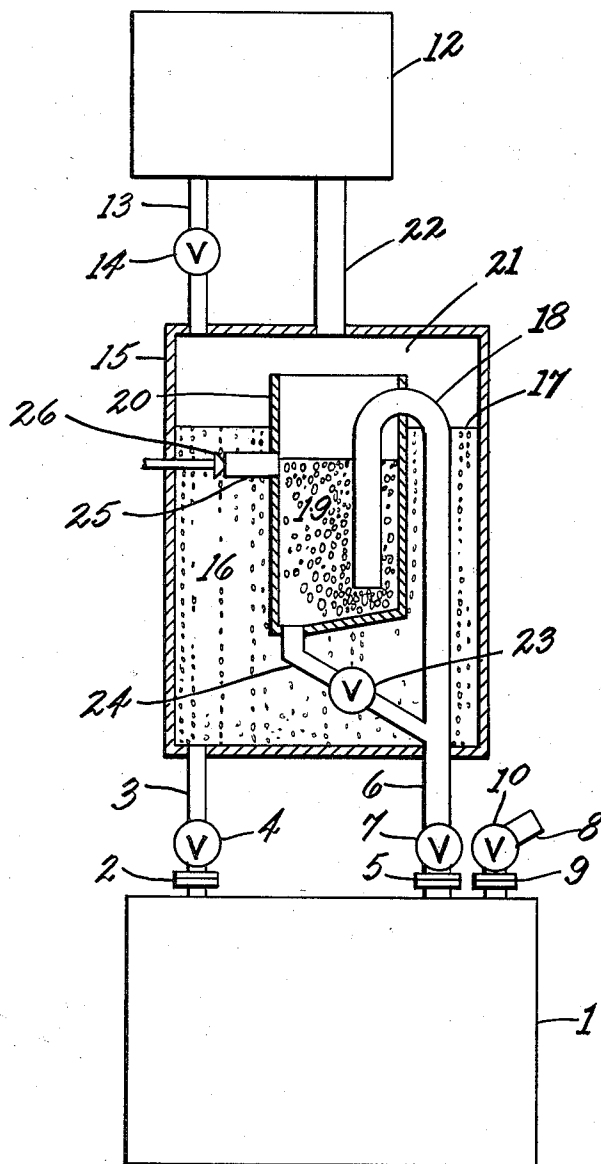


June 9, 1959

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METHOD AND APPARATUS FOR CHILLING PERISHABLE
MATERIALS SUCH AS FOODSTUFFS
Filed Nov. 16, 1956

2,889,689



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METHOD AND APPARATUS FOR CHILLING PERISHABLE MATERIALS SUCH AS FOODSTUFFS

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Application November 16, 1956, Serial No. 622,658

6 Claims. (Cl. 62—64)

My apparatus relates to improvements in method and apparatus for chilling perishable materials such as foodstuffs and the like and has for one object to make it possible under economic and safe conditions to chill foodstuffs by bringing liquid nitrogen at generally atmospheric pressure into contact with them or their immediate containers, so that the latent heat of evaporation needed to cause the liquid to boil at atmospheric pressure and -320° F. will be supplied to the liquid by the foodstuffs in contact with it. The resultant gas will be immediately discharged from the closed chamber, the chilling zone, to be recompressed, reliquefied and again returned to chill the foodstuffs.

Since before the foodstuffs are to be chilled they must be packed in a closed container or cooling zone, there will be a certain amount of air with perhaps water vapor in the clearances between the packages. If this air and moisture is allowed to enter the reliquefaction system with the nitrogen gas, it may, as it builds up, do harm and I propose therefore to prevent such entrance by bubbling the vaporized nitrogen with any entrained air and water vapor through a liquid nitrogen bath. The gaseous nitrogen will bubble through and go on to reliquefaction but the oxygen, water vapor and any other diluents will be liquified and retained in the bath.

By this arrangement all diluents, removed from the gas before it is recycled, will be concentrated in the bath for disposal. Such disposal may take a number of forms. One easy solution would be, as the bath became excessively diluted, periodically to waste the entire contents, replacing it with new liquid nitrogen. Another solution would be to purge the diluents from the bath by any one of a number of well known methods applied to the relatively small bath content rather than the relatively large nitrogen content of the entire system.

A preferred solution is as follows: The volume, weight and character of the material in the cooling zone is known, the quantity of liquid nitrogen in the bath is known and the quantity of liquid necessary to cool the material to the desired low temperature can be determined. Liquid will be fed to the cooling zone at a known rate, the gaseous nitrogen bubbling through the bath until the desired low temperature of the foodstuffs is approached. When just the quantity of liquid contained in the bath is necessary to reach the desired temperature, the normal liquid supply from and gas return to the reliquefying system will be stopped. The contents of the bath will then be dumped into the cooling zone to supply the necessary additional coolant and will when vaporized be wasted to atmosphere, or the nitrogen evaporated from the liquid will be returned for reliquefaction and the oxygen will be left in the cooling zone.

Then when another batch of material is to be chilled, the cycle will be repeated. Thus each batch of material in its separate container may, toward the end of its cooling period, have returned to it with the liquid nitrogen bath all of the diluents which were in it in the first place

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and so will not in any way interfere with effective storage or shipment of foodstuffs in the insulated container in which they were chilled. The nitrogen, after liquefaction, use as a coolant and reliquefaction will not be deleteriously diluted. The sole loss in nitrogen will be the relatively small quantity of nitrogen which may be lost with the bath contents.

Under other circumstances the dumping of the bath may take place after a number of batches have been chilled.

Another advantage of the use of the bubbling bath is that superheat of the evaporated gas will be suppressed by the bath, thus simplifying the problem of reliquefying the nitrogen evaporated in the cooling zone.

My invention is illustrated diagrammatically in the accompanying drawing, wherein like parts are indicated by like characters throughout the specification and drawing.

An insulated shipper container 1, which will normally before chilling, be filled with foodstuffs to be frozen and chilled, will be removably connected at 2 to the liquid nitrogen supply pipe 3 controlled by valve 4, will be removably connected at 5 to the gaseous nitrogen discharge pipe 6 controlled by the valve 7, and will have a discharge pipe 8, removably connected at 9, and controlled by the valve 10.

The valves 4, 7 and 10 would be manually controlled to open and close as will hereinafter appear, the point being that a multiplicity of shipper containers or chill boxes may be separately successively connected to the system. Only one such box may be connected to the system at a time or a multiplicity of them as the case may be.

A nitrogen reliquefaction plant is indicated diagrammatically at 12 which will, of course, include the usual compressors, intercoolers, etc. and will discharge gaseous nitrogen under high pressure through the pipe 13 and Joule Thompson expansion valve 14 to the liquid nitrogen reservoir 15 from which liquid may be discharged through the pipe 3 when the valve 4 is opened. The pipe 6 extends up through the nitrogen 16 in the reservoir 15, the level of the nitrogen being indicated at 17 and discharges by a gooseneck 18 into a separate liquid nitrogen bath 19 in a bath container 20 contained within the reservoir 15 and immersed in the liquid nitrogen supply 16. The gaseous nitrogen vaporized in the chill box 1 passes up through this pipe and is bubbled into the bath 19. Gaseous nitrogen bubbling out through the bath into the gas dome 21 in the reservoir 15 and thence as gas through the pipe 22 to supply the gaseous nitrogen for recompression and reliquefaction. When valves 4 and 7 are open and liquid nitrogen is being supplied to the chill box 1 and vaporized therein, the foodstuffs furnishing the latent heat to vaporize it, the valve 10 will be closed and all the gas evolved in chamber 1 will be bubbled through the bath 19. Since there will always be a certain amount of water vapor and other diluents in the chill box, such diluents as are mixed in gaseous form or picked up by the gas will be discharged to the bath 19, will be condensed therein, and only nitrogen will be returned to the compression reliquefaction plant. Thus the bath 19 will gradually be contaminated by these diluents and the time will come when they should be removed from the system. This can be done by closing the valve 4 and opening the valve 23 which will permit the bath contents to flow through the pipe 24 into the gas escape duct 6 into the chill box where the bath contents will be gasified. If the valve 10 is open, the gas resulting from the relatively small amount of liquid in the bubble bath may be vented to atmosphere. On the other hand, since the pipe 6 is of relatively large capacity compared to the pipe 24, the valve 10 may remain closed and the liquid will flow by counter current downwardly through the duct 6 into the cold box and the

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resultant gas will pass back through the gooseneck 18 into the bath chamber now empty of liquid and thence return to the compressor, leaving in the cold box the liquid contents other than the nitrogen so that there is return to the cold box the diluents that were removed from it in the first instance.

When a bubbling bath is to be used again, liquid nitrogen from the vessel 16 may be supplied to the bath vessel 19 through duct 25 under control of the valve 26.

I claim:

1. The method of chilling perishable materials, such as foodstuffs, which consists in discharging liquid nitrogen at substantially atmospheric pressure into a cooling zone, wherein the heat of the material being cooled, is given up to provide the latent heat to boil the liquid, discharging the resultant gas from the zone, bubbling it through a bath of liquid nitrogen wherein oxygen and other diluents if any, picked up by the gas in the cooling zone, are condensed, then reliquefying the gaseous nitrogen for return to the cooling zone, periodically stopping the supply of liquid nitrogen to and the reliquefaction of gas from the zone and thereafter supplying the bath contents to the zone, while wasting the resulting gas.

2. The method of chilling perishable materials such as foodstuffs which consists in packing successive batches of material to be chilled in a plurality of completely separated cooling zones, discharging liquid nitrogen at substantially atmospheric pressure into one of said zones wherein the heat of the material being cooled, is given up to provide the latent heat to boil the liquid, discharging the resultant gas from the zone, bubbling it through a bath of liquid nitrogen wherein oxygen and other diluents if any, picked up by the gas in the cooling zone, are condensed, then reliquefying the gaseous nitrogen for return to the cooling zone, stopping the supply of liquid nitrogen to and the reliquefaction of gas from the zone and thereafter supplying the bath contents to the zone, while wasting the resultant gas, then repeating the cycle with another of said cooling zones.

3. The method of chilling perishable materials such as foodstuffs which consists in packing successive batches of material to be chilled in a plurality of completely separated cooling zones, discharging liquid nitrogen at substantially atmospheric pressure into one of said zones, wherein the heat of the material being cooled, is given up to provide the latent heat to boil the liquid, discharging the resultant gas from the zone, bubbling it through a bath of liquid nitrogen wherein oxygen and other diluents if any, picked up by the gas in the cooling zone, are condensed, then reliquefying the gaseous nitrogen for return to the cooling zone, stopping the supply of liquid nitrogen to the zone and the return of the gas for reliquefaction when sufficient liquid has been supplied to the zone to cool it to the desired point, then repeating the process with a successive zone.

4. The method of chilling perishable materials such as foodstuffs which consists in packing successive batches of material to be chilled in a plurality of completely separated

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cooling zones, discharging liquid nitrogen at substantially atmospheric pressure into one of said zones, wherein the heat of the material being cooled, is given up to provide the latent heat to boil the liquid, discharging the resultant gas from the zone, bubbling it through a bath of liquid nitrogen wherein oxygen and other diluents if any, picked up by the gas in the cooling zone, are condensed, then reliquefying the gaseous nitrogen for return to the cooling zone, stopping the supply of liquid nitrogen to the zone and the return of the gas for reliquefaction when sufficient liquid has been supplied to the zone to cool it to the desired point, then repeating the process with a successive zone, and periodically terminating the supply of liquid nitrogen to a zone before the desired temperature has been reached and completing cooling by discharging the bath contents to said zone while wasting such gas.

5. The method of chilling perishable materials such as foodstuffs, for storage and shipment, which consists in packing the material in a portable cooling zone, removably connecting such zone into a gas circulating system wherein gaseous nitrogen is liquefied, discharging such liquid nitrogen at substantially atmospheric pressure and at a temperature of approximately -320 degrees F. into the zone whereby the heat of the material is given up to provide latent heat to boil the liquid, bubbling the resultant gas through a bath of liquid nitrogen wherein oxygen and other diluents if any picked up by the gas in the cooling zone are condensed, then reliquefying the gaseous nitrogen for return to the cooling zone and periodically discharging the contaminated contents of the bath into a cooling zone whereby the heat of the material in the zone is given up to provide latent heat to boil the bath liquid and wasting the resultant gas from the system.

6. The method of chilling perishable materials such as foodstuffs, for storage and shipment, which consists in packing the material in a portable cooling zone, removably connecting such zone into a gas circulating system wherein gaseous nitrogen is liquefied, discharging such liquid nitrogen at substantially atmospheric pressure and at a temperature of approximately -320 degrees F. into the zone whereby the heat of the material is given up to provide latent heat to boil the liquid, bubbling the resultant gas through a bath of liquid nitrogen wherein oxygen and other diluents if any picked up by the gas in the cooling zone are condensed, then reliquefying the gaseous nitrogen for return to the cooling zone and periodically replacing the contaminated contents of the bath.

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