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Breuning

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[54] **METHOD AND APPARATUS FOR COOLING FOODS CONTAINED IN PORTION CONTAINERS**

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[52] **U.S. Cl.** **34/33,** 34/20, 34/196, 165/2, 165/108

[51] **Int. Cl.**.....**F26b 3/00**

[58] **Field of Search**.....34/20, 22, 31, 33, 194, 196; 165/2, 108, 1; 312/236; 219/388, 400; 126/21 A

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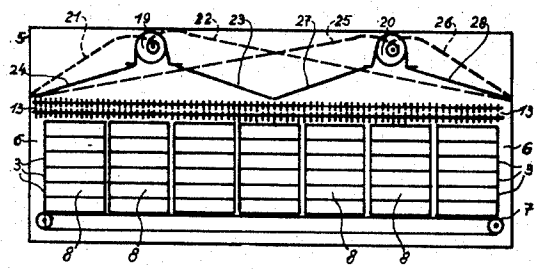
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[57] **ABSTRACT**

In the cooling of foods, particularly yogurt, stored in portion containers, the containers are arranged in groups in air permeable receptacles and the receptacles are stacked before being introduced into a tunnel whose interior is cooled to change the temperature of the food. The stacks introduced into the tunnel have cross sectional areas approximating the tunnel cross sectional area, and the receptacles have air flow openings in either their side walls or their bases. The stacks in the tunnel are uniformly traversed by a cooling air flow provided by a radial blower, and the air current flowing to the interior of the stacks flows through air flow passages formed at least by the exterior surfaces of the stacks and the interior surfaces of the tunnel. The air current is directed through one or more heat exchangers before it traverses the stacks. The tunnel may be divided into twin tunnels and, when several radial blowers are used, the various air currents may be mixed for uniformity of temperature.

4 Claims, 9 Drawing Figures



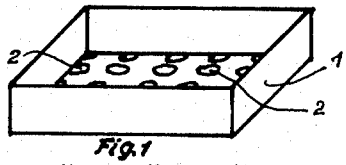


Fig.1

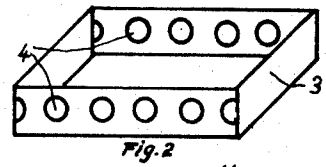


Fig.2

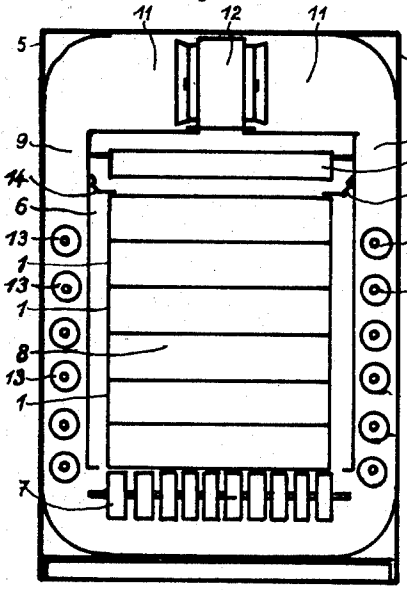


Fig.3

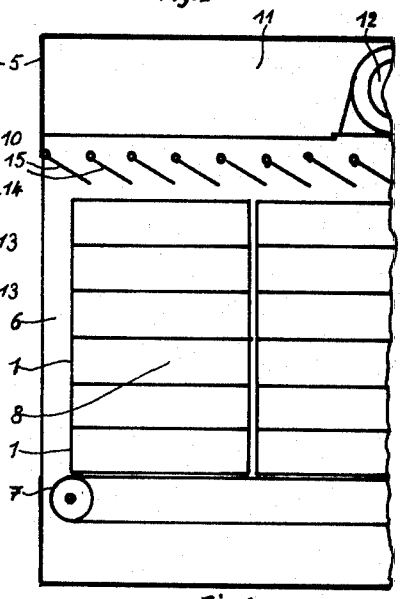


Fig.4

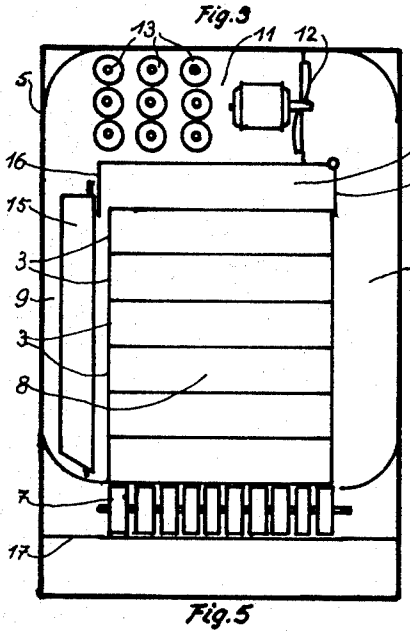


Fig.5

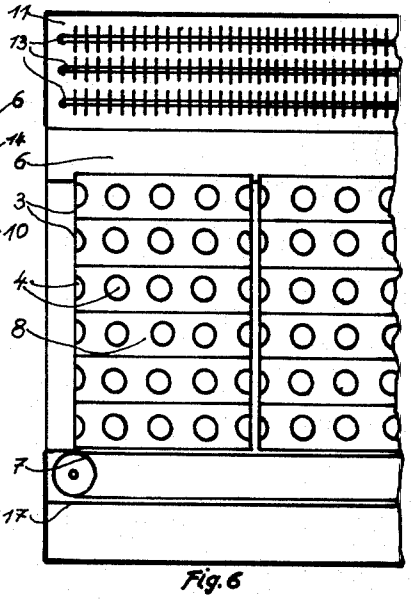


Fig.6

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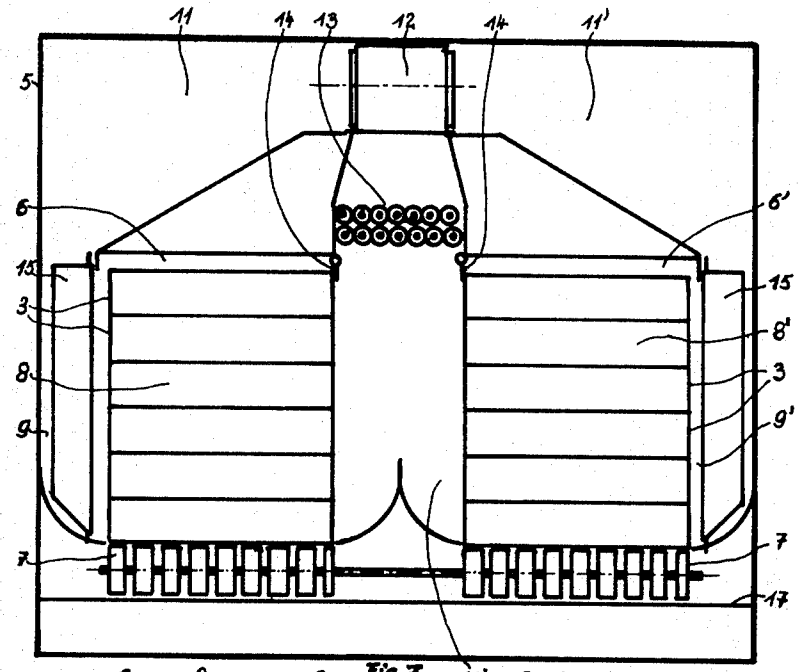


Fig. 7

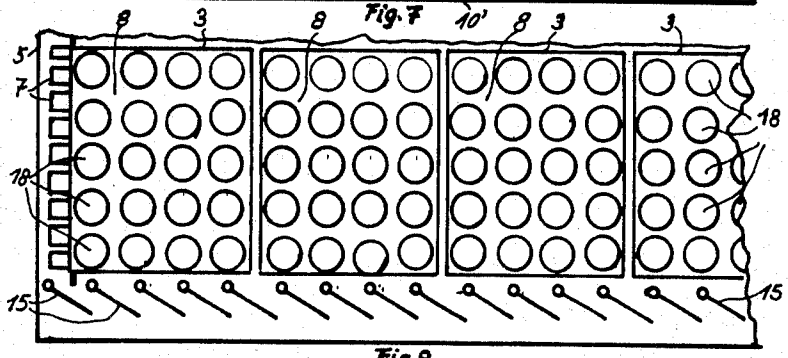


Fig. 8

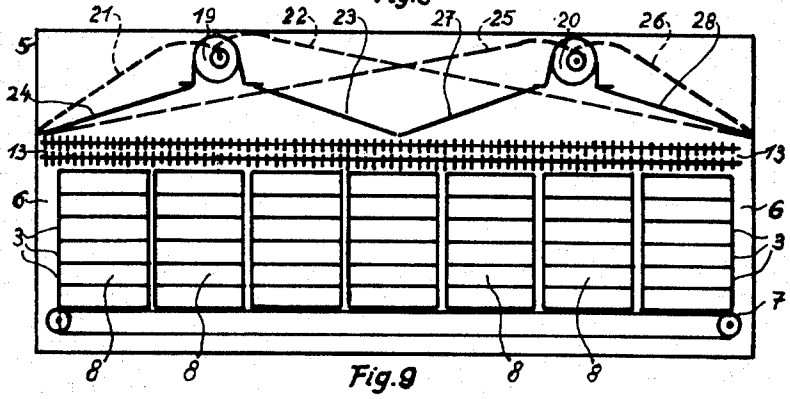


Fig. 9

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METHOD AND APPARATUS FOR COOLING FOODS CONTAINED IN PORTION CONTAINERS

BACKGROUND OF THE INVENTION

In the production of certain foods, the latter are introduced, in large volume, in so-called portion containers which are then closed and subjected to a heating or cooling process. An example of such a cooling process is found in the production of yogurt, wherein the yogurt is filled into plastic cups and sealed therein after the incubation process and, if necessary, after the addition of fruits. The thus sealed in yogurt is then subjected to a cooling process. For various reasons, a very rapid cooling of more than 1°C./min, and which is uniform for all the cups, is desired.

A known apparatus for this purpose is provided in the form of so-called chambers where the portion containers, inserted into moving receptacles, are cooled in large stacks. However, this technique has the substantial disadvantage that a temperature reduction of more than 1°C./min, and which is uniform for all portion containers of a stack, cannot be attained in large scale production. There is also a known method where the cups filled with yogurt, and arranged in receptacles, are conducted through a flat tunnel in which liquid nitrogen is evaporated so that the yogurt is cooled. The objection to this method is its high cost, which makes it too expensive, in many cases, for cooling end temperatures above the freezing point. In addition, for reasons of cost, the containers can be conducted through the tunnel only arranged in rows, and not stacked one above the other.

SUMMARY OF THE INVENTION

This invention relates to changing the temperatures of materials such as foods contained in portion containers and, more particularly, to a novel and improved method and apparatus for this purpose and which is free of the disadvantages of prior art methods and apparatus.

The objective of the invention is to provide a method and apparatus which permit the rapid cooling or the rapid heating of a large number of containers filled with foods, such as yogurt. On the other hand, it is an objective to maintain the dimensions of the apparatus as small as possible, that is, a favorable ratio between the size of the apparatus and the number of containers is selected.

In order to solve the problem presented, in accordance with the present method, the temperature of materials, such as foods and particularly yogurt, contained in portion containers, is changed by introducing the containers in groups into a tunnel in air-permeable receptacles whose interiors are cooled to change the temperature of the material. A feature of the invention method is that several receptacles are so stacked, before they are introduced into the tunnel, that the cross section of the stack approximates the cross section of the tunnel, that the stack introduced into the tunnel is uniformly traversed by a cooling air or a heating air current produced by means of a blower or the like, such as a radial blower, and that the air current flows to the interior of the stacks through air flow passages which are formed or defined at least by the interior surfaces of the tunnel and the exterior surfaces of the stacks. The air current is cooled or heated by a heat exchanger before traversing the stack.

The apparatus of the invention comprises several receptacles each receiving a plurality of portion containers. These receptacles are superposed upon each other to form stacks, with each stack being spaced a relatively small distance from the opposite side walls of the tunnel and from the roof of the tunnel to form air passages. Both the suction side and the pressure or outlet side of at least one blower are in communication with the air flow passages, and a heat exchanger is arranged either beyond the blower outlet or in front of the blower outlet. The receptacles are provided with air inlet ports and air outlet ports communicating with the air flow passages, and flow gaps are provided between the individual portion containers. The air current thus is positively conducted past the individual portion containers, with the above-mentioned features, as well as further features of the invention, assuring that the air does not take the path of least resistance with incomplete stacks and gaps between the series-arranged stacks, to pass unused through these undesired gaps longitudinally and vertically of the stack without performing heating or cooling work. Due to the above-mentioned forced conduction, the air must flow, in any case, past each portion container, so that the desired heat exchange can take place and a maximum efficiency be attained.

An object of the invention is to provide an improved heat exchange method for the production of foods in portion containers.

Another object of the invention is to provide an improved apparatus for heating or cooling foods contained in portion containers.

A further object of the invention is to provide such a method and apparatus which provide for rapid cooling or rapid heating of a large number of portion containers filled with foods, such as yogurt.

Another object of the invention is to provide such an apparatus in which there is a favorable ratio between the overall size of the apparatus and the number of portion containers treated thereby.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIGS. **1** and **2** are somewhat schematic perspective views of receptacles used in practicing the method of the invention;

FIG. **3** is a somewhat schematic transverse vertical sectional view of a tunnel having stacked receptacles therein;

FIG. **4** is a partial vertical longitudinal sectional view of the tunnel shown in FIG. **3**;

FIGS. **5** and **6** are views, similar to FIGS. **3** and **4**, respectively, illustrating another embodiment of the invention apparatus;

FIG. **7** is a transverse vertical sectional view of a tunnel illustrating a particularly advantageous embodiment of the invention;

FIG. **8** is a somewhat schematic horizontal sectional view of the embodiment of the invention shown in FIGS. **5** and **6**; and

FIG. 9 is a somewhat schematic vertical longitudinal sectional view of the tunnel illustrating a particularly advantageous air guiding arrangement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a receptacle 1 preferably used with the invention method and apparatus if the portion containers are substantially cylindrical. Receptacle 1 preferably has air flow passages 2 only in its bottom or base, so that the air can flow upwardly easily through receptacle 1 and between the portion containers.

FIG. 2 illustrates a receptacle 3 used for portion containers which are conical. Receptacle 2 preferably has air flow passages 4 in two opposite side walls, and through which air can flow horizontally between the portion containers even in the stacked form.

Referring to FIG. 3, a tunnel 6 has an outer covering 5 and, on the underside of tunnel 6, there is arranged a conveyor 7 which is designed, in the illustrated example, as an air-permeable endless belt trained over rollers. Conveyor 7 moves the stacks 8 of receptacles 1 through tunnel 6. Side ducts or air flow passages 9 and 10 are formed on opposite sides of tunnel 6. A blower arrangement 12 which, in the illustrated embodiment, includes a twin radial blower, produces an air current which flows vertically downwardly from the blower outlet, through the stacks 8 in tunnel 6 and which then flows upwardly in the side ducts 9 and 10 to the top of the tunnel and, in the air chamber 11, to the blower respective inlets of arrangement 12. The air is constantly cooled by means of the heat exchanger 13 positioned in the side ducts 9 and 10.

The application of a recirculating air current in this manner, instead of the use of outside air or room air, has various advantages. Apart from the possible exclusive deposit of water of condensation on the heat exchangers, the dirt, which is always contained in the outside air or room air, is kept away practically from the plant and the portion containers positioned therein, by the use of a recirculating air current. Air shut-off elements 14, arranged in tunnel 6, and which are designed, in the illustrated embodiment, as flaps bearing resiliently against stacks 8, have the effect that the air can flow downwardly only through stacks 8. In addition, a plurality of flaps 15 are arranged at the roof of tunnel 6, and these flaps close automatically but are opened or kept open by stacks moving beneath the same by means of known control elements, for example, control contacts and lifting magnets. This arrangement has the advantage that no marked amount of secondary air can flow unused through the gaps or spaces between stacks 8. The stacks 8 of receptacles 1 pass through tunnels 6 one behind the other on conveyor 7, keeping flaps 15 open.

A substantial feature of the method of the invention consists in that the receptacles 1, containing the portion vessels, as shown in FIGS. 1, 3 and 4, are stacked in a definite manner before they are introduced into tunnel 6. In the embodiment of the invention shown in FIGS. 1, 3 and 4, where the portion containers have a substantially cylindrical form and where a vertically moving air current is used, stacks 8 consist of six superposed moving receptacles 1. This permits, on the one hand, a relatively small base area for the entire apparatus. On the other hand, the fan output attained with an air velocity of 5 to 10 m/sec, used according to the invention, with a maximum of 10 superposed receptacles 1, is still quite acceptable for a uniformly distributed high temperature variation rate as desired in the stack. The usual stack height with more than 10 layers results in such high temperature differences in the stacks, as tests have shown, that temperature variation rates of more than 1°C/min. cannot be attained.

If portion containers in the form of conical cups are used, the method of the invention provides for the use of receptacles 3 as shown in FIG. 2. In this case, the air flow current is conducted horizontally through the receptacles 3. The operation of the method and apparatus will be described on the basis of the schematic illustrations in FIGS. 5, 6 and 8.

In contrast to the embodiment of the invention shown in FIGS. 3 and 4, the roof and the bottom of tunnel 6 are closed in the embodiment of FIGS. 5, 6, and 8 and, instead, the opposite side walls are provided with air flow passages. The blower arrangement 12 comprises one of several axial blowers arranged along tunnel 6, and produces an air current flowing in side duct 10 which is formed partly by the outer covering 5 and partly by stacks 8. The air current flows horizontally through stacks 8 transversely of the longitudinal extent of tunnel 6, and this air flow is conducted upward partly through side ducts 9 formed by stacks 8, and again reaches blower arrangement 12 after flowing over heat exchangers 13 and air chamber 11. The side wall of tunnel 6 has, in duct 10, air shut-off elements 14 which are designed as flaps bearing resiliently against stacks 8. This has the result that no air can flow unused above stacks 8. In addition, the side wall 16, as shown in FIG. 5, is provided with a plurality of flaps 15 which close automatically but which are opened or kept open by the stacks 8 moving past these flaps by means of known control elements. If an air permeable belt is used for conveyor 7, a horizontal continuous bottom cover 17 is provided.

FIG. 8 illustrates the flaps 15 in their open position, and also shows the portion containers 18 arranged in receptacles 3. If portion containers 18 in the form of conical cups, and receptacles 3 as shown in FIG. 2, are used with the apparatus shown in FIGS. 5, 6, 7, 8 and 9, the invention method provides a certain dimensioning of the stacks 8 in that stacks 8 have two to ten portion containers transverse to the longitudinal axis of the tunnel. The height of the stacks 8 is limited, in accordance with the method of the invention. By limiting the horizontal transverse dimension of the stacks 8, a temperature variation rate of more than 1°C/min. is attained with a low horizontal temperature difference and a technically easily obtainable blower pressure.

FIG. 7 illustrates an embodiment of the invention particularly suitable for the heat treatment of a large number of pieces. By combining two tunnel arrangements to form a unit, not only are the overall technical expenditures considerably reduced but also the space requirements, the heat losses or cold losses, and the cleaning costs likewise are considerably reduced.

Referring to FIG. 7, blower arrangement 12 comprises one or several double radial blowers which drive the air downwardly through heat exchangers 13 and the central duct 10' common to both tunnels 6 and 6', and

then drive the air across the rows of stacks 8 and 8'. The two side ducts 9 and 9' conduct the air upwardly into the air chambers 11 and 11', from where the air is drawn in, on both sides, by the blower arrangement 12.

FIG. 9 illustrates schematically the method of operation of another embodiment of the invention which permits mixing of the air issuing along the tunnels, with different temperatures, from the stacks, even when using several unilateral radial blowers arranged along the tunnels. The mixing of this air has the advantage that all of the heat exchangers 13 are uniformly admitted and the air enters the stack with the same temperature along the tunnels. This results in a maximum cooling effect with a given air temperature.

If it is assumed, for example, that the side duct, which is arranged in the rear in the side elevation view, is associated or in communication with the inlet of the unilateral radial blower 19 throughout the entire length of tunnel 6, the air flows to blower 19 in the zone bounded at the top substantially by the lines 21 and 22. Accordingly, blower 19 draws in air at all temperatures issuing along tunnel 6 when leaving the stacks 8, and mixes this air completely. The blower outlet directs the mixed air into the chamber of the heat exchangers 13, and supplies the heat exchangers 13 over half the length of tunnel 6, when using two blowers 19 and 20 of equal size, as illustrated in FIG. 9. This is indicated by the lines 23 and 24, defining an outlet connection. The radial blower 20 works in the manner similar to the radial blower 19, and its inlet is associated or in communication, over the entire length of tunnels 6, with a side duct arranged in front as viewed in FIG. 9. The air flowing upwardly therein flows to the inlet of blower 20 in the zone bounded at the top by lines 25 and 26. Half of the heat exchangers are supplied from the outlet of blower 20 in the zone bounded by the lines 27 and 28 indicating a second outlet connection.

In accordance with another feature of the invention, the air is not cooled by the heat exchangers below or substantially not below 0°C. This avoids the water of condensation, which may be formed under certain circumstances, freezing, as this ice formation would lead to a disturbance of the mechanically moving parts.

In addition, the amount of the cooling medium or heating medium supplied to the heat exchangers can be controlled by the temperature of the air entering the tunnel.

In the embodiments illustrated in FIGS. 1 through 9, the application of the invention to the cooling of foods is represented and explained. However, the invention is not limited to cooling procedures, but can be used, with equally good results, for heating procedures where a uniformly distributed rapid heating is required.

A great advantage of the method is that the temperature of the air has only to be 5° to 10°C above the desired end temperature of the material to be heated, so that thermal overstressing of plastic vessels, which would otherwise occur, is avoided.

While the heat exchangers are operated, in cooling processes, with a cooling medium, this is replaced by a heating medium, such as steam, for heating processes. However, electrical heating coils also can be used for the heating processes.

Finally, the method and apparatus of the invention are by no means limited to the production of food.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In a method for changing the temperature of materials, such as food including yogurt, contained in portion containers, wherein the containers, arranged in groups in air permeable receptacles, are introduced into a tunnel whose interior is maintained at a temperature effective to change the temperature of the material to a desired value: the improvement comprising the steps of stacking the receptacles, before introduction into the tunnel, into stacks whose elevational cross-sections approximate the tunnel cross-sections; transversing the stacks, moving longitudinally through the tunnel, uniformly by a temperature changing dynamic air current flowing to the interior of the stacks through longitudinally extending air flow passages in the tunnel formed by at least the exterior surfaces of the stacks and the interior surfaces of the tunnel; directing the air current through a heat exchanger before it transverses the stacks; and directing the air substantially vertically through the stacks.

2. In a method for changing the temperature of materials, such as food including yogurt, contained in portion containers, wherein the containers, arranged in groups in air permeable receptacles, are introduced into a tunnel whose interior is maintained at a temperature effective to change the temperature of the material to a desired value: the improvement comprising the steps of stacking the receptacles, before introduction into the tunnel, into stacks whose elevational cross-sections approximate the tunnel cross-sections; traversing the stacks, moving longitudinally through the tunnel, uniformly by a temperature changing dynamic air current flowing to the interior of the stacks through longitudinally extending air flow passages in the tunnel formed by at least the exterior surfaces of the stacks and the interior surfaces of the tunnel; directing the air current through a heat exchanger before it traverses the stacks; mixing the air leaving the stacks over the entire length of the tunnel; and directing the mixed air to the stacks as plural respective air currents each covering a respective zone of the tunnel with the zones being serially contiguous throughout the tunnel length.

3. In apparatus for changing the temperature of materials, such as food including yogurt, contained in portion containers, wherein the containers, arranged in groups in air permeable receptacles, are introduced into a tunnel having an inlet and an outlet and having a conveying means for moving the portion containers therethrough, the interior of the tunnel being maintained at a temperature effective to change the temperature of the material to a desired value: the improvement comprising, in combination, plural receptacles each receiving a plurality of portion containers, said receptacles being superposed one upon the other on the conveyor means to form stacks with each stack being spaced a small distance from opposite walls of the tunnel to form laterally spaced longitudinally extending air flow passages; and at least one blower having its inlet and outlet in communication with respective air flow passages; and a heat exchanger arranged in

operative relation with said blower; the stack receptacles being formed with air inlet ports and air outlet ports communicating with respective air flow passages, and flow gaps being provided between the individual portion containers on each receptacle; whereby air flows from the outlet of each blower through a first associated passage and through the stack receptacles to the second associated passage and then to the inlet of the respective blower; said receptacles being formed with air inlet ports and air outlet ports only in their bottom walls; one of the pressure side and the suction side of said blower being associated with the upper end of each stack and the other with the lower end of each stack; said conveyor means being air-permeable.

4. In apparatus for changing the temperature of materials, such as food including yogurt, contained in portion containers, wherein the containers, arranged in groups in air permeable receptacles, are introduced into a tunnel having an inlet and an outlet and having a conveying means for moving the portion containers therethrough, the interior of the tunnel being maintained at a temperature effective to change the temperature of the material to a desired value: the improvement comprising, in combination, plural receptacles each receiving a plurality of portion containers, said receptacles being superposed one upon the other on the conveyor means to form stacks with each stack being spaced a small distance from opposite walls of the tunnel to form laterally spaced longitudinally extending air flow passages; and at least one blower having its inlet and outlet in communication with respective air flow passages; a heat exchanger arranged in operative relation with said blower; the stack receptacles being formed with air inlet ports and air outlet ports communicating with respective air flow passages, and flow gaps being provided between the individual portion containers on each receptacle; whereby air flows from the outlet of each blower through a first associated passage and through the stack receptacles to the second associated passage and then to the inlet of the respective blower; there being two blowers arranged in series longitudinally of said tunnel; each blower having an inlet extending over the entire length of said tunnel; and two outlet connections arranged, in series with their lengths, longitudinally of said tunnel and, with the blowers having substantially equal outputs, each having a length corresponding to substantially half the length of the tunnel; each blower having a respective outlet communicating with a respective outlet connection; said heat exchanger comprising tubular evaporators positioned in the path of air flow from said outlet connections.

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