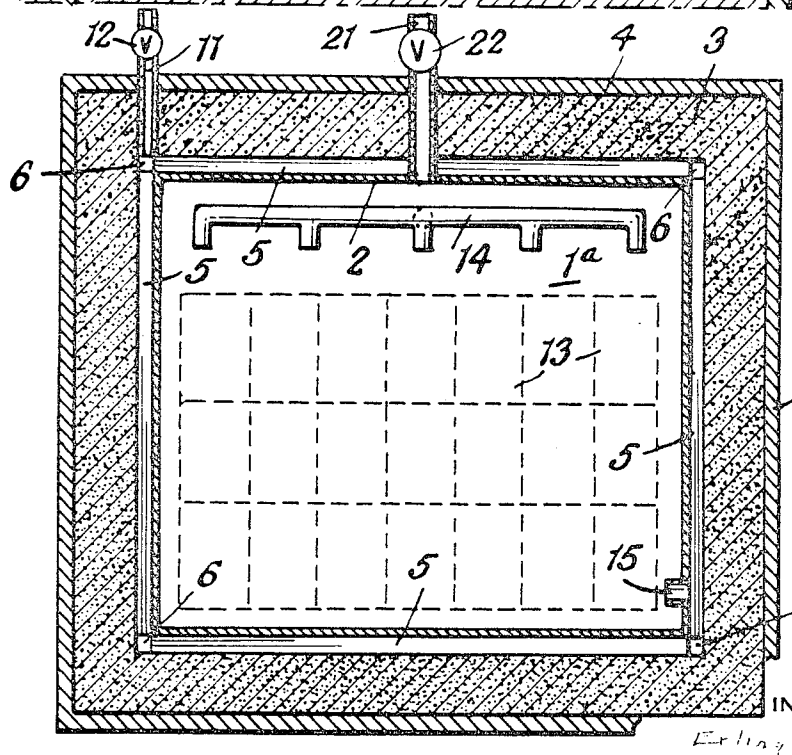


FIG. 2.

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FIG. 3.

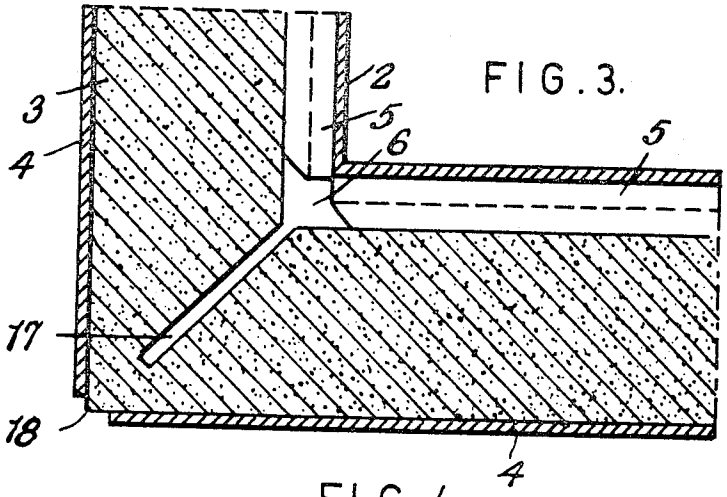
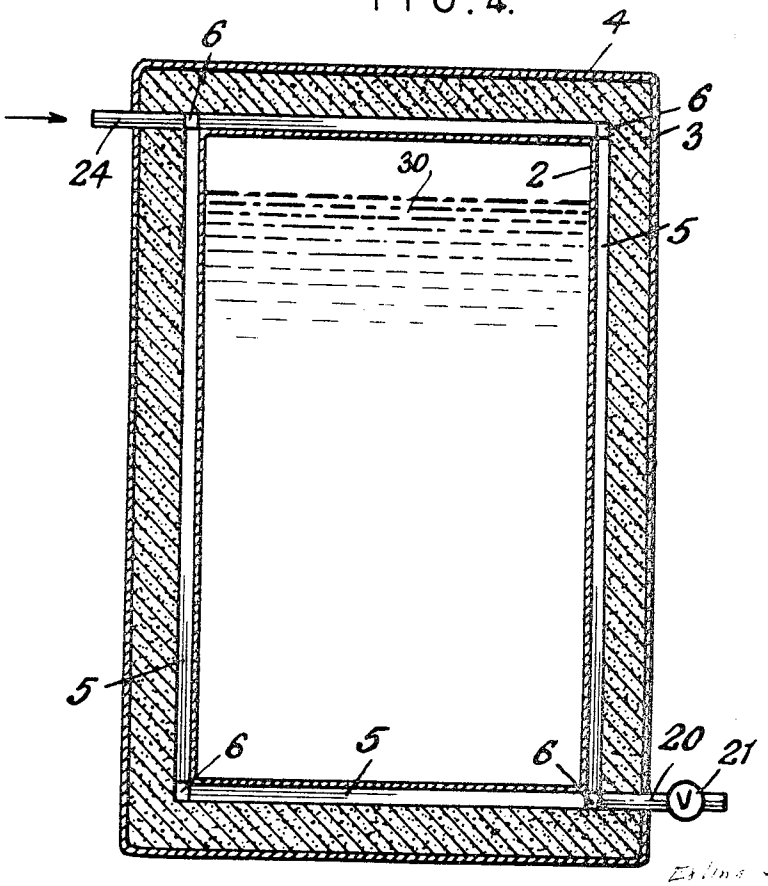


FIG. 4.



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FIG. 5.

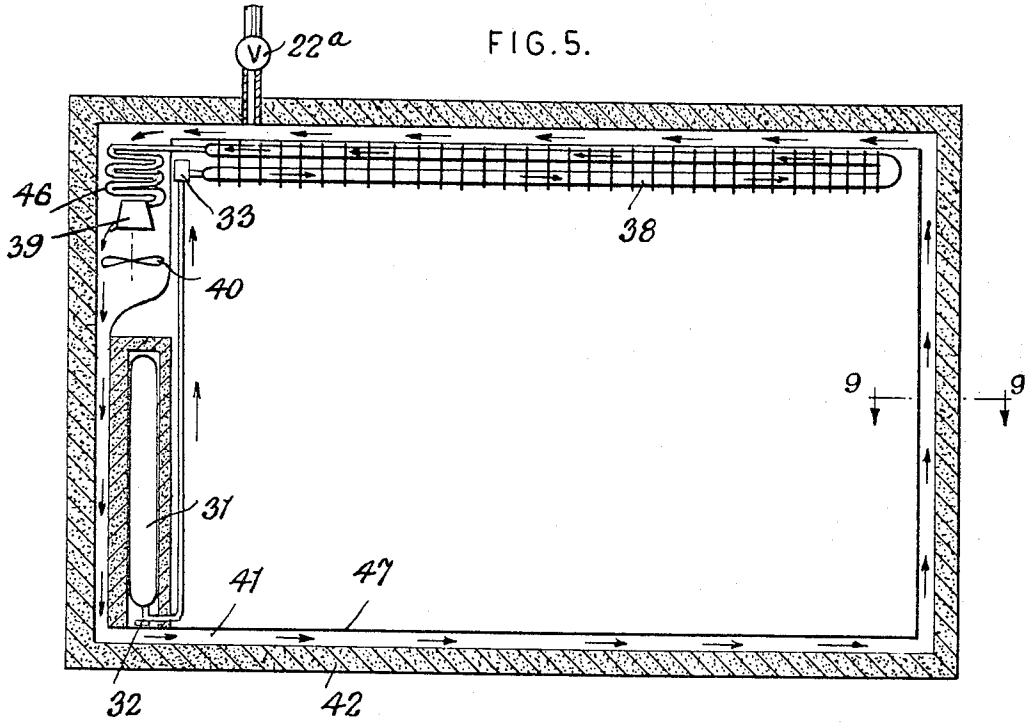
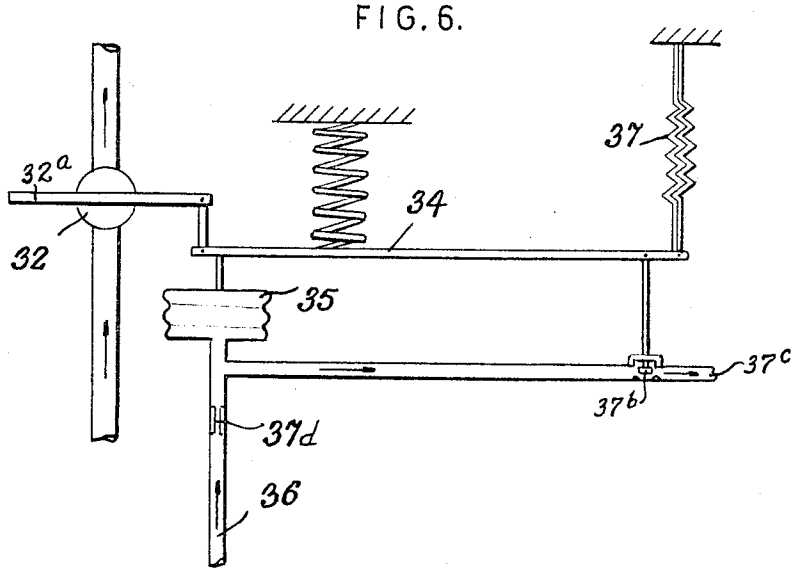


FIG. 6.



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FIG. 7.

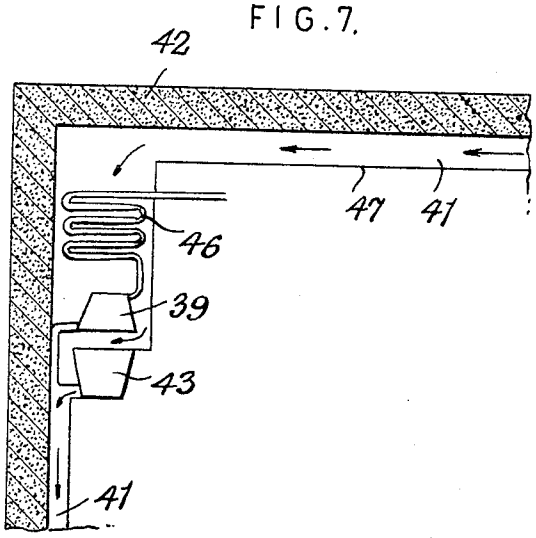


FIG. 8.

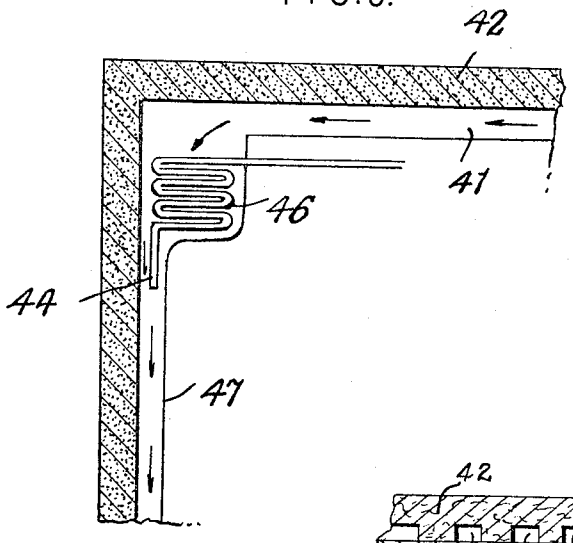
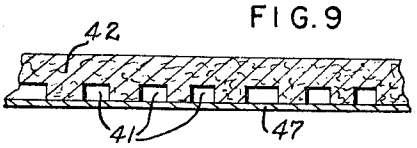


FIG. 9



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United States Patent Office 3,271,970 Patented Sept. 13, 1966

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INSULATED COLD STORAGE ROOMS OR SIMILAR ENCLOSURES

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Filed Oct. 29, 1962, Ser. No. 233,841
13 Claims. (Cl. 62—223)

This application is a continuation-in-part of my application Ser. No. 168,847, filed Jan. 25, 1962, and now abandoned.

This invention relates to a liquid gas refrigeration system and particularly to a system employing liquified gas for effecting refrigeration and dehumidification of insulated cold storage rooms or similar enclosures or chambers, and has for one of its objects the provision of means by which the accumulation of water condensate or ice in the walls of the room or chamber will be prevented.

In cold storage walls, moisture can transfer by diffusion from the air outside of the building and can condense at the lower temperature present in the wall structure. Water can in this manner accumulate in substantial quantities with a resultant decrease in the thermoconductivity of the insulating material, and may under certain circumstances, endanger the wall. In the insulation of a room having a lower temperature than the surrounding outside temperature, the higher water pressure outside of the room in vapor form will cause the vapor to penetrate into the insulation. Depending upon the permeability of the different materials embodied in the wall, the water vapor will at least partially penetrate the wall and will partly condense and remain in the walls. The part of the vapor which remains in the wall will enter the insulation and will either condense to water or ice depending upon the temperature of the room and will thus decrease the insulating effect of the insulation contained within the wall.

It is an object of the present invention to provide means by which the penetration of water vapor into the walls will be prevented or at least very materially retarded so that the accumulation of water and/or ice in the walls of the insulated room will be prevented. In securing this desirable result an over-pressure of the air is maintained in the interior of the room or chamber so that the dry cold air therein is forced in a direction against the incoming water vapor to prevent the same from entering the walls of the room or chamber. Such air under pressure, moving in the direction mentioned, will also absorb any moisture condensed in the wall. For the efficient operation of the suggested use of the over-pressure, an arrangement of passages or channels is provided in the inner surface of the wall insulation, or between the insulation and the interior lining of the walls, and with means providing for the access of the cold, dry air into such grooves, and pump means can be employed to force the air into the grooves in the insulation.

It is a further object of the invention to provide an arrangement whereby a free gas emanating from cooling means such as carbon dioxide or nitrogen can, when released under pressure, be employed and forced into the grooves or channels in the insulation, thereby preventing the entry of the water vapor into the insulation.

It is also an object of the invention to provide means for circulating a low temperature gas between the inner surface of the insulation and an inner wall lining, and particularly when said inner wall lining is composed of a material with very high heat transfer coefficient, to thereby secure a relatively homogeneous cooling of the storage in the cooling chamber.

It is a further object of the invention to employ gases as herein described, in the insulation of containers used for holding inflammable liquids, to thereby not only protect the insulation around such containers but to also add fire-resistant characteristics thereto.

With these, and other objects to be hereinafter set forth in view, I have devised the arrangement of parts to be described and more particularly pointed out in the claims appended hereto.

In the accompanying drawings, wherein illustrative embodiments of the invention are disclosed,

FIG. 1 is a vertical sectional view through a low temperature room or chamber provided with an arrangement according to the invention;

FIG. 2 is a similar sectional view of another chamber, showing another embodiment of the invention;

FIG. 3 is a sectional view through a part of a wall structure, showing means at the corner thereof for aiding in the prevention of entry of the water vapor;

FIG. 4 is a sectional view through a container in which liquid material is stored under low temperature and which container is constructed according to the present invention;

FIG. 5 is a sectional view through a chamber provided with means for circulating the gas in space between the insulation and inner wall lining;

FIG. 6 is a diagrammatic view of the flow regulator incorporated in the structure of FIG. 5;

FIG. 7 shows an embodiment in which a turbine and compressor are employed for propelling the flow through the spacing between the insulation and lining of the cooling chamber;

FIG. 8 shows an embodiment in which a jet is employed for the above purpose; and

FIG. 9 is a fragmentary transverse section through the walls of any of the embodiments hereof, for example, along the line 9—9 of FIG. 5, showing the grooved insulation in accordance herewith.

Referring to the drawings, and more particularly to FIG. 1 thereof, there is therein shown a room or chamber 1 intended for storage or other purposes requiring the interior of the chamber to be maintained at a low temperature through suitable cooling means. The walls of the chamber are each composed of an inside lining 2 which can be made of cement plaster or other suitable material, an outer lining or covering 4, and a suitable relatively thick, insulating material 3 arranged between the lining and the outer covering. Said insulation may be of the plastic foam type or of one of the other materials generally used for insulating purposes.

The insulation 3 is provided in its inner face, or in that surface which is directed toward the interior of the room, with a network of passages consisting of a plurality of grooves or channels 5, said grooves being disposed behind the lining 2 and being connected at their ends by the ducts or headers 6 so that communication is established between them.

Communication is established between the grooves 5 and the interior of the room 1 by means of a conduit shown at 7, provided with a pump 8 for pumping air from the interior of the room into the network of grooves. For the control of over-pressure in the grooves, an outlet pipe 9 is provided. Said pipe establishes communication between the interior of the room and the grooves and it is provided with a regulating valve 10.

The above described arrangement is such that the dry cold air from the interior of the room or chamber 1 is delivered by means of the pump 8, and such air will prevent the entry of water vapor from outside of the room into the insulation. If it is possible to maintain sufficient over-pressure within the room, the pump may not be needed, since the grooves might then be filled with the air under pressure through the over-pressure in the room.

In containers of various types and sizes, as well as in trailers and railroad cars where food or other materials are kept for long or short periods under low temperature, carbon dioxide in solid or liquid form or nitrogen as a liquid, is used as a refrigerant. These gases can be kept in liquid form in containers with high over-pressure and when released into the storage room they will cool the whole volume of the room. The cool gas will, however, create an over-pressure in the room and this over-pressure is released to escape into the outside atmosphere. I have found it desirable to cause free gas, which creates an over-pressure in the room, to be forced into grooves in the wall insulation. A means by which this can be done is shown in FIG. 2. The gas under over-pressure enters into the grooves **5** by means of the inlet **15** and attains the result ascribed to the structure of FIG. 1. With this arrangement however, the over-pressure in the insulation is created when the liquid gas (carbon dioxide or nitrogen) assumes a gaseous form in the storage room. The liquid gas being discharged is usually above the material **13** being stored and in the arrangement shown in FIG. 2, the gas flows out through the manifold **14** for discharge into the interior of the container. An outlet pipe **11**, provided with a valve **12**, controls the pressure of the gas in the grooves. The outlet conduit shown at **21** contains a safety valve **22**. The material being stored in the chamber **1***a* of FIG. 2 is usually spaced away from the walls thereof for free circulation of the gas around it.

In addition to the use of the gas for the purpose of preventing the admission of water vapor into the walls, the gas possesses the additional advantage of replacing the air in the insulation used. This is particularly true of certain insulating materials such as fibre glass. Since gases of the kind mentioned and especially carbon dioxide, are heavier than air, such a gas will materially increase the efficiency of the insulation when it replaces the air therein. When a material having the characteristics of fibre glass is used as insulation, grooves or channels in such insulation may not be necessary as entry of the gas into the insulation will occur rapidly.

In order to make the insulation as efficient as possible, the gas entry to the insulation can be located where the water vapor has the easiest entry into the insulation and where water and ice is more likely to collect to materially reduce the efficiency of the insulation. This is particularly true at the corner joints of a trailer or railroad car where it is found difficult to make the outside covering of the body completely water vapor tight. Through handling, and for numerous other reasons, water vapor leakage usually starts in the corners of the body. When using over-pressure, as disclosed in FIGS. 1 and 2, an arrangement can be provided by which more of the compressed air or gas will enter the walls through the corners thereof. An arrangement of this kind is shown in FIG. 3. Therein, each of the channels **6**, communicating wtih the grooves **5**, and through which the compressed air or gas passes, is in communication with an angular slot or cut **17** extending from the channel **6** through the insulation **3** for a substantial portion of its thickness. When a corner portion **18** of the covering **4** is broken away, and the water vapor tends to enter at this point, it is met by the cold, dry gas or air in the slot **17** and prevented from entry.

In containers in which liquid materials are kept at a very low temperature, problems of keeping the insulation in good shape always exists. This is especially true of large containers used for the transportation of liquids such as liquid methane and butane. The temperature is very low in the liquid gases and they are also very combustible. In FIG. 4 is shown a container holding a liquid **30** and provided with an arrangement by which such gases as nitrogen and carbon dioxide under over-pressure are circulated around the container and through the grooves **5** in the insulation. The over-pressure of non-combustible gas enters through the conduit **24** and enters the grooves, thereby keeping the water

vapor out of the insulation. An outlet **20** from the grooves is provided and which outlet has a regulating valve **21**. With an arrangement of this kind the insulating value is not only maintained but may even be increased due to the fact that a heavier gas will replace the air in the cells of the insulation and will force out any moisture therein. Also, by the admission of the gas into the insulation, the insulation will be made more fireproof since gases of this character are often used for fire-extinguishing purposes.

It should be understood that the locations of the grooves or channels **5**, referred to herein is not to be restricted to the inner face or surface of the insulation, but may be disposed at any location between the outer and inner surfaces of the insulating material.

In connection with the arrangement herein disclosed, it has been found desirable to employ the cooling effect obtained when the cool gas (air, nitrogen or carbon dioxide) passes through the grooves in the insulation. By this means, the surfaces of the low temperature or cooling chamber can be kept cool easier. It is also possible to secure better temperature control if the goods to be cooled are stored at a distance from the walls to allow the cold air to circulate, or directly against the walls in which case, no means have been usually available to provide for sufficient cooling.

It is also possible to increase the cooling effect if, instead of a plurality of grooves, a completely open or uninterrupted spacing is provided between the insulation of the wall and the lining therefor. Thereby it is possible to circulate the cool gas faster around the storage chamber for cooling purposes. Another expedient to increase the transfer of heat and to make the temperature difference in different parts of the chamber vary as little as possible, is to circulate the cold gas around the chamber in a space between the insulation and the lining, which circulation can be aided by one or more fans, one of which is shown at **40** in FIG. 5, or by a jet ejector as shown at **44** in FIG. 8.

In some cases it might be found impossible to operate a fan as above described for lack of electric power. This is particularly true in cases where the storage space might be in a van, trailer or truck. In such case, the pressure difference between the gas when leaving the pipe leading from the liquid gas container and the pressure in the grooves or ventilation space can be used to drive the fan, as in FIGS. 5 or 7, or it can work as an ejector as in FIG. 8, and thus recirculate the gas that has already been circulated in and around the insulation.

It is desirable that no gas shall pass into the storage chamber, but rather that it passes directly into the ventilation space between the insulation and the inner lining. By using the low temperature in the liquid gas, the cooling can be done wholly or partly through this space.

In the arrangement shown in FIG. 5, the liquid gas is supplied from a supply tank **31**, and passes valve **32** to a flow regulator **33** which may be of known type and constructed substantially as shown in FIG. 6. It will be therein noted that the valve **32** is controlled by movement of the arm **32***a* by means of the pneumatic cylinder **35** into which high pressure gas enters through the pipe **36** controlled by the throttle **37***d*. The liquified gas from the tank **31** has a flow course indicated by the arrows in FIG. 5, the flow being controlled by the temperature-sensitive element **37** which is placed in direct contact with the interior of the room. This control element will change in length with the temperature whereby throttle **37***b* will move up or down, causing more or less gas to pass out through the outlet **37***c*, the gas flowing into control conduit **36** being bled off from the main gas supply. As a result, the pressure on the cylinder **35** will decrease or increase, thus causing the cylinder to decrease or increase in height, which in turn will cause the valve **32** to open to a greater extent or to close more. The liquified gas flows into the finned piping **38** constituting an evapo-

rator, and from thence through the coil **46** forming a heat exchanger, to the turbine **39** using part of the pressure energy of the gas, to run the fan **40**, into the gas channel **41** located between the wall lining **47** and the insulation **42**.

In a modified structure shown in FIG. 7, a compressor **43** is used in conjunction with the turbine **39**, and in the embodiment shown in FIG. 8, an ejector or jet **44** is used to move the flow through the channel **41**. In the structure shown in FIG. 7, the turbine **39** is driven by the high pressure gas and it serves as a fan to drive the compressor **43**, pumping the gas from the gas channel **41** into the passage **41***a*, giving the gas a higher pressure.

Through the several arrangements described, the liquified gas will evaporate in the evaporator **38** placed within the storage chamber. From the evaporator which converts the liquified gas into a true gas, the gas so formed reaches the heat exchanger **46** and by means of the turbine **39** and fan **40**, as shown in FIG. 54, or by means of the compressor **43** or jet **44**, the gas will be circulated through the space **41** between the insulation and the lining **47**.

A further arrangement is possible in which the spacing between the insulation and the inner wall or lining can be so arranged that the cold gas can first circulate through a portion of the spacing and thereafter through a succeeding section thereof whereby the insulation can be used as a heat exchanger.

In FIG. 5 a safety valve **22***a* is provided for the same purpose as the valve in FIG. 2.

Having thus described several embodiments of the invention, it is obvious that the same is not to be restricted thereto, but is broad enough to cover all structures coming within the scope of the annexed claims.

What I claim is:

1. In cold storage apparatus of the character described with the interior thereof refrigerated by heat transfer contact with a cold gas and having spaced apart inner and outer walls with heat-insulating material disposed therebetween, said inner walls having higher heat transferability than said insulating material, the combination which comprises a source of said cold gas, gas-circulating grooves in the inner surface of said insulating material forming a network of gas-circulating passages extending throughout substantially the entire wall area of said apparatus between said inner walls and said insulating material, means for introducing and circulating at least a portion of said cold gas through said grooves and around the outside of said inner walls and in heat-transfer contact with both said inner walls and said insulating material effecting both cooling of the interior of said cold storage apparatus and removal of moisture from said insulating material, said cold gas being maintained at superatmospheric pressure in said grooves for minimizing leakage of moisture into said insulating material from outside said apparatus, and means for exhausting said gas from said grooves to the atmosphere.

2. Cold storage apparatus as recited in claim **1** in which said source of said cold gas is refrigerated air in the interior of said apparatus.

3. Cold storage apparatus as recited in claim **1** in which said source of said cold gas is disposed outside the refrigerated interior of said apparatus.

4. Cold storage apparatus as recited in claim **1** which also includes deep diagonal slots in said insulating material at corners of said apparatus extending toward said outer walls and in flow communication with said grooves for flow of said superatmospheric cold gas in said slots for minimizing leakage of moisture into said insulating material from outside said apparatus at said corners thereof.

5. Cold storage apparatus as recited in claim **1** in which the aggregate flow capacity of said cold gas through said grooves is in excess of that required merely to dry said insulating material and prevent leakage of moisture from outside said apparatus into said insulating material.

6. Cold storage apparatus as recited in claim **1** in which said cold gas circulated through said grooves between said inner walls and said insulating material is a gas other than air and supplied from a source of liquefied gas constituting substantially the only means of refrigerating said cold storage apparatus.

7. Cold storage apparatus as recited in claim **6** which also includes evaporator means in heat-transfer relation with the interior of said apparatus, conduit means connecting said source of liquefied gas into flow communication with said evaporator means, additional conduit means connecting said evaporator means into flow communication with said grooves between said inner walls and said insulating material for flow of said liquefied gas upon evaporation thereof from said source through said evaporator means and then through said grooves, and control means for regulating said flow of gas through said apparatus.

8. Cold storage apparatus as recited in claim **7** which also includes means for regulating said exhausting of said gas from said grooves for maintaining a superatmospheric pressure in said grooves.

9. Cold storage apparatus as recited in claim **7** which also includes means for providing a forced flow of said gas through said grooves.

10. Cold storage apparatus as recited in claim **9** in which said forced flow means includes a turbine driven by said gas after leaving said evaporator means and blower means driven by said turbine for providing said forced flow of said gas.

11. Cold storage apparatus as recited in claim **9** in which said forced flow means includes a jet ejector through which said gas passes after leaving said evaporator means.

12. Cold storage apparatus as recited in claim **7** in which said evaporator means is at the top of said apparatus and extends substantially throughout the length of the interior thereof for providing the primary source of heat transfer for the refrigeration of said apparatus.

13. Cold storage apparatus as recited in claim **6** in which said source of liquefied gas is a tank of liquid nitrogen disposed within said apparatus.

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