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(54) **TRANSPORTABLE PRODUCT COOLING APPARATUS AND METHOD**

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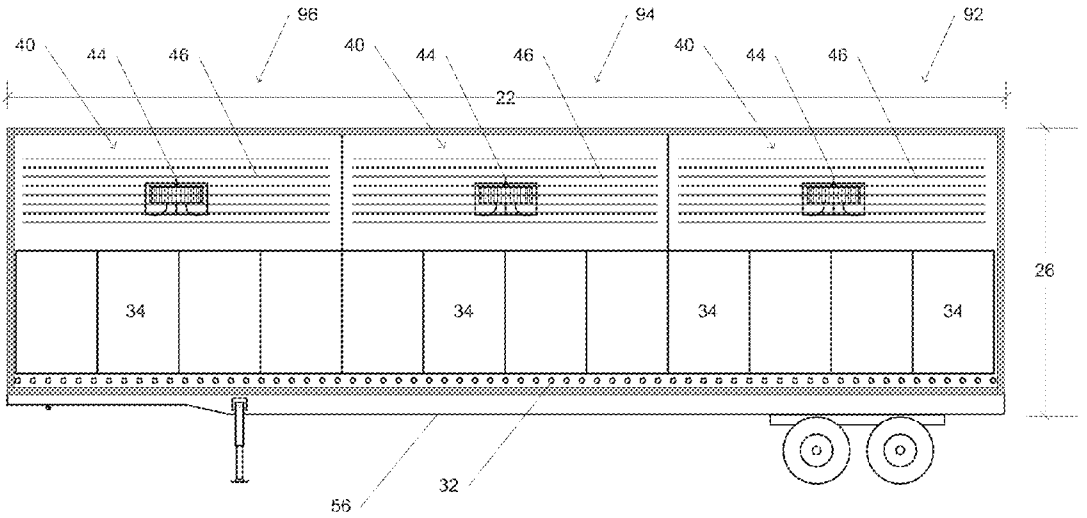
(52) **U.S. Cl.** **62/62**; 62/380; 62/457.1; 62/407; 62/268

(57) **ABSTRACT**

A portable, automated, cold-chain maintaining, cooling apparatus is disclosed. This apparatus comprises one or more portable cooling modules in communication with one or more portable transition modules. The cooling modules have cooling module conveyor apparatus to move containers of product through the module and a product cooling apparatus to provide cooling air to the product. The portable transition module is in communication with each of said one or more portable cooling modules in such a manner to maintain the cold temperature of said cooled product. A transition module conveyor apparatus within the transition module is in communication with the cooling module conveyor apparatus and automatically transfer the product from the cooling modules into the portable transition module.



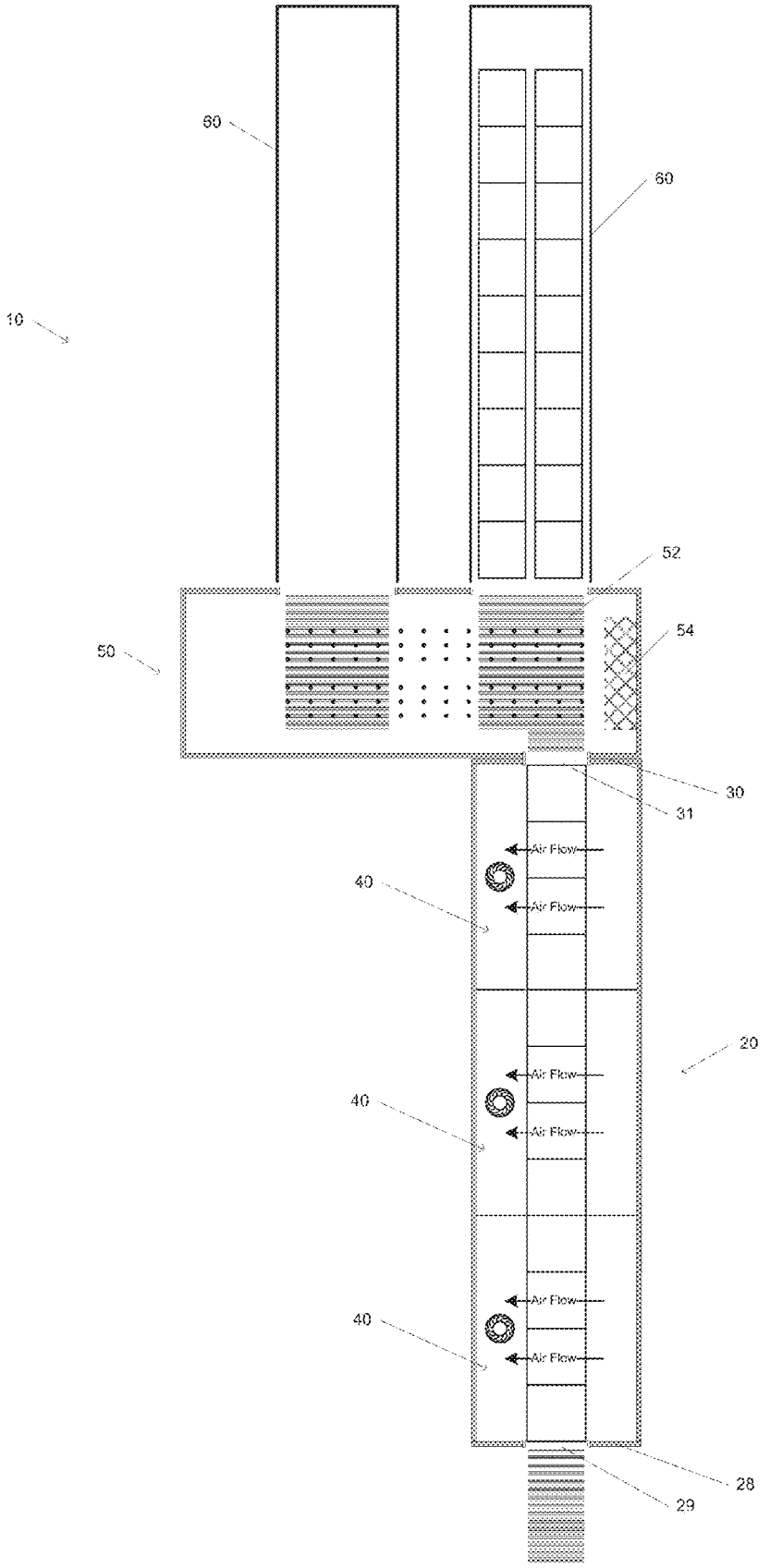

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Fig. 1

Fig. 2

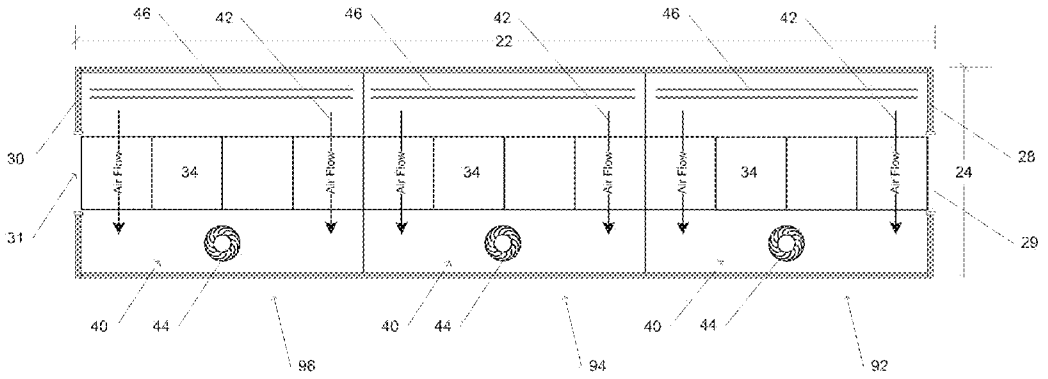
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Fig. 3

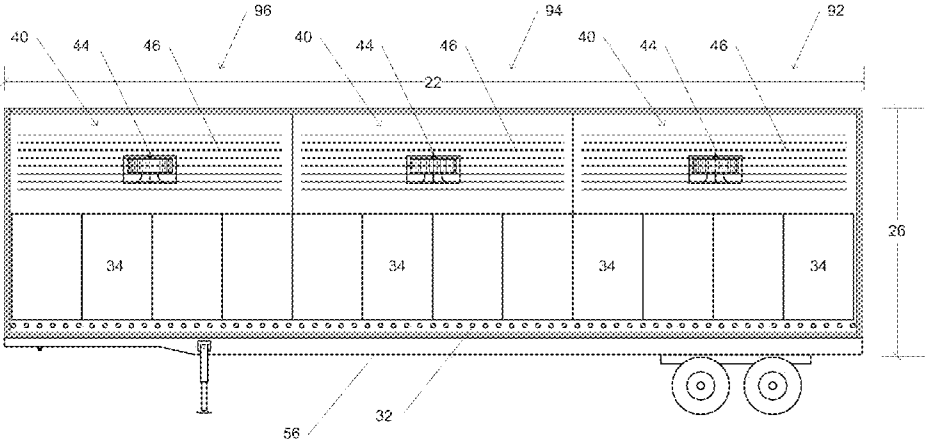
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Fig. 4

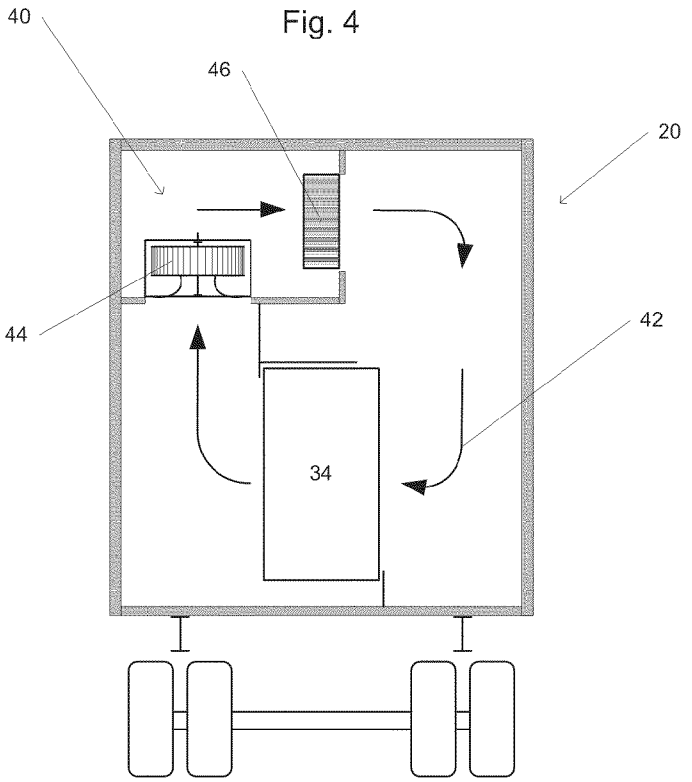


Fig. 5

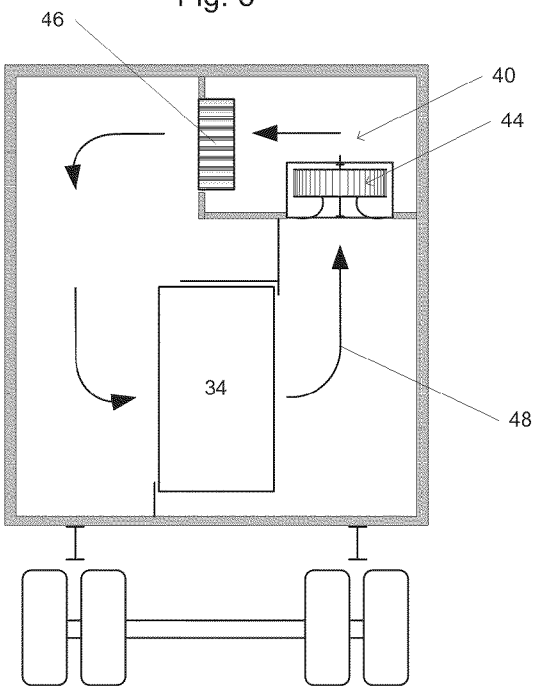


Fig. 6

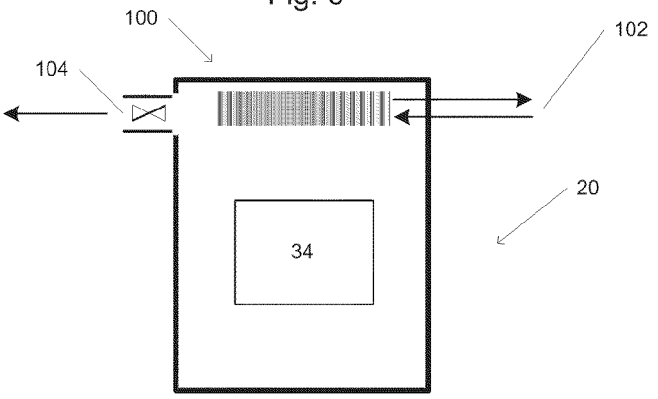


Fig. 7

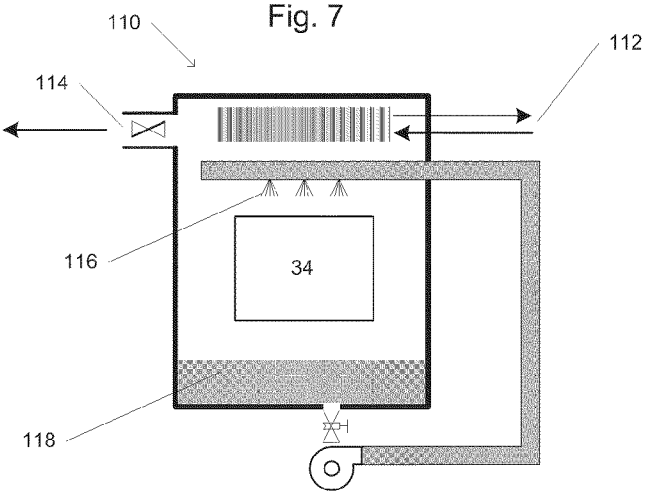
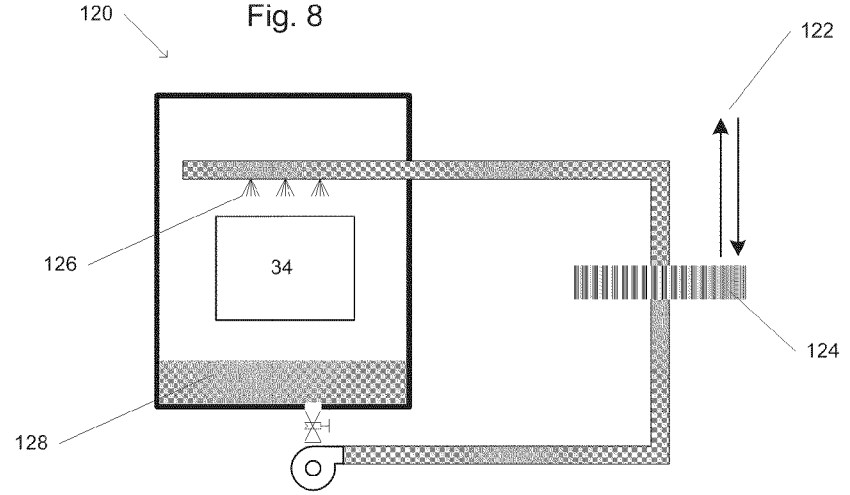
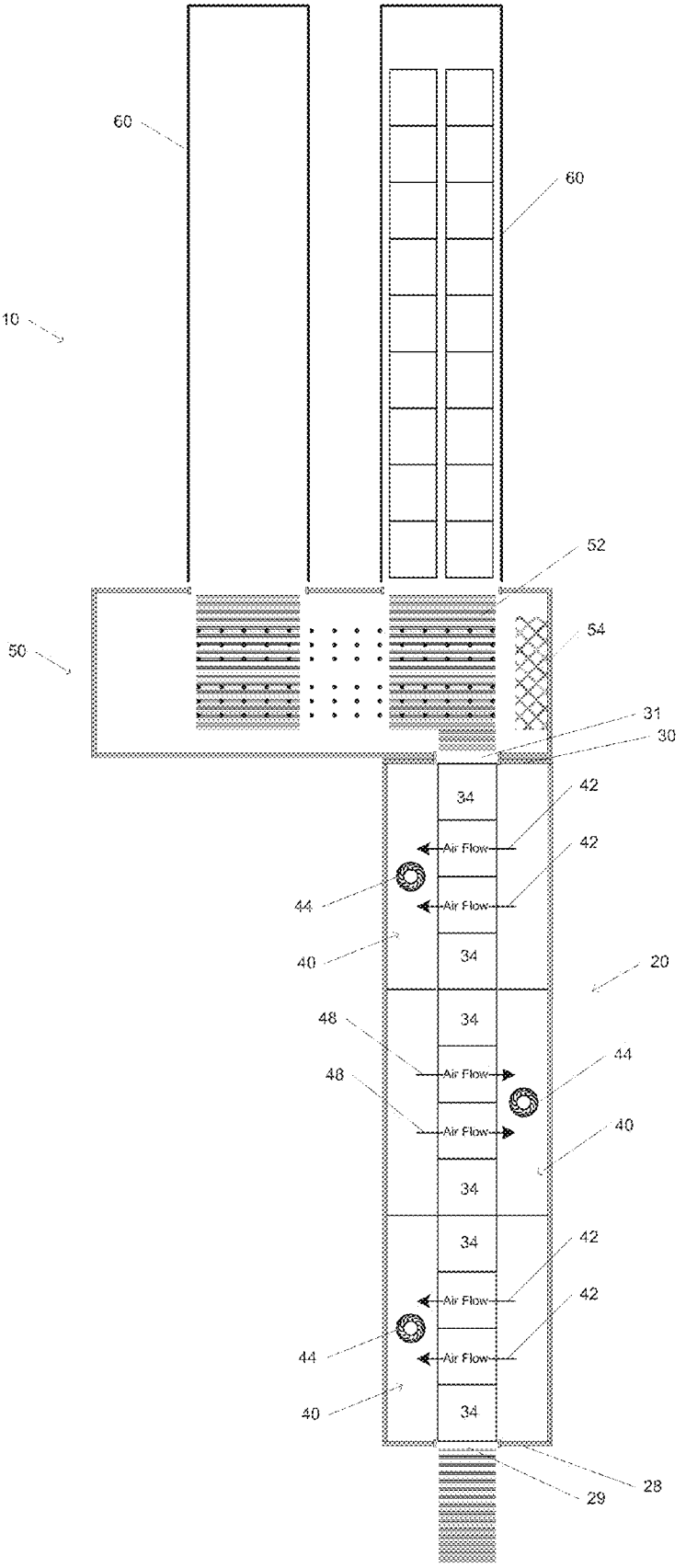


Fig. 8

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Air Flow
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Air Flow
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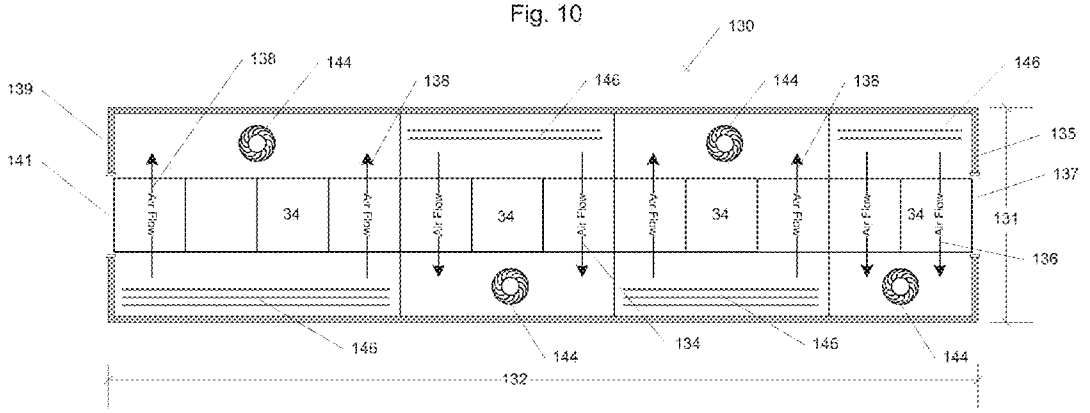
Fig. 9

Fig. 10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Air Flow
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Fig. 11

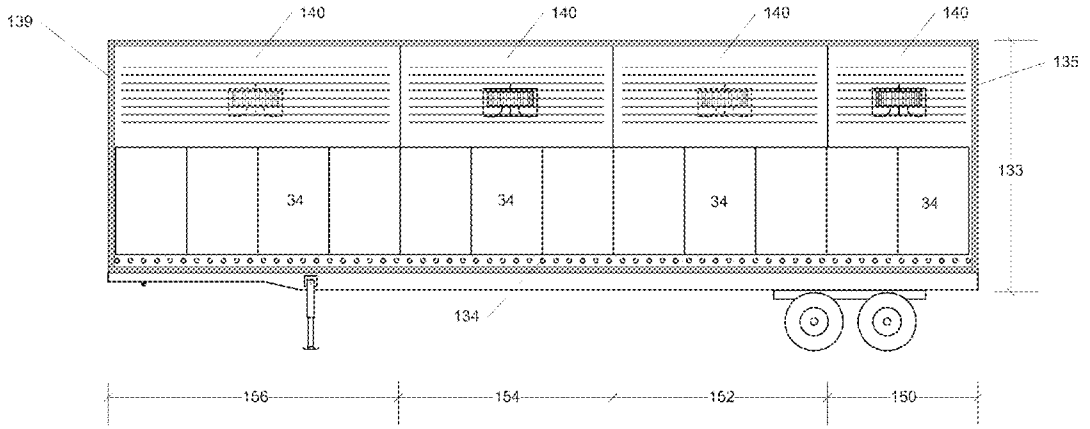
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Fig 12

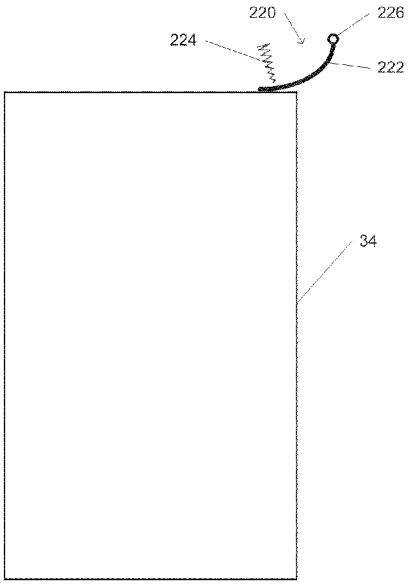


Fig 13

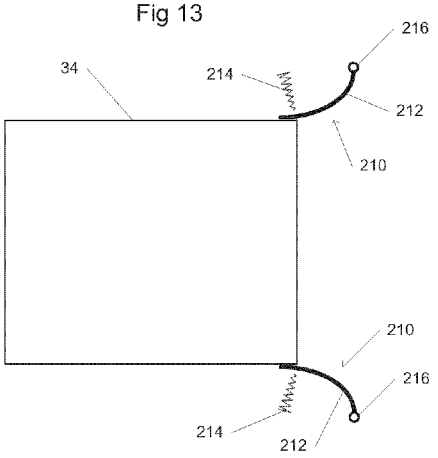


Fig 14

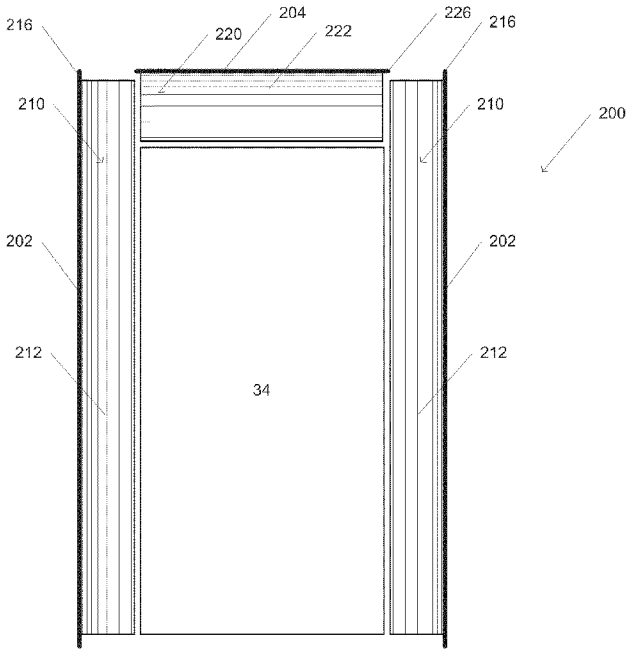


Fig. 15

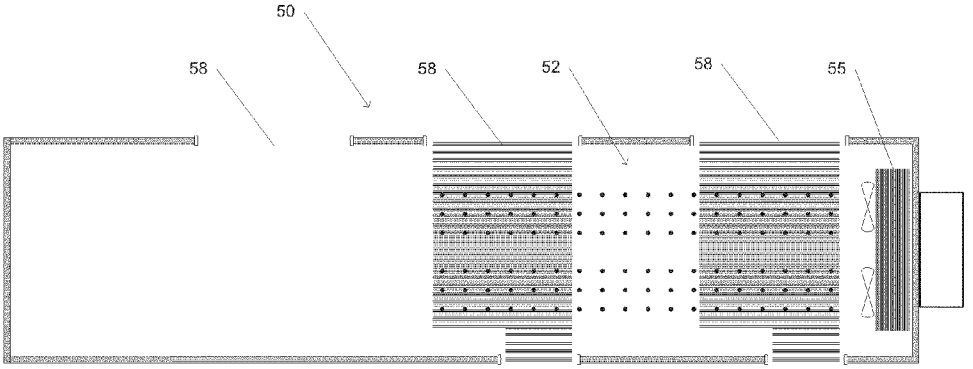
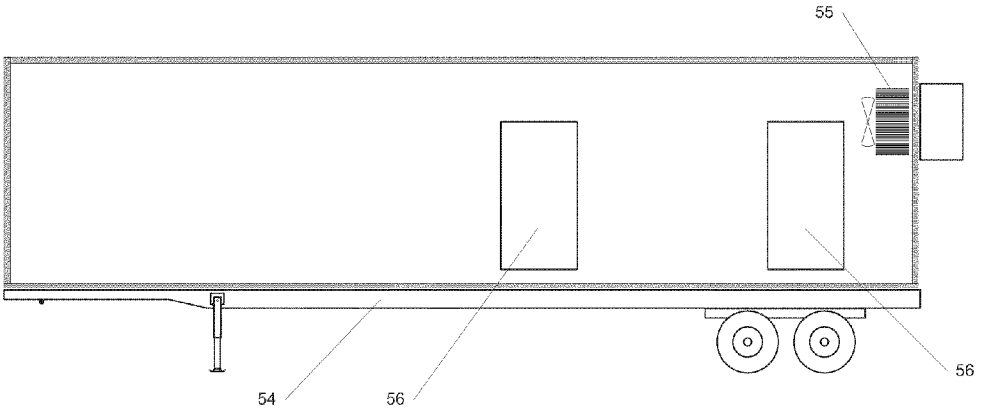


Fig. 16



TRANSPORTABLE PRODUCT COOLING APPARATUS AND METHOD

REFERENCE TO PENDING APPLICATIONS

[0001] This application does not claim the benefit of any pending patent application.

REFERENCE TO MICROFICHE APPENDIX

[0002] This application is not referenced in any microfiche appendix.

BACKGROUND OF THE INVENTION

[0003] The present invention is generally directed toward a transportable product cooling apparatus and method. More specifically, the present invention is directed toward a transportable product handling method and apparatus for the post-harvest cooling of perishable fruits and vegetables while sustaining the cold chain.

[0004] Fruits and vegetables are living organisms that continue essential chemical and physiological activities after harvest. These activities can include physiological breakdown, physical injury to tissue, invasion by microorganisms, and moisture loss. Additionally, some fruit can suffer damage while being transported hot from the field. Thus, the time between harvest and cooling to remove field heat and slow plant respiration, otherwise known as the "cut-to-cool" interval, is critical for ensuring the quality and safety of the product.

[0005] The term "cold chain" refers to the uninterrupted temperature management of perishable products in order to maintain quality and safety from the point of post-harvest cooling through the distribution chain to the final consumer. The cold chain ensures that perishable products are safe and of a pleasant quality at the point of consumption. Failing to keep product at the correct temperatures can result in a variety of negative attributes including, among others, textural degradation, discoloring, bruising, and microbial growth.

[0006] Various apparatus and methods to cool perishable products are disclosed in the prior art. U.S. Pat. No. 2,825,211 issued to Gessel discloses the use of a fixed structure, such as a building, to cool, or otherwise known as removing heat, from products. This disclosure, however, has the disadvantage of not being able to rapidly remove the heat from the products, and thus, is not very effective.

[0007] U.S. Pat. No. 4,736,592 issued to Ohling and U.S. Pat. No. 5,789,007 issued to Bianco also disclose permanently fixed cooling buildings having cooling air rooms in a batch processing tunnel cooling systems that employ bi-directional air systems for the purpose of increasing cooling rates and efficiency.

[0008] U.S. Pat. Publ. 2007/0017233 applied for by Hawkins also discloses a cooling system having a step-continuous dual-conveyor tunnel cooling system with sequential cooling zones wherein the air flow direction is reversed.

[0009] The prior art is not without its disadvantages. A permanent building cold-storage facility has a high capital cost, utility is limited by seasonality and distance to the growing fields, and a large volume of cold air must be maintained at significant energy cost. Ohling and Bianco are "in and out" batch product handling systems that do not anticipate continuous process cooling. The Hawkins system is mechanically complex requiring sophisticated automation to control components including doors, air seals, fans, and zone conveyors. Such complexity and automation increases capital costs, repair and maintenance costs, and risk of system breakdown. Most importantly, none of the prior art anticipates a complete transportable cooling system that can cool produce and deliver such cooled produce directly into over the road refrigerated transportation without breaking the cold chain.

[0010] There is a need for an efficient, cost effective, mechanically durable, transportable cooling system that can reduce the cut-to-cool interval while maintaining the cold chain. Such a system can improve food quality and food safety.

BRIEF SUMMARY OF THE INVENTION

[0011] The present invention satisfies the need discussed above. The present invention is generally directed toward a transportable product cooling apparatus and method. More specifically, the present invention is directed toward a transportable product handling method and apparatus for the post-harvest cooling of perishable fruits and vegetables while sustaining the cold chain.

[0012] One aspect of the present invention provides for a portable cooling system that cools fruits and vegetables and maintains the cold-chain for the product. This aspect discloses one or more portable cooling modules and a portable transition module in combination.

[0013] Each of the cooling modules have a length and a width. An entry end allows for the product to be placed into the cooling module wherein it will be cooled. An exit end allows for the cooled product to exit the cooling module and enter uninterrupted into the transition module.

[0014] Within the cooling module, a cooling module conveyor apparatus is located in order to move containers of product from said entry end to said exit end. During its travel through the cooling module, the product is subject to cooling air that is produced by a product cooling apparatus.

[0015] The transition module is in direct communication with the cooling module and is configured to maintain the cold temperature of the cooled product, thereby keeping intact the cold-chain. In this aspect, a transition module conveyor is in communication with the cooling module conveyor apparatus in order to automatically transfer the product from the cooling modules into the transition module.

[0016] The cooling module and transition module are portable. They do not require a fixed base or permanent structure to operate. They can be located next to a field during the harvest of that field and then can be relocated to another field during the harvest of the second field. This allows for a reduction of the "cut-to-cool" time and damage resulting from transportation of hot product. Portability can be provided by incorporating a wheeled chassis into the cooling module and transition module or to allow the cooling module and transition module to be loaded upon a removable structure, such as a dolly or flat bed truck.

[0017] One aspect of the portable transition module of the present invention provides for such module to be in communication with one or more cold storage containers. These containers can be permanent, fixed foundation buildings or can be transportable cold storage vehicles. Further, the communication between the portable transition module and the cold storage container is also configured to maintain cold temperature of the cooled product.

[0018] Other aspects of the portable transition module include having a non-automated product handling apparatus and a product gas treatment apparatus.

[0019] One aspect of the product cooling apparatus of the present invention provides for the creation of cooling air flow across and through the product in one or more different directions. Various alternatives for the product cooling apparatus can include vacuum cooler apparatus, a hydro-vacuum cooler apparatus, and a hydro cooler apparatus.

[0020] One aspect of the cooling module of the present invention provides for having two or more sequential cooling zones, each having a product cooling apparatus adapted to create a cooling air flow across and through said product in one or more directions relative to said product. By having multiple cooling zones, the cooling air flow can be uniform, that is all air is flowing in the same direction, or can be bi-directional, that is air flow can be in opposite directions alternating between the sequential cooling zones.

[0021] One aspect of the two or more sequential cooling zones of the present invention provides for variable dimensions for each cooling zone, that is, the dimension of the cooling zones can be non-uniform. Further, each cooling zone can be equipped to provide non-uniform cooling air flow in the form of non-uniform temperature and non-uniform flow rate.

[0022] Further features of the present invention will be apparent to those skilled in the art upon reference to the accompanying drawings and upon reading the following description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** is a top view of an embodiment of the present invention.

[0024] FIG. **2** is a top view of an embodiment of the cooling module of the present invention.

[0025] FIG. **3** is a side view of an embodiment of the cooling module of the present invention.

[0026] FIG. **4** is an end view of an embodiment of the cooling module showing an embodiment of the product cooling apparatus of the present invention.

[0027] FIG. **5** is an end view of an embodiment of the cooling module showing a second embodiment of the product cooling apparatus of the present invention.

[0028] FIG. **6** is an end view of a third embodiment of the product cooling apparatus of the present invention.

[0029] FIG. **7** is an end view of a forth embodiment of the product cooling apparatus of the present invention.

[0030] FIG. **8** is an end view of a fifth embodiment of the product cooling apparatus of the present invention.

[0031] FIG. **9** is a top view of a second embodiment of the present invention.

[0032] FIG. **10** is a top view of a second embodiment of the cooling module of the present invention.

[0033] FIG. **11** is a side view of a second embodiment of the cooling module of the present invention.

[0034] FIG. **12** is a side view of a third embodiment of the cooling module of the present invention.

[0035] FIG. **13** is a top view of a second embodiment of the cooling module of the present invention.

[0036] FIG. **14** is a rear view of a second embodiment of the cooling module of the present invention.

[0037] FIG. **15** is a top view of an embodiment of the transition module of the present invention.

[0038] FIG. **16** is a side view of an embodiment of the transition module of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Before explaining the present invention in detail, it is to be understood that the invention is not limited to the preferred embodiments contained herein. The invention is capable of other embodiments and of being practiced or carried out in a variety of ways. It is to be understood that the phraseology and terminology employed herein are for the purpose of description and not of limitation.

[0040] FIGS. **1-3** illustrates an embodiment **10** of the present invention, which comprises generally a portable cooling module **20** that cools product **34**, such as fruits and vegetables, and a portable transition module **50** that maintains the cold-chain for the product during the product's transition from the cooling module into longer term storage or into transportable cold storage vehicles **60**.

[0041] Cooling module **20** has a length **22**, a width **24** and a height **26**. An entry end **28** having an entry way **29** allows for the product **34** to be placed into the cooling module **20** wherein it will be cooled. An exit end **30** having an exit way **31** allows for the cooled product **34** to exit the cooling module **20** and enter uninterrupted into the transition module **50**.

[0042] Within the cooling module **20**, a cooling module conveyor apparatus **32** moves containers of product **34** from the entry end **28** to the exit end **30**. Further, a product cooling apparatus **40** providing cooling air to the product **34** as product **34** moves along the cooling module conveyor apparatus **32**. Additionally, cooling module **20** is divided into multiple, sequential cooling zones **92**, **94** and **96**.

[0043] FIG. **4** illustrates an embodiment of product cooling apparatus **40**. This embodiment is located along the interior upper portion of each of the cooling zones **92**, **94** and **96** of cooling module **20** and creates a clockwise air flow **42** by utilizing a fan **44** in combination with an evaporator coil **46**. Product cooling apparatus **40** cools product **34** by forcing air across and through product **34**.

[0044] FIG. **5** illustrates an additional embodiment of product cooling apparatus **40**. This embodiment is also located along the interior upper portion of each of the cooling zones **92**, **94** and **96** of cooling module **20** and creates a counter clockwise air flow **48** by utilizing a fan **44** in combination with an evaporator coil **46**.

[0045] Those skilled in the art will recognize that the fan in combination with the evaporator coil is illustrative of one type of apparatus to cool product **34** and is not meant to be limiting. FIGS. **6-8** illustrate other types of cooling apparatus. FIG. **6** illustrates a vacuum tube cooling apparatus **100** which in operation utilizes refrigerant **102** and a vacuum system **104** to cool product **34**. FIG. **7** illustrates a hydro vacuum tube cooling apparatus **110** which in operation utilizes refrigerant **112**, a vacuum system **114**, water spray **116** and a water reservoir **118** to cool product **34**. FIG. **8** illustrates a hydro cooling apparatus **120** which in operation utilizes refrigerant **122**, an evaporator coil **124**, water spray **126** and a water reservoir **128** to cool product **34**.

[0046] As illustrated in FIG. **1**, the air flow **42** within cooling module **20** is in a uniform direction, i.e. all in a clockwise or counterclockwise direction. One skilled in the art will understand that this is illustrative and is not meant to be limited. As illustrated in FIG. **9**, the direction of the air flow or can vary, i.e. alternate between clockwise **42** and counter

clockwise **48**. By alternating the direction of the air flow, which can be referred to as bi-directional air flow, the cooling of product **34** can be more uniform.

[0047] FIGS. **10-11** illustrates an additional embodiment the cooling module **130** of the present invention. Cooling module **130** is similar to the above embodiment in that it has a length **132**, a width **131** and a height **133**. Cooling module **130** also has an entry end **135** having an entry way **137** to allow product **34** to be placed therein and an exit end **139** having an exit way **141** allows for the cooled product **34** to exit the cooling module **130** and enter uninterrupted into the transition module **50**. Cooling module also includes a cooling module conveyor apparatus **134** and product cooling apparatus **140**.

[0048] Additionally, cooling module **130** is divided into multiple, sequential cooling zones **150**, **152**, **154** and **156**. The direction of air flow **134** within each cooling zone can be uniform with respect to the air flow of the other cooling zones or can bi-directional, alternating direction from cooling zone to cooling zone. In order to maximize the thermodynamic conditions as product **34** cools, this embodiment **130** provides for the size of each cooling zone **150**, **152**, **154** and **156** to be non-uniform in order to accommodate a different amount of product **34** per cooling zone. As illustrated in FIGS. **10-11**, cooling zone **150** is dimensioned to accommodate two containers of product **34**, while cooling zone **152** can accommodate three containers and cooling zone **156** can accommodate four containers.

[0049] Further, product cooling apparatus **140** located within each cooling zone and is illustrated to include a fan **144** in combination with an evaporator coil **146**. Product cooling apparatus **140** provides air flow at variable velocity and temperature relative to the air flow velocities and temperatures within the remaining cooling zones. For example, air flow **136** located within cooling zone **150** may be of a greater velocity than air flow **134** located within cooling zone **154**.

[0050] As illustrated in FIGS. **12-14**, an additional embodiment of the cooling module **200** is disclosed. This embodiment is similar to the above embodiments and further includes a pair of side pressure doors **210** and a top pressure door **220**. These doors **210** and **220** are located between each sequential cooling zone and assist with preventing the air flow contained in each such cooling zone from escaping into the other cooling zones. This is especially important when one cooling zone has a higher air flow velocity or pressure than a neighboring cooling zone. Further, these doors **210** and **220** allow for continuous movement of containers of product **34** through the multiple cooling zones **150**, **152**, **154** and **156** via cooling module conveyor apparatus **32** while at the same time not allow for any significant transfer of air flow from one cooling zone into a neighboring cooling zone.

[0051] Each side pressure door **210** includes a side curved door panel **212** pivotally secured to a side wall **202** of cooling module **200** by a side pivot hinge **216**. Side curved door panel **212** can be constructed from various metals, including stainless steel and rolled into a parabolic curve. Side curved door panel **212** is also dimensioned to be taller than the containers of product **34**, preferably substantially floor to ceiling in height. Side pivot hinge **216** allows for the automatic adjustment of the various sizes of containers of product **34** and the side to side movement of product **34** as it travels through cooling module **200**. A side door spring **214** is secured to side curved door panel **212** and the side wall of cooling module **200**. Tension pressure is provided upon side door portion **212** causing a substantially air tight connection between product **34** and side pressure door **210**.

[0052] Top pressure door **220** is similar to side pressure door **210** in that is includes a top curved door panel **222** pivotally secured to the top **204** of cooling module **200** by a top pivot hinge **226**. Top curved door panel **222** can also be constructed from various metals, including stainless steel and rolled into a parabolic curve. It is dimensioned to be slightly narrower than the container of product **34** so that the container can fit between the side pressure doors **210**. Top pivot hinge **226** allows for the automatic adjustment for various heights of the containers of product **34**. A top door spring **224** is secured to top curved door panel **222** and the side wall of cooling module **200**. Tension pressure is provided upon top curved door panel **222** causing a substantially air tight connection between product **34** and side pressure door **210**.

[0053] As illustrated in FIGS. **15** and **16**, an embodiment of portable transition module **50** has a transition module conveyor apparatus **52** contained therein and is in communication with the cooling module conveyor apparatus **32** to automatically transfer product **34** from the cooling module **20** into the transition module **50**. In order to maintain the cold chain of product **34**, transition module **50** includes a transition cooling apparatus **55** which provides ambient cooling air into the interior of transition module **50**.

[0054] Other embodiments of transition module **50** can include various features such as having an apparatus to provide product gas treatment to aid extending the shelf life or the ripening of the fruit.

[0055] Transition module **50** is also in communication with one or more cold storage containers **60**. These cold storage containers can be permanent, fixed foundation buildings or transportable cold storage vehicles. After product **34** has been received into transition module **50**, it can automatically or manually be moved into cold storage container **60**.

[0056] Due to the continued controlled environment from the time product **34** enters cooling module **20**, to its transition into transition module **50** and finally into cold storage container **60**, the cold chain of the product **34** is maintained.

[0057] Both cooling module **20** and transition module **50** are portable. While embodiment **20** illustrates both cooling module **20** being secured to a trailer apparatus **56** (FIG. **3**) and transition module **50** being secured to a similar trailer apparatus **54** (FIG. **7**), those skilled in the art will recognize that this is for illustration and is not meant to be limiting. Both cooling module **20** and transition module **50** can be transported via other known transportation methods, such as by way of removable transportation equipment. Due to this portability, the present invention can be moved as close to the fruit and vegetables during harvest as possible, such as alongside the actual fields where the product **34** is being harvested. Once one field has been harvested, the present invention can be relocated to a different field. This portability allows for a decrease in the "cut to cool" time for the harvested product **34** and damage resulting from transportation of hot product **34**. Transporting the cooled product in enclosed refrigerated over-the-road trailers rather than unprotected field harvest trucks increases food safety by reducing product exposure to the elements.

[0058] An example of the operation of this embodiment **10**, as illustrated in FIG. **1**, product **34** is placed into cooling module **20** at the entry end **28**. Product **34** travels along cooling module conveyor apparatus **32** and is subjected to cooling air being provided by product cooling apparatus **40**.

The direction of the air flow provided by product cooling apparatus **40** can be uniform or can vary in direction along the length **22** of cooling module **20**. Due to cooling module **20** and transition module **50** being in communication, product **34** automatically moves from cooling module **20** into transition module **50**. At this point, product **34** is transferred, automatically or manually, to a cold storage container **60**.

[0059] While the invention has been described with a certain degree of particularity, it is understood that the invention is not limited to the embodiments set forth herein for purposes of exemplification, but is to be limited only by the scope of the attached claims or including the full range of equivalency to which each element thereof is entitled.

What is claimed is:

1. A portable, automated, cold-chain maintaining, cooling apparatus comprising:

one or more portable cooling modules, each of said one or more cooling modules having length, a width, a height, an entry end, an exit end, a cooling module conveyor apparatus to move containers of product from said entry end to said exit end, and a product cooling apparatus providing cooling air to said product as said product moves from said entry end to said exit end; and

a portable transition module having a transition module cooling apparatus, said portable transition module being in communication with each of said one or more portable cooling modules, wherein said communication is configured to maintain cold temperature of said cooled product, said portable transition module having a transition module conveyor apparatus in communication with said cooling module conveyor apparatus to automatically transfer said product from each of said portable cooling modules into said portable transition module.

2. The apparatus of claim **1**, wherein said one or more portable cooling modules and portable transition module are transportable.

3. The apparatus of claim **1**, wherein said one or more portable cooling modules and portable transition module are secured to one or more trailer apparatus.

4. The apparatus of claim **1** wherein said portable transition module being further defined as being in communication with one or more cold storage containers, wherein said communication is configured to maintain cold temperature of said cooled product.

5. The apparatus of claim **4** wherein said one or more cold storage containers being defined as one or more permanent, fixed foundation buildings.

6. The apparatus of claim **4** wherein said one or more cold storage containers defined as one or more transportable cold storage vehicles.

7. The apparatus of claim **4** wherein said portable transition module is further defined as having a non-automated product handling apparatus.

8. The apparatus of claim **4** wherein said portable transition module is further defined as having product gas treatment apparatus.

9. The apparatus of claim **1** wherein said product cooling apparatus being defined as adapted to create a first cooling air flow across and through said product in a first direction.

10. The apparatus of claim **9** wherein said product cooling apparatus being further defined as adapted to created a second cooling air flow across and through said product in a second direction.

11. The apparatus of claim **1** wherein said product cooling apparatus being defined as a vacuum cooler apparatus.

12. The apparatus of claim **1** wherein said product cooling apparatus being defined as a Hydro-Vacuum cooler adapted to remove heat across and through said product by means of circulating cooled water over the product and condensing water vapor formed by a vacuum.

13. The apparatus of claim **1** wherein said product cooling apparatus being defined as a hydro cooler vacuum cooler adapted to remove heat across and through said product by means of circulating cooled water over the product.

14. The apparatus of claim **1** wherein each of said one or more portable cooling modules having two or more sequential cooling zones, each of said two or more sequential cooling zones having a product cooling apparatus adapted to create a cooling air flow across and through said product in one or more directions relative to said product.

15. The apparatus of claim **14** wherein the direction of the cooling air flow alternates between a first air flow direction and second air flow direction between each of said two or more sequential cooling zones.

16. The apparatus of claim **15** wherein the temperature of the air flow within each of said two or more sequential cooling zones is non-uniform relative to the temperature of the air flow within the remaining two or more sequential cooling zones.

17. The apparatus of claim **15** wherein the rate the air flow within each of said two or more sequential cooling zones is non-uniform relative to the rate the air flow within the remaining two or more sequential cooling zones.

18. The apparatus of claim **14** wherein each of said one or more portable cooling modules further comprising one or more sets of pressure doors to define the interior boundaries of each said two or more sequential cooling zones.

19. The apparatus of claim **18** wherein each of said one or more sets of pressure doors comprising a pair of side pressure doors and a top pressure door.

20. The apparatus of claim **19** wherein each of said pair of side pressure doors comprises a side curved door panel being pivotally secured to the side wall of said portable cooling module cooling module.

21. The apparatus of claim **19** wherein said top pressure door comprises a top curved door panel being pivotally secured to the ceiling of said portable cooling module cooling module.

22. A method for cooling harvested fruits and vegetables located within containers, said method comprising the steps of:

providing a portable cooling module having length, a width, a height, an entry end, an exit end;

providing a portable transition module in communication with said portable cooling module to maintain cold temperature of said cooled product;

providing a cooling module conveyor apparatus within said portable cooling module to move containers of product from said entry end to said exit end;

providing two or more sequential cooling zones within said portable cooling module;

providing a product cooling apparatus within each of said two or more sequential cooling zones to provide cooling air to said fruits and vegetables as said containers thereof moves from said entry end to said exit end;

providing a transition module cooling apparatus to maintain environmental conditions to maintain the cold temperature of said cooled product; and

providing a transition module conveyor apparatus in communication with said cooling module conveyor apparatus to automatically transfer said product from each of said portable cooling modules into said portable transition module.

23. The method of claim **22** further comprising the step of providing one or more sets of pressure doors to define the interior boundaries of each said two or more sequential cooling zones.

24. The method of claim **22** wherein the step of providing a product cooling apparatus is further defined as providing cooling air to said fruits and vegetables, wherein the direction of said cooling air alternates between a first air flow direction and second air flow direction between each of said two or more sequential cooling zones.

25. The method of claim **22** wherein the step of providing a product cooling apparatus is further defined as providing cooling air to said fruits and vegetables having a non-uniform rate the air flow relative to the rate the air flow within the remaining two or more sequential cooling zones.

26. The method of claim **22** wherein the step of providing a product cooling apparatus is further defined as providing cooling air to said fruits and vegetables having a non-uniform temperature of air flow relative to the temperature of air flow within the remaining two or more sequential cooling zones.

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