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Cool room temperature control apparatus

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ABSTRACT

A method of controlling the temperature in an enclosure comprises the step of providing means for dispersing a vaporised cryogenic life supporting gas within the enclosure to supplement and/or replace a mechanical refrigeration system 14 normally provided therein. Such cryogenic gas being breathable allows for an operator to enter the enclosure without presenting any hazard thereto. Additionally, the chilling capacity of such a cryogenic system is significantly greater than that available in any presently known mechanical system and hence enhanced overall operation may be achieved.

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title: "COOL ROOM TEMPERATURE CONTROL APPARATUS"

The following statement is a full description of this invention, including the best method of performing it known to us:-

(File: 19382.00)

COOL ROOM TEMPERATURE CONTROL APPARATUS

The present invention relates to temperature control apparatus and relates particularly, but not exclusively, to such apparatus for use in refrigeration applications.

Presently known refrigeration apparatus generally comprise mechanical refrigeration equipment which is employed to chill the atmosphere in which items such as, for example, perishable foodstuffs are stored. Generally, the foodstuff is stored in a purpose built compartment or building which is insulated from its surroundings and directly linked to the refrigeration apparatus itself. The apparatus itself must be of sufficient size and refrigeration capacity to ensure adequate refrigeration is provided during even the hottest of weather and/or during periods of peak demand. Such peak demands occurring, for example, as and when new supplies of materials to be refrigerated are deposited in the storage room. Often, there exists a requirement for a temporary refrigerated storage facility which may only be provided at great expense to the user. In addition to this, it will be appreciated that, the cost of providing a mechanical refrigeration system sufficiently large to cope with the occasional but significant peak demand is also undesirable. Further, it is often necessary to provide a backup refrigeration system in the event that the primary system is being maintained or breaks down.

It is an object of the present invention to provide a method of controlling the temperature in an enclosure which reduces and possibly overcomes the problems associated with presently known refrigeration systems.

Accordingly, the present invention provides a method of controlling the temperature in an enclosure, the method comprising:

a) forming an insulated enclosure in the form of a temporary structure the interior of which is to be subjected to temperature control;

b) providing a storage vessel, for storing a quantity of liquefied breathable, life supporting gas;

c) providing a dispensing means, within said insulated enclosure for dispensing said gas and including vaporising means for vaporising the gas during dispensing;

d) dispensing the gas in a vaporised form from the dispensing means such that the vaporised gas acts to chill any atmosphere within the enclosure thus reducing the temperature therein.

Unless the context clearly requires otherwise, throughout the description and the claims, the words 'comprise', 'comprising', and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

Preferably, the gas is provided in the form of a gas having an oxygen concentration of between 18% and 23% when fully vaporised. Such a gas being breathable and life supporting without presenting a significantly enhanced fire hazard over and above that of natural air.

Conveniently, the remaining portion of the gas is provided in the form of nitrogen.

The method may include the step of providing a plurality of spray bars extending within the enclosure for receiving said liquefied gas and a plurality of spray nozzles positioned along the spray bars for causing gas to be vaporised and dispensed from the bars, thereby to cause the vaporised gas to disperse within the enclosure.

In a particularly advantageous arrangement, the method includes the step of providing temperature sensing means within the enclosure and control means operably linked to each other and the dispensing means and causing said sensing means and control means to allow or inhibit dispersing of cryogen so as to maintain the temperature within the enclosure within a predetermined range.

Preferably, the method includes the step of providing the insulated enclosure in the form of a bubble wrap material having an air gap of substantially 4-5 mm and having inner and outer reflective surfaces for preventing or reducing the passage of heat through the material.

In another embodiment of the present invention there is provided a method of operating a refrigeration system of a type comprising an enclosure for the storage of items to be refrigerated, a mechanical refrigeration apparatus for refrigerating the atmosphere within the enclosure and maintaining it within a predetermined temperature range, the method comprising the step of dispensing a quantity of breathable life supporting cryogenic gas from a plurality of spray nozzles within the enclosure, thereby to chill or further chill the atmosphere therein.

In a particularly advantageous arrangement, the method includes operation of the cryogenic gas dispenser during a start-up phase of the refrigeration system, thereby to more rapidly chill the atmosphere within the enclosure.

Conveniently, the cryogenic gas may be dispensed during operation of the mechanical refrigeration system, thereby to supplement said system during periods in which an enhanced chilling effect is required.

In some arrangements, the cryogenic gas may be dispensed continually during the operation of the mechanical refrigeration system, thereby to supplement the mechanical system and enhance the chilling capacity thereof.

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a prior art cold store;

Figure 2 is a cross sectional view of a cold store suitable for operation in accordance with the present invention;

Figure 3 is a schematic representation of an alternative gas supply apparatus; and

Figure 4 is a cross sectional view of the insulation material provided in Figure 2.

Referring briefly to Figure 1, a cold store generally comprises an insulated enclosure such as building 10 having an entrance 12 and a mechanical refrigeration apparatus 14 for extracting, refrigerating and then returning the atmosphere within the enclosure. Such systems must provide a refrigeration apparatus 14 of sufficient refrigeration capacity to accommodate what can be significant variations in the demand for chilling atmosphere. For example, whilst it is comparatively easy to maintain an already established temperature under stable conditions, it is difficult and sometimes impossible to provide sufficient chilling capacity to accommodate situations where large batches of product to be chilled are being added to and/or removed from the enclosure. This is particularly the case during periods of high ambient temperature during which heat inleak into the enclosure can be a significant problem. Also, fresh produce entering the enclosure will be at a somewhat higher temperature than normal and hence requires significantly more chilling once it is stored within the enclosure. Some mechanical systems even when operated at fully capacity, are unable to meet peak demands placed thereon. Consequently, the integrity of the produce can be compromised.

Turning now to Figure 2 it will be appreciated that the enclosure of Figure 1 may be supplemented with a liquid cryogen spray bar arrangement 16 and a supply of a liquefied breathable, life supporting gas 18 stored in storage vessel 20. The spray bars 16 extend within the enclosure and are each provided with a plurality of spray nozzles 22 positioned along the spray bars for causing gas to be vaporised and dispensed from the bars, thereby to cause the vaporised gas to disperse within the enclosure as illustrated by arrows A. Often, produce 24 stored within the enclosure is stacked on the pallets 26 so as to form a number of rows separated by air spaces through which delivery vehicles or fork lift trucks may be driven. By suitable positioning of the spray bars 16 and nozzles 22, it will be possible to ensure that vaporised gas is directed downwardly into these open regions and reach the produce even at the most remote portion of each stack. In a particularly advantageous arrangement, the apparatus further includes a temperature sensor 28 positioned within the enclosure and adjacent any produce 24 stored therein which acts to monitor the temperature within the enclosure and provide the data to control apparatus 30 which is operably linked to control valve 32 for allowing or inhibiting the flow of cryogenic gas as and when necessary thereby to maintain the temperature within the enclosure within a predetermined range. It will be appreciated that the above described apparatus may be employed independently of, or in addition to a mechanical refrigeration apparatus 14 which is, therefore, optional and, hence, shown in a broken outline in Figure 2. Full details of the operational modes will be provided later herein.

It will be appreciated that enclosure 10 may take the form of a presently existing enclosure or may be in the form of an insulated but temporary structure as more specifically shown at 32 in Figure 2. This structure need only comprise a simple support frame 34 and an insulating coating provided in the form of, for example, sheets of bubble wrap material 36 as best seen in Figure 4. Such material comprises a plurality of bubbles of entrapped air 40 formed between inner and outer surfaces 42, 44. Preferably, each of the inner and outer surfaces 42, 44 is provided with a thin reflective surface 46, 48 for reducing the passage of heat through the insulation material. Such coatings 46, 48 are well known in the art and are therefore not described further herein. However, it has been found that optimum insulation performance can be achieved with an air gap of substantially 4-5mm between the inner and outer surfaces 42, 44.

The liquefied breathable gas 18 may be a mixture of liquid nitrogen and liquid oxygen mixed at the source of production such that the mixture provided is capable of dispensing a gas having an oxygen concentration of between 18% and 23% when fully vaporised. For convenience, the balance of the liquid gas comprises nitrogen. It will however be appreciated that other gaseous elements may be provided if the addition thereof is found to be desirable. Whilst the actual ratio of the mixture required in its liquid form will very much depend upon the magnitude of any "enrichment" during storage and transfer, it has been found that mixtures of liquid nitrogen and liquid oxygen are surprisingly stable and, hence, little if any enrichment will take place. Indeed, enrichment will only take place when the liquid mixture boils and is therefore a function of storage tank heating. Any heating of the storage tank will result in the more volatile nitrogen boiling off and vaporising within any headspace in the storage tank. Such vaporisation will result in the remaining liquid becoming slightly enriched in the less volatile oxygen. Provided the vessel does not overpressurise and vent the vaporised atmosphere, the enrichment will be negligible. However, if in practice the liquid in the vessel does become excessively enriched then the remaining gas should be vented off and the vessel refilled.

The percentage of oxygen present in the final vaporised form should be sufficient to provide a comfortable, breathable atmosphere which does not present a fire hazard. In practice, an oxygen concentration of between 18% and 23% oxygen by volume in the fully vaporised state has been found to provide sufficient oxygen to support life whilst still being fire safe.

The person skilled in the art will be well aware of the mixing process required to produce a gas mixture which, when fully vaporised, provides an oxygen concentration within the above-mentioned range. However, we offer the following calculations by way of example.

BASIC DATA

	At Boiling Point	At 0°C
Density of Oxygen	1140. kg/m^3 (at -183°C)	1.429 kg/m^3
Density of Nitrogen	808.1 kg/m^3 (at -196°C)	1.2505 kg/m^3

EXAMPLE 1

Atmosphere required = 18% oxygen by volume at 0°C once dispensed from nozzles (remainder = N_2).

Assuming 100m³ volume.

Mass of O_2 required = 18 x 1.429 = 25.722 kg
Mass of N_2 required = 82 x 1.2505 = 102.541 kg

Therefore percentage O_2 by weight = 19.96%

Therefore the liquid will need this proportion of its mass as O_2.

Hence assuming a liquid load of 100 kg the 25.722 kg of O_2 equates to a liquid volume of 22.56 litres and the 102.541 kg of N_2 equates to a liquid volume of 126.90 litres.

EXAMPLE 2

Atmosphere required = 21% oxygen by volume at 0°C.

Mass of O_2 required per $100m^3$ = 30.009 kg
Mass of N_2 required per $100m^3$ = 98.789 kg

Therefore percentage O_2 by weight = 23.3%

Assuming a liquid load of 100 kg.

23.30 kg O_2 = 20.439 litres (at boiling point)
76.70 kg N_2 = 94.91 litres (at boiling point)

EXAMPLE 3

Atmosphere required = 22% oxygen by volume at 0°C.

Mass of O_2 required per $100m^3$ = 31.438 kg
Mass of N_2 required per $100m^3$ = 97.539 kg

Therefore percentage O_2 by weight = 24.37%

Assuming a liquid load of 100 kg.

24.37 kg O_2 = 21.38 litres (at boiling point)
75.63 kg N_2 = 93.59 litres (at boiling point)

EXAMPLE 4

Atmosphere required = 23% oxygen by volume at 0°C.

Mass of O_2 required per $100m^3$ = 32.867 kg
Mass of N_2 required per $100m^3$ = 96.288 kg

Therefore percentage O_2 by weight = 25.45%

Assuming a liquid load of 100 kg.

25.45 kg O_2 = 29.013 litres (at boiling point)
74.55 kg N_2 = 60.244 litres (at boiling point)

Alternatively, separate vessels 60, 62 of liquid nitrogen and liquid oxygen may be provided for the supply of their respective liquids to a mixing device 64 upstream of control valve 32. Gas supplied to mixer 64 is mixed in the desired ratios so as to provide a gas concentration in the vaporised form thereof which is both breathable and life supporting.

Operation of the above mentioned apparatus is fairly simple and comprises the steps of monitoring the temperature within the enclosure and operating control valve 32 to allow or inhibit the flow of cryogenic gas from storage vessel 20 or 60, 62 such that it flows into spray bars 16 and exits via spray nozzles 22 in a manner which causes the vaporised gas to disperse within the enclosure. The control system 30 is operated by configuring it to maintain the temperature within a predetermined temperature range set by the operators of the apparatus. Whenever the apparatus is employed in conjunction with a mechanical refrigeration apparatus 14 it will be appreciated that the mode of operation may be varied in any one of a number of different manners. For example, the cryogenic gas may be dispensed during a start-up phase of the refrigeration system, thereby to more rapidly chill the atmosphere within the enclosure. In practice, it has been found that the chilling capacity of such a cryogenic system is such as to allow the interior of an enclosure to be chilled from ambient temperature to a refrigeration temperature within a period of time as short as 8 minutes. This is in stark contrast with presently known mechanical systems which can often take many hours to achieve the same temperature. Clearly, the advantages of rapid temperature reduction would allow an operator to turn off any mechanical refrigeration system during periods of which the enclosure is not being used to refrigerate items placed therein, whilst still being able to ensure a refrigeration atmosphere is available at even the shortest of notice periods. In a further mode of operation, the cryogenic system is operated alongside a normal mechanical refrigeration system, thereby to supplement said system during periods in which an enhanced chilling effect is required. Typically, such periods might be during days of high ambient temperature and/or when large quantities of fresh produce is being delivered to the enclosure for refrigeration therein.

If so desired, the cryogenic system may be operated continually during the operation of the mechanical refrigeration system 14, thereby to supplement the system 14 and allow for a significant reduction in its chilling capacity. In this mode, a much smaller than normal mechanical refrigeration system may be employed for a given enclosure volume. Other advantages of the present invention and its combination with a mechanical refrigeration system 14 present themselves to an operator. For example, it is often necessary to provide a backup system for any mechanical refrigeration system 14 and this may be eliminated if a cryogenic system such as that disclosed above is employed. Also, the present apparatus and method of operation thereof allows for the maintenance of a single mechanical refrigeration system whilst the enclosure is still being used for the storage of perishable items. In addition to the above, it will be appreciated that the present arrangement maybe employed to supplement an already existing enclosure 10 thereby to provide the operator with an economic way of accommodating short term excess demand. In such an arrangement, the temporary structure shown in Figure 2 may be added to that of a permanent structure such as that shown in Figure 1. Once the demand has dropped, the temporary structure may be removed thereby returning the space associated therewith to be returned to its normal use.

Although the invention has been described with reference to specific examples it will be appreciated to those skilled in the art that the invention may be embodied in many other forms.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS :

1. A method of controlling the temperature in an enclosure, the method comprising:

a) forming an insulated enclosure in the form of a temporary structure the interior of which is to be subjected to temperature control;

b) providing a storage vessel, for storing a quantity of liquefied breathable, life supporting gas;

c) providing a dispensing means, within said insulated enclosure for dispensing said gas and including vaporising means for vaporising the gas during dispensing;

d) dispensing the gas in a vaporised form from the dispensing means such that the vaporised gas acts to chill any atmosphere within the enclosure thus reducing the temperature therein.

2. A method as claimed in Claim 1 including the step of providing the insulated enclosure in the form of a bubble wrap material having an air gap of substantially 4-5mm and having inner and outer reflective surfaces for reducing the passage of heat through the material.

3. A method as claimed in Claim 1 or Claim 2 in which the gas is provided in the form of a gas having an oxygen concentration of between 18% and 23% when fully vaporised.

4. A method as claimed in Claim 1, Claim 2 or Claim 3 in which the remaining portion of the gas is provided in the form of nitrogen.

5. A method as claimed in any preceding Claim including the step of providing a plurality of spray bars extending within the enclosure for receiving said liquefied gas and a plurality of spray nozzles positioned along the spray bars for causing gas to be vaporised and dispensed from the bars thereby to cause the vaporised gas to disperse within the enclosure.

6. A method as claimed in any preceding Claim including the step of providing temperature sensing means within the enclosure and control means operably linked to each other and the dispensing means and causing said sensing means and control means to allow or inhibit dispensing of the gas so as to maintain the temperature within the enclosure within a predetermined range.

7. A method substantially as described herein with reference to Figures 1 to 4 of the accompanying drawings.

DATED this 24th day of March, 2000.

THE BOC GROUP PLC

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Fellow Institute of Patent and Trade Mark Attorneys of Australia
of BALDWIN SHELSTON WATERS

FIG. 1

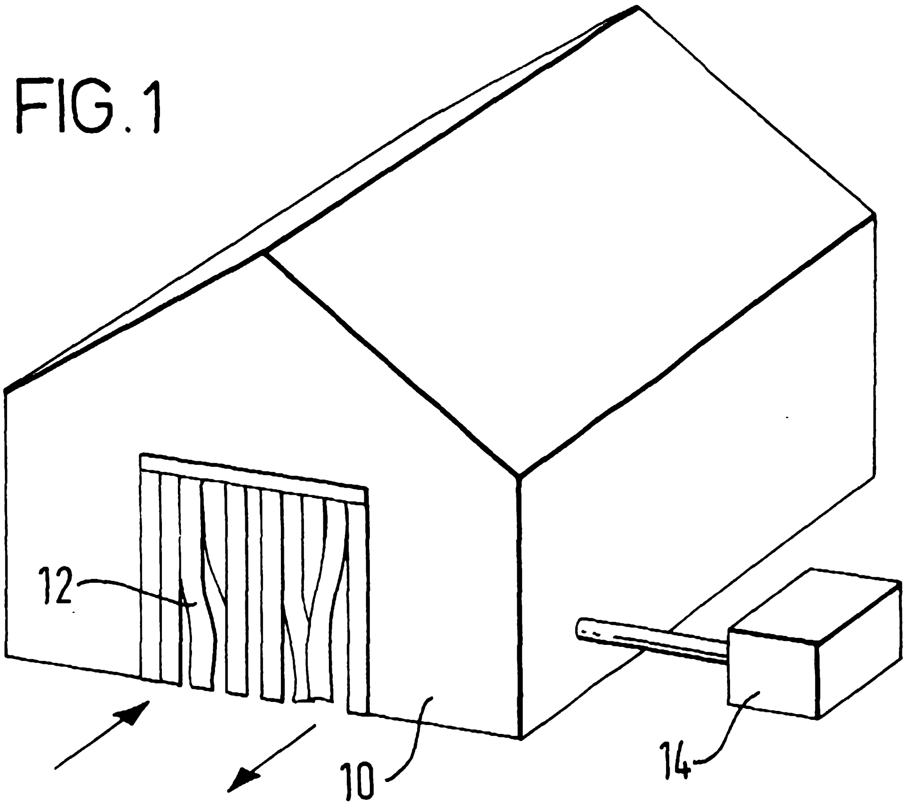
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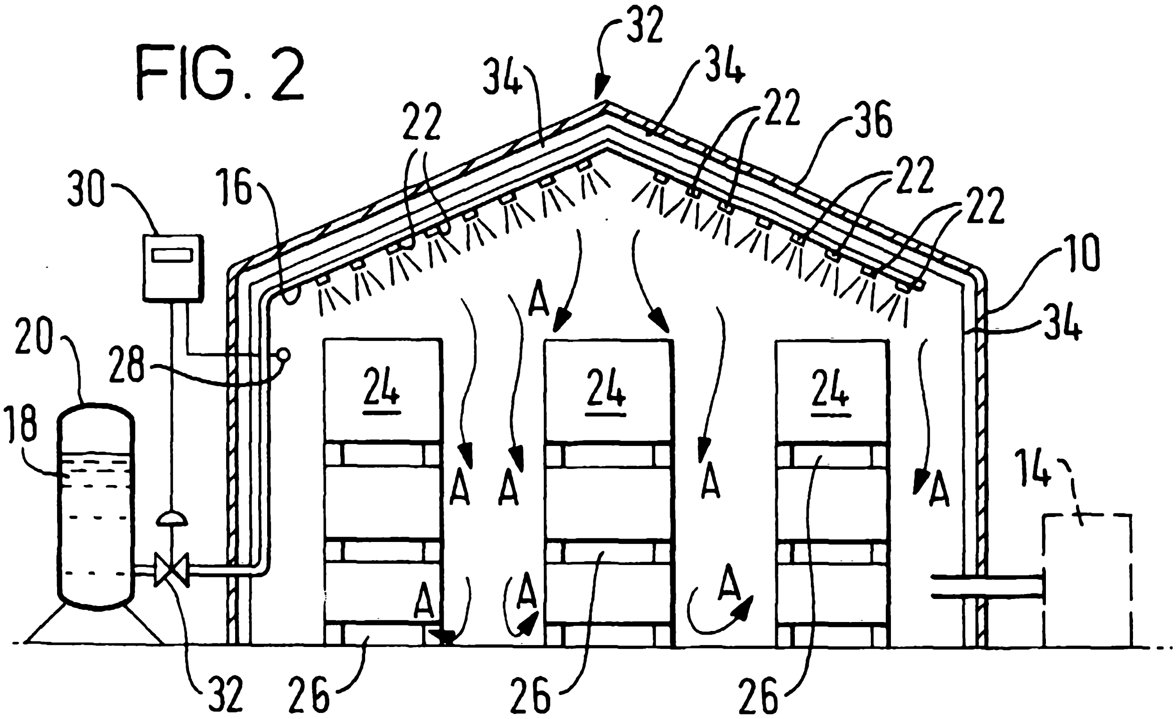
FIG. 2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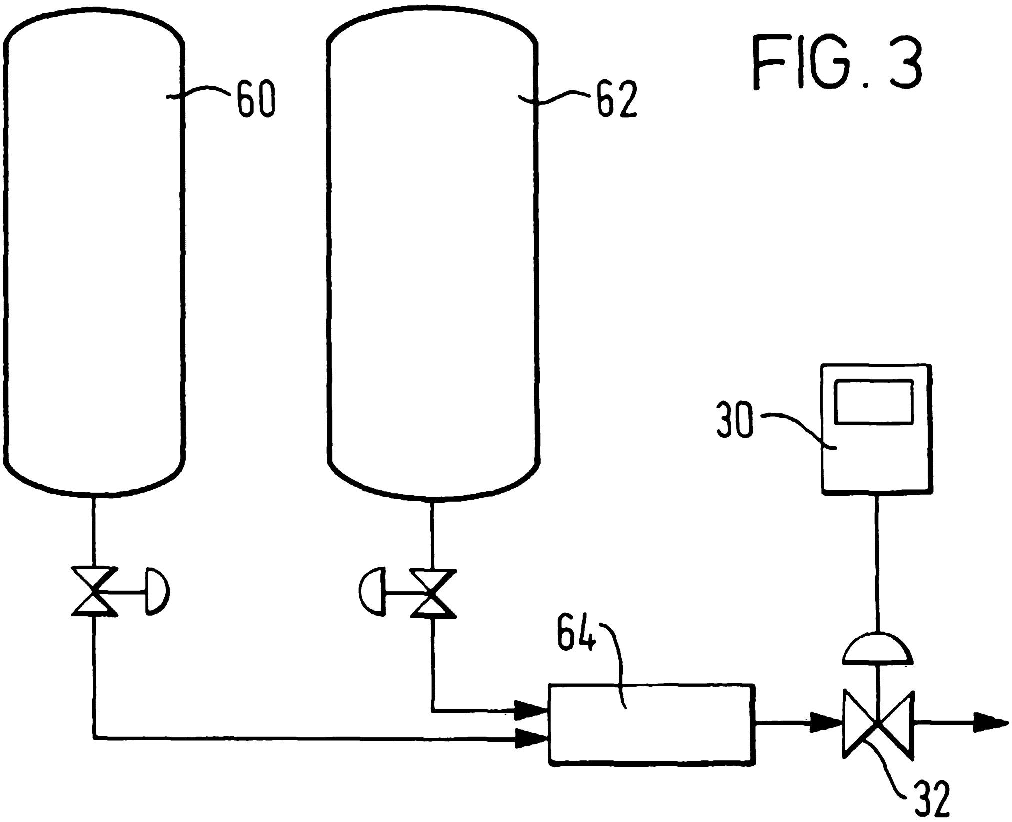

FIG. 3

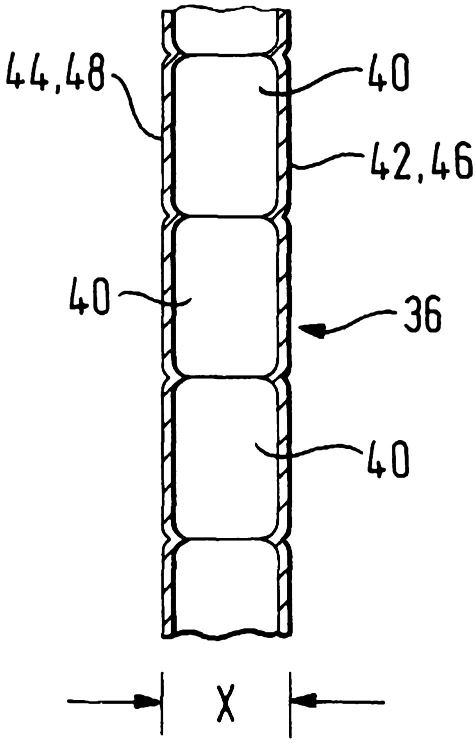

FIG. 4