United States Patent [19]

Wagner

[11] **3,871,186**

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[54] **APPARATUS AND METHOD FOR REFRIGERATING ARTICLES**

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[73] Assignee: **Integral Process Systems, Inc.,** Park Forest, Ill.

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[21] Appl. No.: **390,755**

[52] **U.S. Cl.** **62/64,** 62/298, 62/303, 62/375, 62/380

[51] **Int. Cl.** **F25d 17/02**

[58] **Field of Search** 62/374, 375, 376, 380, 62/63, 298, 302, 303, 64

[56] **References Cited**

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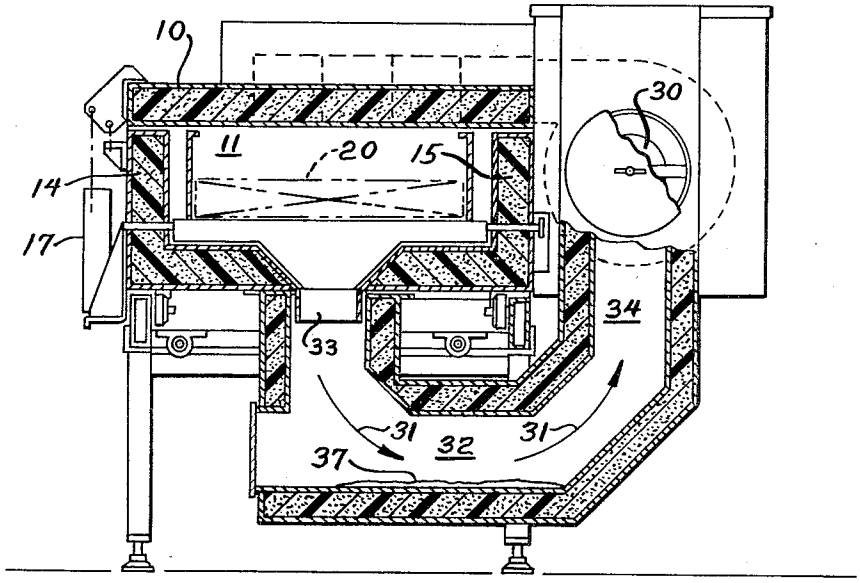
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Primary Examiner—Meyer Perlin
Assistant Examiner—Ronald C. Capossela
Attorney, Agent, or Firm—Hofgren, Wegner, Allen, Stellman & McCord

[57] **ABSTRACT**

Apparatus and method for refrigerating articles including an insulating chamber, a conveyor for moving articles through the chamber, a liquid spray system for introducing the liquid cryogen such as liquid nitrogen for contact with the articles with resulting generation of cryogen gas through the chamber in a recirculation path that includes a path portion located externally of the chamber and means for collecting liquid cryogen from the chamber in the external path portion for contact with the recirculated fluid cryogen passing therethrough with resulting vaporization of the collected liquid and entrainment of the liquid in the recirculated gas.

14 Claims, 10 Drawing Figures



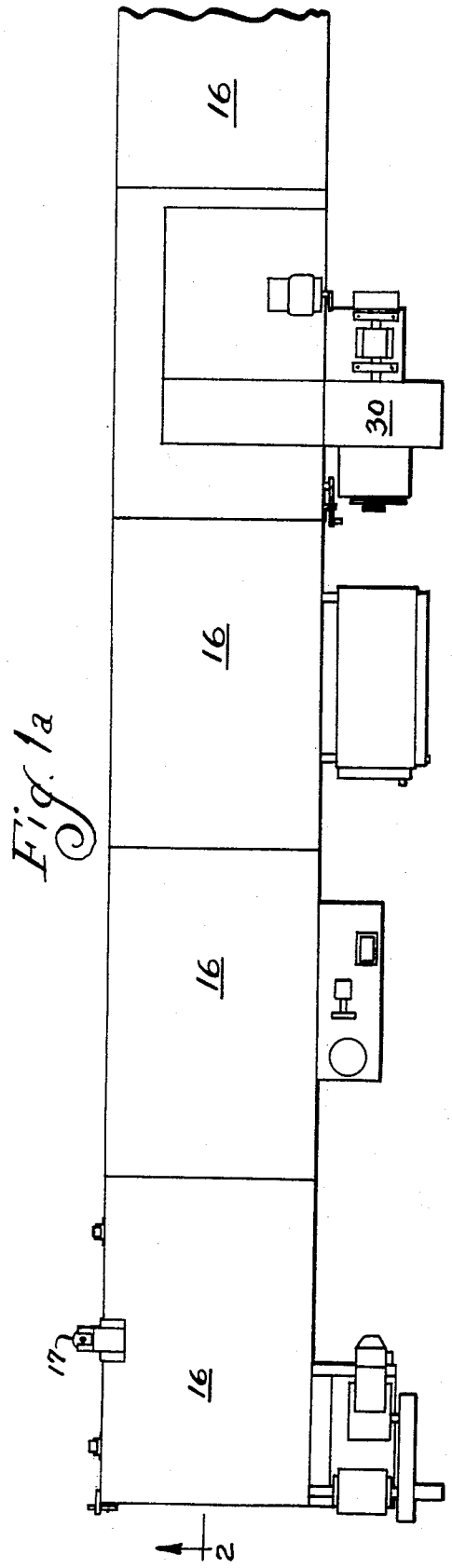


Fig. 1a

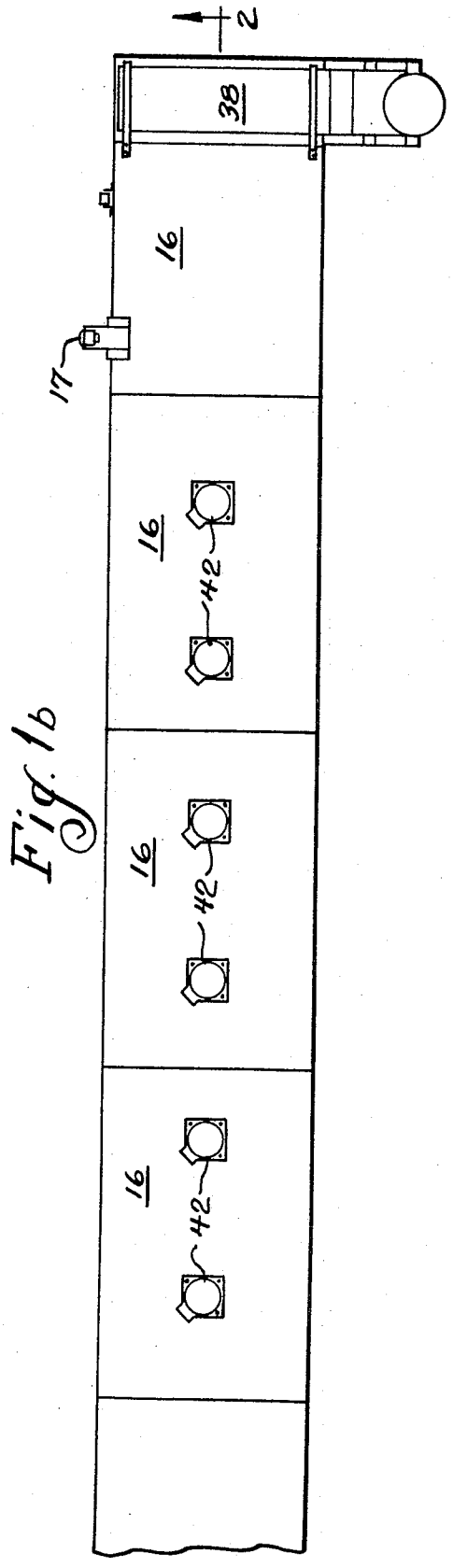


Fig. 1b

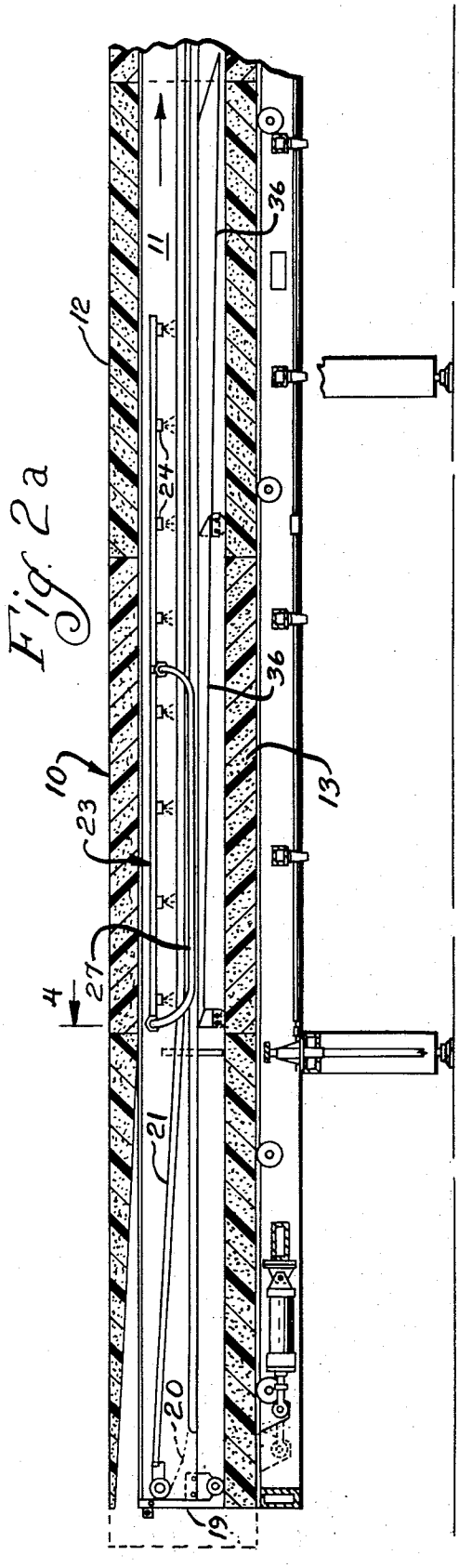

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Fig. 2a

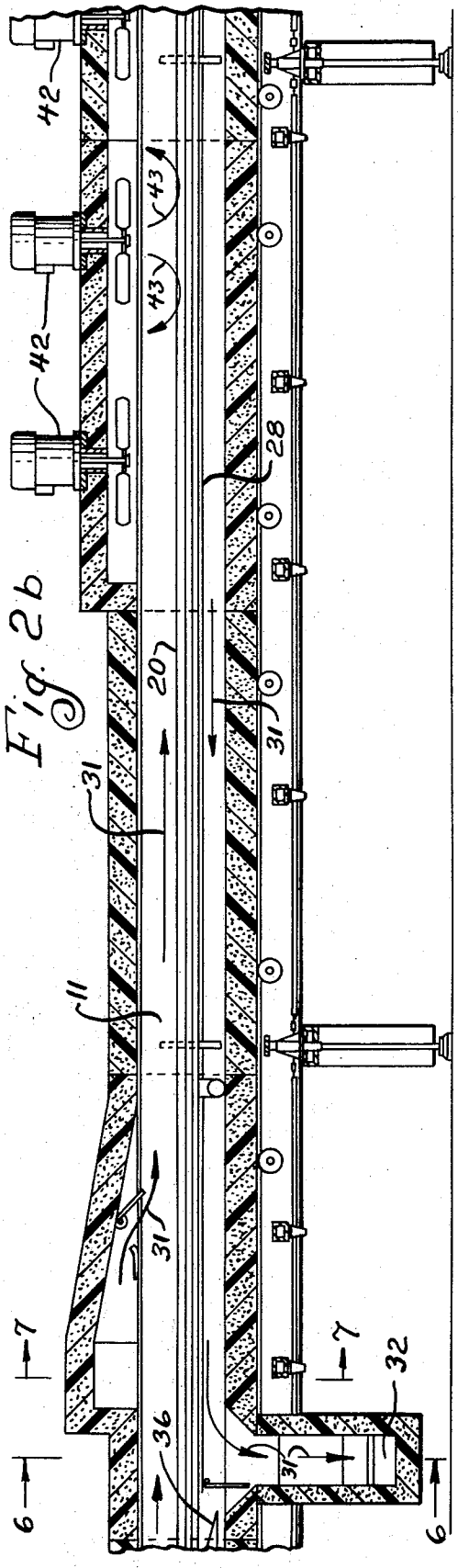

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Fig. 2b

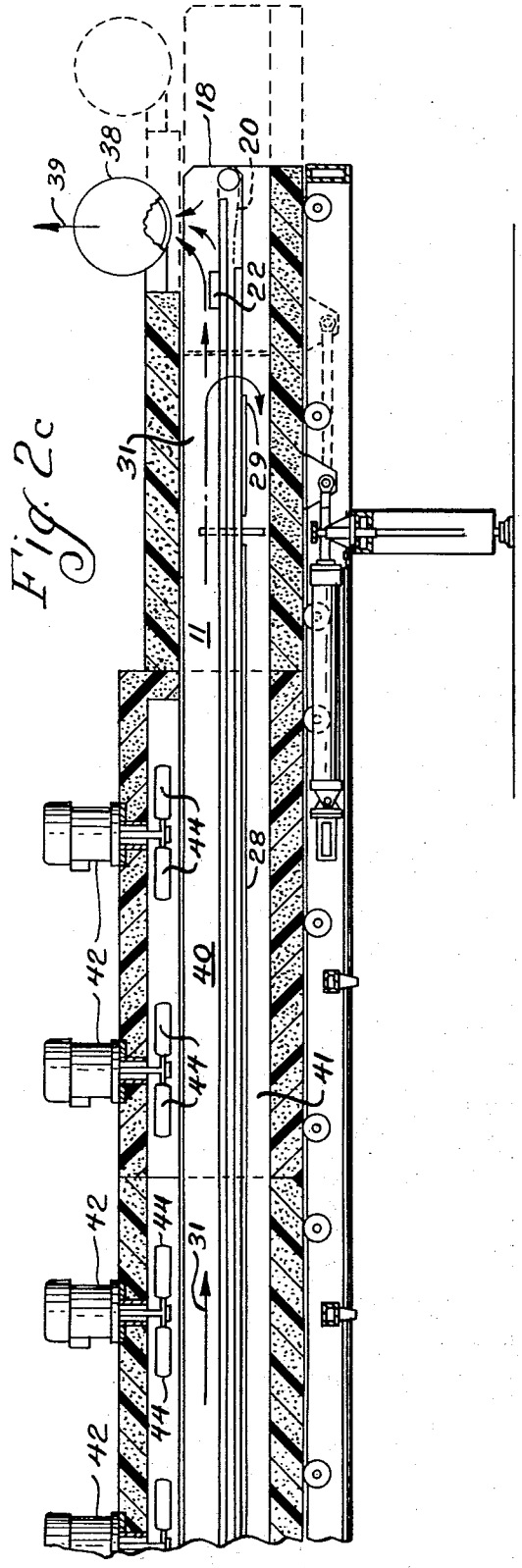


Fig. 2c

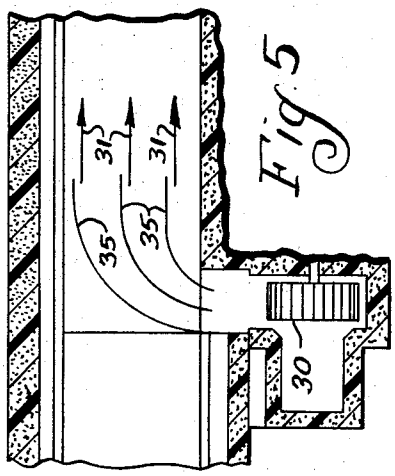


Fig. 5

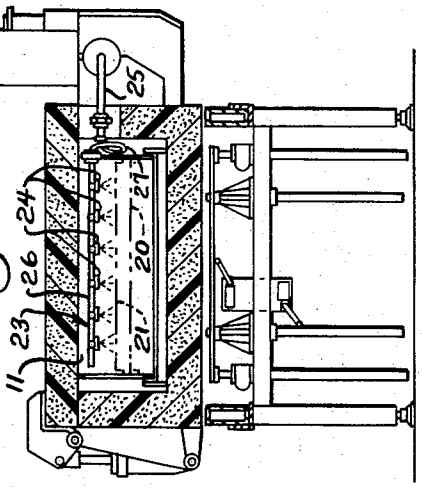


Fig. 4

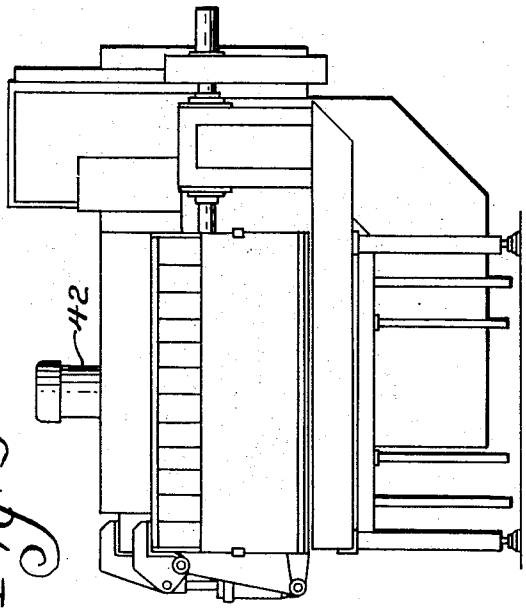


Fig. 3

Fig. 6

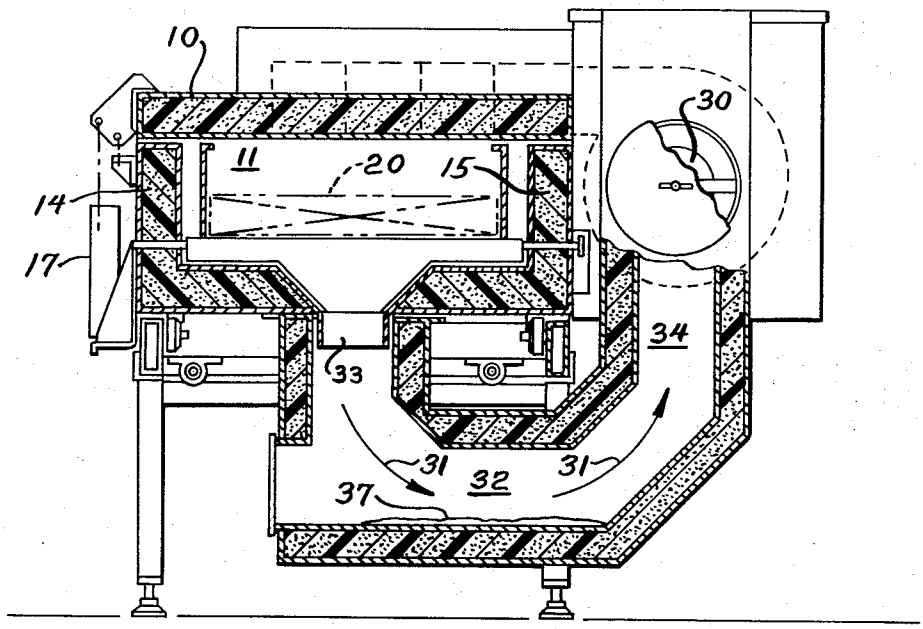
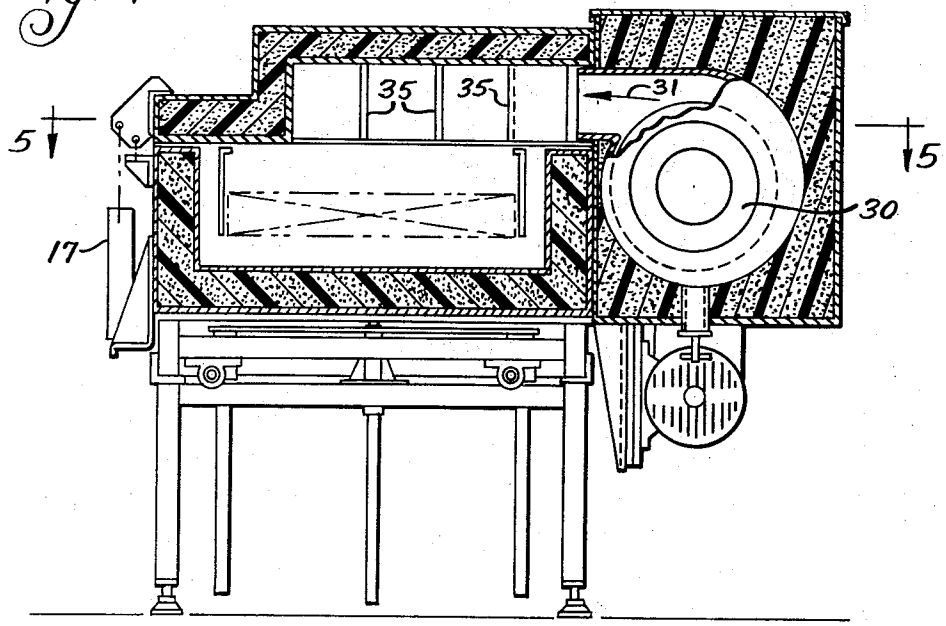


Fig. 7



APPARATUS AND METHOD FOR REFRIGERATING ARTICLES

BACKGROUND OF THE INVENTION

One of the features of this invention is to provide an apparatus for refrigerating articles and particularly for freezing them in which a liquid cryogen is sprayed or otherwise contacted with the articles with the resulting production of cryogen gas together with means for recirculating a portion of the gas through the chamber for more efficient refrigeration including a recirculation path portion externally of the chamber together with means for collecting excess liquid cryogen from the spraying and directing it into the external path portion for contact with the recirculated cryogen gas.

Another feature of the invention is to provide a method of refrigerating articles including the recirculating of the gas and the collecting of excess liquid in a portion of the recirculation path externally of the chamber.

The most pertinent prior art of which applicant is aware are prior U.S. Pats. Nos. 3,287,932, 3,298,188, 3,345,828 and 3,403,527 which, however, do not disclose the features of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1*a* and 1*b* are a plan view of an apparatus embodying the invention.

FIGS. 2*a*, and 2*b* and 2*c* are a longitudinal sectional view through the apparatus of FIGS. 1*a* and 1*b*.

FIG. 3 is an end elevational view taken from the left end of FIG. 1*a*. FIG. 4 is a vertical sectional view taken substantially along line 4—4 of FIG. 2*a*. FIG. 5 is a fragmentary and semi-schematic horizontal sectional view taken substantially along line 5—5 of FIG. 7.

FIG. 6 is a vertical sectional view taken substantially along line 6—6 of FIG. 2*b*.

FIG. 7 is a vertical sectional view taken substantially along line 7—7 of FIG. 2*b*.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the embodiment shown in the drawings the apparatus **10** for refrigerating articles comprises an elongated freezing tunnel **11** or chamber having top **12**, bottom **13** and side **14** and **15** insulated walls. The top insulated walls **12** are in the form of hinged lids **16** which may be raised and lowered by means of hydraulic cylinders **17**, in the customary manner, of which only two are illustrated in FIGS. 1*a* and 1*b* and which are illustrated in side elevation in FIGS. **5** and **6**.

Positioned within the chamber or tunnel **11** between an entrance **18** and an exit **19** thereto is a customary conveyor **20** for conveying articles in the chamber in a path coinciding with the upper reach **21** of the conveyor between the entrance and exit. One such article is illustrated schematically at **22** in FIG. 2*c*.

In the illustrated embodiment the fluid cryogen is a liquid of which liquid nitrogen is an excellent example that is introduced into contact with the articles traveling on the conveyor to generate a gas and with the liquid being in excess. The fluid cryogen also includes the gas itself caused by the liquid vaporizing on heat extracted from the articles. As is shown most clearly in FIGS. 2a and **4**, a liquid cryogen is introduced by means of a liquid flow means **23** which as illustrated is

an assembly of nozzles **24** arranged in the assembly **23** and spaced longitudinally and transversely of the chamber.

Thus in the illustrated embodiment of FIG. **4** there are six nozzles spanning the width of the chamber **11** and eight nozzles arranged longitudinally in each row as shown in FIG. 2*a*. The liquid cryogen is supplied to the nozzle assembly by means of a pipe **25** which communicates with the piping **26** interconnecting the nozzles **24** by means of a flexible hose **27**. With this arrangement the entire liquid flow assembly **23** may be removed for cleaning when the lids or top walls **12** are raised without requiring dismantling of the assembly **23**.

In order to aid in the heat transfer the cryogen gas is recirculated over the articles within the chamber **11**. This recirculation aids the intimate contact with the articles particularly where the conveyor **20** is of the preferred open mesh metal construction. The recirculating means comprises a horizontal baffle **28** beneath the conveyor **20** and thus beneath the articles **22** conveyed thereon with this baffle **28** having an end **29** adjacent to but short of the entrance end **18** of the tunnel **11**. The recirculation flow which is caused by the rotatable blower **30** is in a path illustrated by the recirculation arrows **31** as shown in FIGS. 2*b*, 2*c*, **5**, **6** and **7**.

The recirculation path as is illustrated most clearly in FIGS. 2*b* and **6** includes a path portion **32** located externally of the chamber **11**. Thus as shown in FIG. **6** this recirculation portion is located beneath and to the side of the apparatus **10** and communicates with the bottom of the chamber **11** by means of a vertical fitting **33** that causes gas to flow vertically downwardly into the external portion **32** and upwardly at the side through a passage **34** into the blower **30** where the recirculated gas is introduced laterally back into the tunnel where it is deflected by curved spaced vanes **35** for longitudinal flow toward the entrance **18** as illustrated in FIG. **5**.

Beneath the spray head assembly **23** there is provided a baffle **36** in two overlapping sections as shown in FIG. 2*a* for ease in cleaning with this baffle **36** being sloped toward the recirculation path portion **32** which being beneath the chamber **11** functions as a sump to collect any excess and unevaporated liquid cryogen illustrated schematically at **37** in FIG. **6**. The result is that the recirculated external cryogen gas shown at **31** in FIG. **6** picks up the liquid **37** in the form of small droplets and reintroduces it back into the tunnel **11** at the turning vanes **35**.

A portion of the liquid **37** will of course be evaporated by the recirculating portion of the gas **31** but any unevaporated liquid is physically picked up in the form of droplets and carried back into the tunnel for refrigerating articles carried therethrough. Because the recirculation path portion **32** is at a lower level than the chamber **11** and because of the sloped nature of the baffle **36** the excess cryogen is collected by gravity flow and is redistributed without requiring a separate pump as has been required heretofore.

Communicating with the tunnel or chamber **11** adjacent the entrance **18** are gas evacuation means **38** for exhausting the cryogen gas after the refrigeration in the customary manner as illustrated schematically by the arrow **39**. The baffle **28** which is adjacent the entrance **18** to the tunnel and therefore adjacent the gas evacuation means **38** separates the chamber **11** into upper **40** and lower **41** gas recirculation sections of the internal

recirculation loop **31.** As illustrated in FIGS. **2***b* and **2***c* this provides countercurrent flow with respect to the direction of movement of the articles **32** gas contact with the articles.

Provided in the chamber **11** above the conveyor **20** and in communication with the upper recirculation section or space **40** are a plurality of gas moving devices **42** here shown as vertical axis fans for providing axial flow illustrated by the arrows **43.** These fans **42** are longitudinally spaced from each other and in the illustrated embodiment are six in number although more or less can be used depending upon the desired capacity of the apparatus.

As illustrated by the arrows **43** in FIG. **2***b* the exhaust from the fans is downwardly through the conveyor and over the articles **22** carried thereon and is then directed back upwardly by impingement upon the baffle **28.** The fans **42** serve as turbulizers to obtain better heat transfer between the articles conveyed through the tunnel by the conveyor **20** and the gas. This results in the exhaust gases illustrated at **39** in FIG. **2***c* having a higher temperature caused by heat extracted from the entering articles **22.** Thus in one embodiment of the apparatus of this invention the temperature of the exhaust gases **39** was not more than 60° less than the temperature of the incoming articles **22.** Furthermore, the transverse or in this embodiment vertical exhaust from the axial flow fans **44** is in a direction transverse to the longitudinal recirculation flow **31** with the combination of gas flows at 90° to each other increasing the turbulence with corresponding increases in heat transfer so that a shorter tunnel **11** may be employed for a given refrigerating capacity.

The apparatus **10** is constructed in separable sections for cleaning. Such a separable arrangement is disclosed in my prior U.S. Pat. No. 3,580,000.

Various parts of the apparatus shown in the drawings are similar to corresponding parts of my earlier copending applications Ser. No. 264,133, filed June 19, 1972 now U.S. Pat. No. 3,824,806, and Ser. No. 339,395, filed Mar. 8, 1973, with both applications being assigned to the same assignee as the present application.

Having described my invention as related to the embodiment shown in the accompanying drawings, it is my intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the appended claims.

1. Apparatus for refrigerating articles, comprising: means defining an insulated chamber having an entrance and an exit for said articles; conveyor means for moving said articles in the chamber in a path from the entrance to the exit; liquid flow means for introducing a liquid cryogen into said chamber for contact with said articles at an introduction area spaced from said entrance with resulting generation of cryogen gas; means between said introduction area and entrance for recirculating cryogen gas from said chamber in a recirculation path including a path portion located externally of the chamber; and means for collecting any remaining liquid cryogen from said chamber in said external path portion for contact with the recirculated cryogen gas passing therethrough.

2. The apparatus of claim **1** wherein said chamber is provided with baffle means beneath said liquid flow means sloped toward said enternal path portion for directing liquid cryogen into said path portion as a sump for contact with recirculated gas in said path portion.

3. The apparatus of claim **1** wherein said external path portion includes a part at a lower level than said chamber and thereby operating as a gravity flow liquid collecting sump.

4. The apparatus of claim **1** wherein said liquid flow means comprises spray apparatus located between said chamber exit and said recirculating path portion for spraying liquid cryogen in contact with said articles and including a flexible conduit to an external source of liquid cryogen for removal of said apparatus for cleaning, servicing and the like without requiring dismantling.

5. The apparatus of claim **1** wherein there are provided in said chamber adjacent its entrance evacuation means for exhausting spent cryogen gas and a baffle within the chamber extending to adjacent the evacuation means for separating the chamber into upper and lower recirculation sections of an internal recirculation loop that extends within the chamber toward said evacuation means for countercurrent gas contact with said articles.

6. The apparatus of claim **5** wherein there are provided in said chamber above the baffle and downstream with respect to the path of movement of said articles a plurality of gas moving devices means for creating cross flow of gaseous cryogen over and between said articles.

7. The apparatus of claim **6** wherein said plurality of gas moving devices comprise axial flow fans spaced along a substantial portion of said chamber and exhausting transversely to said path of the articles.

8. The apparatus of claim **7** wherein said evacuation means is located adjacent to said chamber entrance, said plurality of fans are arranged in series along a portion of the chamber between said withdrawal area and said recirculating path portion, and said liquid flow means is located between said recirculation path and said chamber exit.

9. The apparatus of claim **8** wherein said chamber is provided wtih baffle means beneath said liquid flow means sloped toward said external path portion for directing liquid cryogen into said path portion as a sump for contact with recirculated gas in said path portion.

10. The method of refrigerating articles in an insulated chamber having an entrance and an exit and liquid flow means for introducing a liquid cryogen into said chamber for contact with said articles in an excessive amount so as to provide both cryogen liquid and cryogen gas from said liquid in the chamber, comprising: recirculating said cryogen gas into contact with articles within the chamber in a recirculation path including a path portion located externally of the chamber and collecting any remaining liquid cryogen from the chamber in the recirculation path portion for contact by said recirculated gas and redistribution of the liquid in conjunction with the gas back into the chamber.

11. The method of claim **10** wherein said path portion is at a lower level than said chamber to function as a sump and said liquid is collected therein by gravity flow from the insulated chamber.

12. Apparatus for refrigerating articles, comprising: means defining an insulated chamber having an entrance and an exit for said articles; conveyor means for moving said articles in the chamber in a path from the entrance to the exit; and liquid flow means for introducing a liquid cryogen into said chamber for contact with said articles at an introduction area spaced from

said entrance with resulting generation of cryogen gas, said liquid flow means comprising spray apparatus located between said chamber exit and said recirculating path portion for spraying liquid cryogen in contact with said articles and including a flexible conduit to an external source of liquid cryogen for removal of said apparatus for cleaning, servicing and the like without requiring dismantling.

13. Apparatus for refrigerating articles, comprising: means defining an insulated chamber having an entrance and an exit for said articles; conveyor means for moving said articles in the chamber in a path from the entrance to the exit; fluid flow means for introducing a fluid cryogen into said chamber for contact with said articles at an introduction area spaced from said entrance; means for circulating gaseous cryogen from said fluid in countercurrent with said articles; and a plurality of gas moving device means between said introduction area for said cryogen and said entrance for creating cross flow of gaseous cryogen over and between said articles.

14. The apparatus of claim **13** wherein said plurality of gas moving devices comprise axial flow fans spaced along a substantial portion of said chamber and exhausting transversely to said path of the articles.

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