

[54] **PROCESS AND APPARATUS FOR COOLING ARTICLES WITHIN A STEAM CHAMBER**

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[58] Field of Search **21/56, 78, 94, 95, 96, 21/97, 98; 23/290; 165/1**

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[57] **ABSTRACT**

Process of rapidly cooling containers located in a chamber having an at least partially vaporous atmosphere, comprises the steps of introducing into said chamber a cooling liquid which does not come into contact with the containers and a compressed gas which maintains the pressure within the chamber substantially constant while the vapor condenses, and then spraying into the chamber, while still controlling the pressure therewithin, a cooling liquid which does come into contact with the containers and the temperature of which decreases progressively. Apparatus for carrying out said process.

19 Claims, 6 Drawing Figures

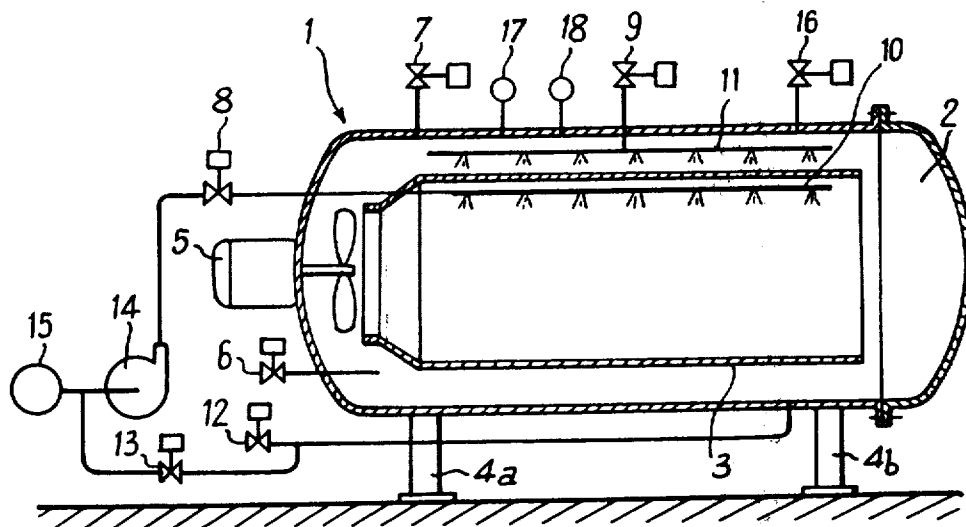


Fig. 1

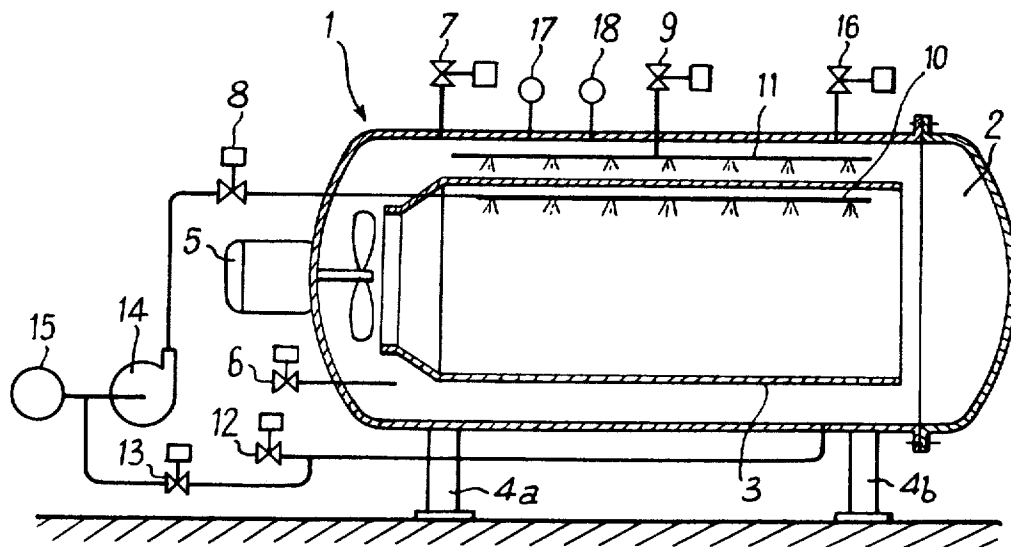


Fig. 2

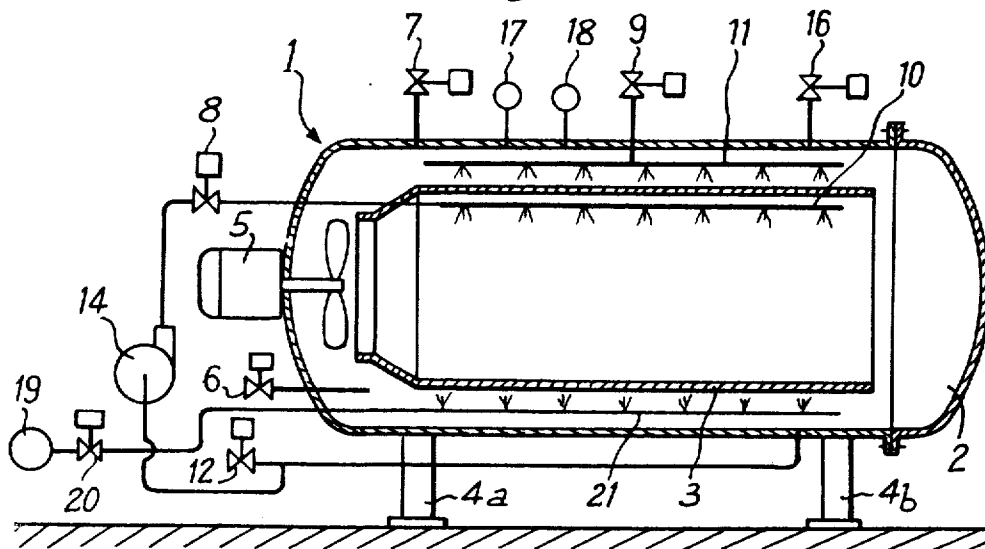


Fig. 3

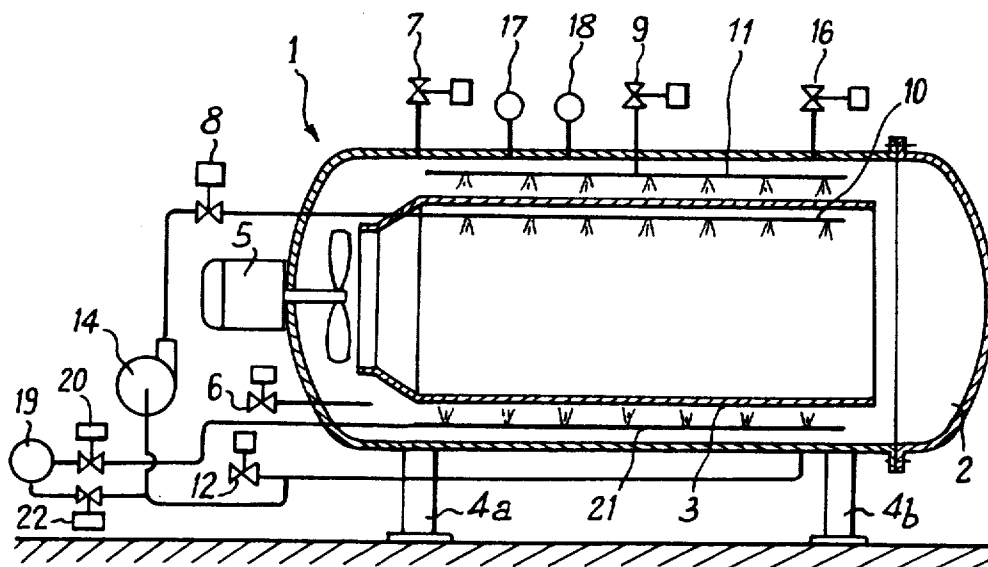


Fig. 6

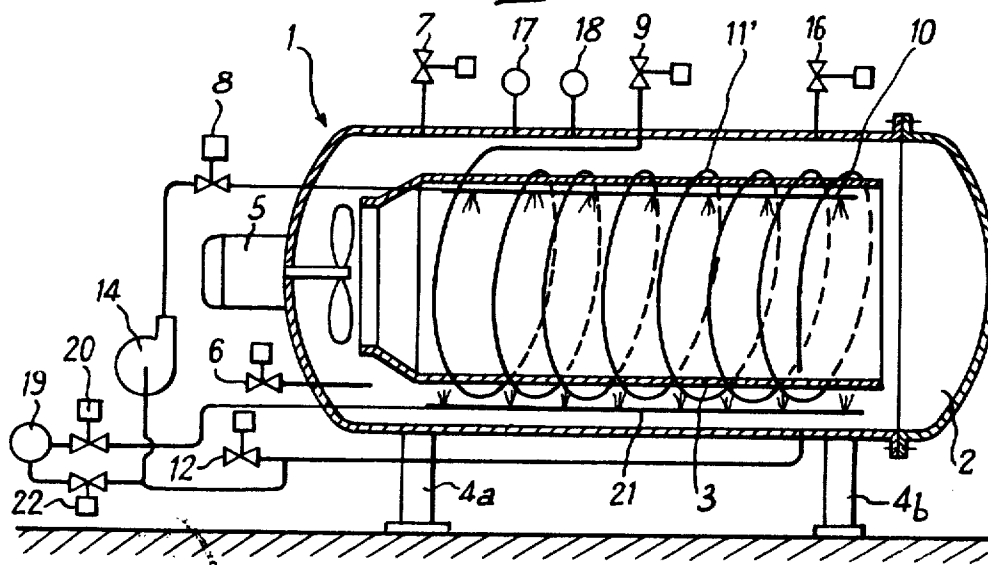


Fig. 4

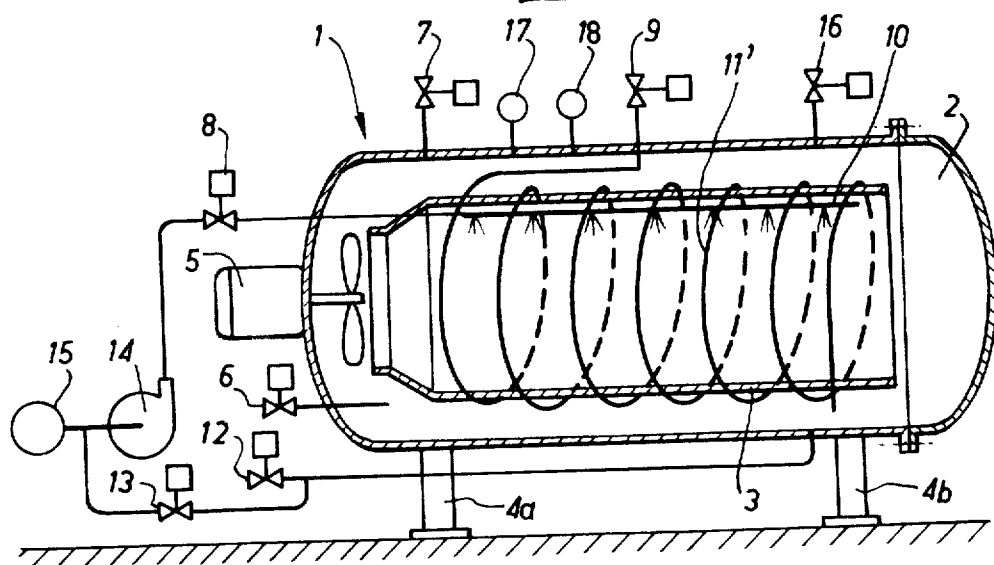
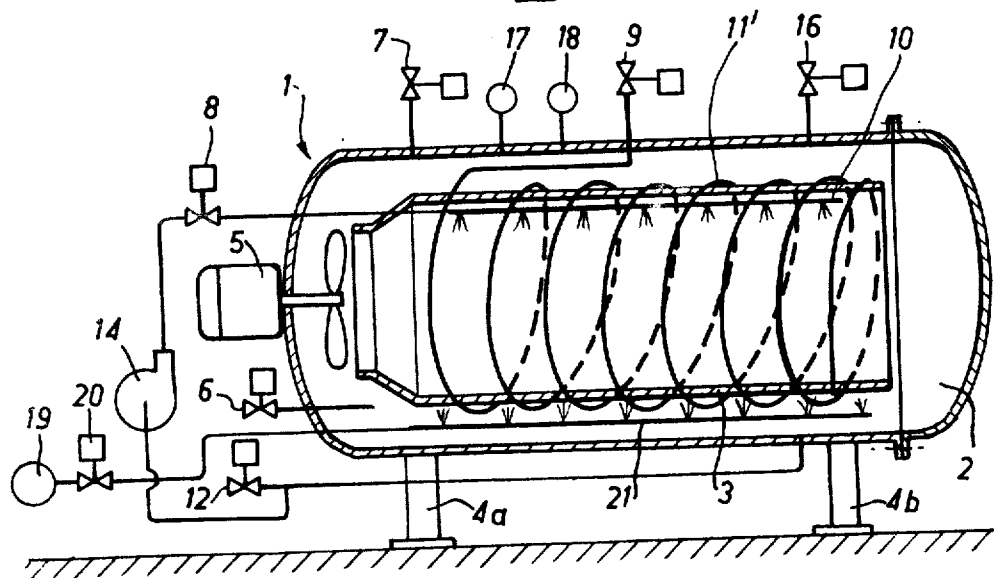


Fig. 5



PROCESS AND APPARATUS FOR COOLING ARTICLES WITHIN A STEAM CHAMBER

SUMMARY OF THE INVENTION

This invention relates to a process and apparatus for rapidly cooling containers located in a chamber containing steam or steam and air, and particularly containers holding food products located in a sterilizing autoclave.

In many industries it is necessary to be able to cool as rapidly as possible containers which are sensitive to thermal-shock and which contain various products, for example, glass containers used in the food industry.

The containers are generally placed in superposed layers in autoclaves having a steam and air atmosphere and brought to a temperature high enough to appropriately treat the products within the containers, for example, high enough to sterilize food products.

The containers are then cooled, after the treating step, by spraying a liquid over them, for instance, water sprayed into the autoclave.

In the processes of this type heretofore used the following two principal disadvantages are encountered:

1. Because the water sprayed into the autoclave inevitably condenses the vapor therein it is also necessary to simultaneously introduce air into the autoclave. This air is generally compressed air and is introduced in a quantity sufficiently substantial to maintain near its original level the pressure around the containers which the spray of water tends to reduce, since this pressure is indispensable to avoid damage to the containers by the pressure within them, and, particularly in the case of capped bottles, to prevent the caps from being blown off due to the force exerted by the pressure within the bottles. 2. The second disadvantage results from the necessity of utilizing a very fine spray at a limited rate of flow in order to reduce thermal-shock and avoid breaking the containers, in particular glass bottles. This leads to slow cooling. In order to avoid this disadvantage it is necessary to spray in, at the beginning of the process, a water which is obtained from a heat-exchanger which becomes larger and more expensive as the required rate of flow becomes larger.

The present invention relates to a process which, in a particularly simple and economic manner, makes it possible to avoid the aforesaid disadvantages. According to the invention, these disadvantages are avoided by a method of cooling the containers located in a steam chamber or a steam and gas chamber, and especially containers holding food and located in a sterilizing autoclave, said process being characterized by the fact that a liquid such as cold water is introduced into the chamber, which liquid does not come into contact with the containers, while a compressed gas is introduced to maintain a substantially constant pressure within the chamber, and that a cooling fluid is then sprayed directly against the containers, while the pressure within the chamber is thus controlled.

In a first embodiment, the liquid which does not come into contact with the containers is sprayed into the chamber. In a second embodiment of the invention the liquid which does not come into contact with the containers is introduced into the chamber through a serpentine coil positioned inside said chamber.

In a particularly advantageous embodiment the liquid resulting from the condensation of the steam in contact with the containers within the chamber and the walls of

the chamber is recycled, and said recycled liquid constitutes part of the cooling fluid.

It is also particularly advantageous to thoroughly mix the steam, or gas and steam, atmosphere within the chamber for the introduction of the liquid spray.

The first of the disadvantages of the prior art processes heretofore mentioned is avoided because of the slow condensation of the vapor within the chamber due to the introduction of a liquid whether in spray form or circulating in a coil defining a cold wall, combined with the supply of a compressed gas such as the air. Thus the water introduced condenses the steam progressively, and the supply of compressed air is adjusted to compensate for the decrease in pressure which the condensation of the steam inevitably produces.

Moreover, this progressive replacement of the steam which disappears in the form of water condensed by the air leads to a cooling of the ambience of the autoclave in which the containers are bathed, which thus commences to cool themselves, thus beginning the work which must essentially be performed by the cooling liquid sprayed against the containers, which covers them with a thin film.

The second disadvantage is avoided by the introduction into the fluid cooling circuit of a predetermined quantity of the water of condensation derived from the condensation of the vapor resulting partly from the introduction of said water to replace the vapor pressure with air pressure and partly from the condensation of the vapor on the containers and on the internal walls of the autoclave in the course of the preliminary sterilizing step.

The recycled hot water cools progressively as it flows, partly because of the continual addition of new water into the cooling circuit containing a mixture of condensed water and sprayed water to maintain the level within the autoclave constant.

The present invention also relates to apparatus for carrying out the above described process.

Apparatus according to the invention is characterized by the fact that it comprises an autoclave having an inner jacket within which the containers are enclosed, said autoclave being provided with a steam inlet valve to maintain within the autoclave an atmosphere consisting of steam or a mixture of steam and gas, a liquid inlet valve, especially for water, said liquid being introduced outside of said jacket to produce a decrease in temperature within the autoclave, without the liquid reaching the containers, an inlet for compressed gas, especially air, the opening of which is controlled to maintain substantially constant the pressure within the autoclave during the decrease in temperature, or to control a circuit for admitting a spray of cooling fluid, an outlet valve to evacuate the mixture of condensed liquid and sprayed liquid, and a valve for connecting the autoclave to atmosphere.

In a first embodiment, the liquid inlet valve is associated with spray means mounted outside said jacket. In a second embodiment the said liquid inlet valve is associated with a coil mounted around said jacket. In a particularly advantageous embodiment the circuit for admitting a sprayed cooling fluid comprises a recycling valve for recycling the liquid condensed in the autoclave, pressure means, a valve for admitting a liquid, especially water, and spray means.

According to another embodiment of the invention the circuit for admitting cooling fluid comprises two in-

dependent sections, the first section of the circuit comprising a duct for evacuating liquid condensed within the autoclave, pressure means, a valve for admitting liquid into the autoclave, and first spray means, while the second section of the circuit comprises an external source of cold liquid, such as water, a valve for admitting cold liquid into the autoclave, and second spray means.

As a variation, the second spray means may be eliminated and the cold liquid injected into a coil encircling the inner jacket of the autoclave.

According to another particularly advantageous embodiment of the invention, the circuit for admitting cooling fluid comprises a duct for evacuating liquid condensed within the autoclave, pressure means, a valve for admitting liquid into the autoclave, first spray means, an external source of cold liquid, especially water, a valve for admitting said cold liquid into the autoclave, and second spray means, said external source of cold liquid being connected to the duct for evacuating condensed liquid upstream of the pressure means through a supplemental valve.

In one variation the second spray means may be eliminated and the cold liquid injected through a coil positioned around the inner jacket of the autoclave.

Thus, as a consequence of the independent admission of cold fluid into the autoclave, the thermal-shock to the containers within the autoclave is still further reduced because the water within the autoclave resulting from the condensation of the steam is warmer at the beginning of the cooling step. Moreover this independent supply of cold fluid, a source of which is necessarily at a pressure greater than that within the autoclave, makes it possible to eliminate the risk of stopping the flow of recycled water from the autoclave toward the pressure means during low pressure within the autoclave. In a particular embodiment, the outlet valve may be equipped with electric level-responsive means to maintain the level of liquid within the autoclave constant.

Moreover, and in a particularly advantageous manner, the device may comprise a fan to stir the atmosphere within the autoclave before the actuation of the valve admitting the spray of cooling fluid.

In order that the invention may be better understood, one embodiment thereof will now be described, together with its mode of operation, purely by way of illustration and example, with reference to the accompanying drawings in which:

FIG. 1 illustrates a first embodiment of the apparatus according to the invention;

FIG. 2 illustrates a modification of the apparatus according to FIG. 1 with respect to the circuit for admitting atomized cooling fluid;

FIG. 3 illustrates another modification of the apparatus according to FIG. 1 with respect to the circuit for admitting atomized cooling fluid;

FIG. 4 represents a second embodiment of the apparatus according to the invention;

FIG. 5 represents a modification of the apparatus according to FIG. 4 with respect to the circuit for admitting atomized cooling fluids, and

FIG. 6 represents another modification of the apparatus according to FIG. 4 with respect to the circuit for admitting atomized cooling fluid.

The apparatus shown on FIG. 1 comprises an autoclave, generally indicated by reference numeral 1, pro-

vided with a door 2 through which the containers (not shown) may be introduced into the autoclave, and placed within an inner jacket 3. The autoclave rests on feet 4a and 4b and is equipped with a fan 5.

The autoclave is provided with a steam inlet 6, an inlet 7 for compressed gas, particularly air, valves 8 and 9 for admitting a fluid such as water, each associated with spray means in the form of tubes 10 and 11 having a plurality of perforations, with 10 so positioned that the liquid sprayed thereby comes into contact with the containers within the chamber 3 inside the autoclave, and 11 so positioned that the liquid atomized thereby cannot come directly into contact with the containers.

The device also comprises an outlet valve 12 and a recycling valve 13 supplying a pressure means 14, such as a pump, which also receives liquid such as water from an external source 15 and supplies it to the valve 8 which supplies the cooling liquid to spray means 10.

The device also comprises a valve 16 for connecting the autoclave to atmosphere.

The autoclave is also provided with a thermostat 17 and pressure regulating means 18, which may advantageously be program controlled, and the utility of which will be hereinafter explained.

One method of utilizing the device illustrated will now be described, specifically the case in which it is desired to cool containers such as glass bottles containing food products located in a sterilizing autoclave by running a cooling fluid thereover.

At the end of the sterilizing operation the atmosphere within the autoclave which may be stirred by the fan 5 contains only steam or a mixture of steam and a gas such as air, the steam having been introduced through the valve 6 and the gas through the valve 7 or, in the case of air, this gas may have been introduced into the autoclave during the closing of the door 2 when the containers were being introduced before sterilization.

In the example described, air has been used as the gas and water as the liquid.

In the bottom of the autoclave there is standing water of condensation coming from the steam which heated the bottles within the baskets (not shown) within the jacket 3 inside the autoclave 1, and the walls of autoclave.

In the example described, at the end of the sterilization step, the prevailing temperature is 120°C and the gauge pressure within the autoclave is 1.8 bars.

Because at 120°C the gauge pressure due to the water vapor is 1 bar, 0.8 bars of the pressure is due to the presence of air.

It is desired to decrease the temperature from 120°C to 70°C while maintaining the gauge pressure at 1.8 bars in a time of 3 minutes, for example.

The apparatus operates as follows:

The thermostat 17, which is program controlled, is programmed to actuate the valve 9 for introducing water to produce the desired decrease in temperature during the desired time.

Each time that the thermostat 17 opens the valve 9, water is sprayed through the atomizing tube 11, which water does not come into contact with the containers within the jacket 3, but decreases the temperature in the autoclave 1.

Since the pressure within the autoclave has a tendency to decrease, pressure control valve 18, which is also program controlled, opens the valve 7 to admit

compressed air to compensate for the decrease in pressure.

There is thus obtained a progressive decrease from 120° to 70°C in 3 minutes, the gauge pressure being kept at 1.8 bars, so that the absolute pressure is 2.8 bars.

However, at a temperature of 70°C the water vapor, considered alone, is under a pressure of -0.7 bars. If the absolute pressures are considered, the pressure due to the vapor is thus 1-0.7, or 0.3 bars, for a total pressure of 2.8 bars. Consequently, the absolute pressure due to the air is 2.8 minus 0.3, or 2.5 bars.

Thus, even if no additional compressed air were introduced through the valve 7, the initial absolute pressure would fall only from 2.8 bars to 2.5 bars, or 0.3 bars. Without the apparatus described, the gauge pressure would fall from 1.8 bars to 1.8-1, or 0.8 bars, which would produce a decrease in pressure of 1 bar, that is to say the value of the pressure due to the vapor, since the water spray would condense only the vapor, thus eliminating its contribution to the total pressure.

It is of course well understood that a programmed decrease from 120° to 70°C has been selected purely by way of example and could be, for example, from 120° to 55°C, the part of the pressure due to the vapor being then even smaller, or about 0.1 bars.

During these 3 minutes at a constant pressure while the greater part of the vapor is replaced by compressed air, the temperature of the walls of the bottles has decreased from about 120° to 105°C. After this decrease in temperature at constant pressure the bottles are spray cooled by opening the valves 8 and 13 and starting the pumping means 14. A part of the water of condensation passes through the valve 13 and rejoins the cold water arriving from the source 15 and the resulting mixture is pumped by the pressure means 14 into the circuit comprising the valve 8 and the spray means 10.

If it be supposed that 70 percent of the total flow through the pressure means 14 consists of water at 10°C from the source 15 and 30 percent of water at 100°C from the autoclave through the valve 13, the law of mixtures determines the temperature of the fluid reinjected into the autoclave at 10, which temperature may be calculated to be about 37°C.

Thus the bottles at a wall temperature of 105° receive first water sprayed at 37°, i.e., at a difference in temperature of 105°-37°, or 68°C. Without the second part of the apparatus which recycles the condensed water, the difference in temperature would be 105°-10° or 95°C. Without the complete device according to the invention the difference in temperature would have been 120°-10° or 110°C. The thermal-shock, which is capable of breaking the bottles when there is a temperature difference of 110°C between the water and the bottles, is thus reduced to the extent that the temperature difference is brought to 68°C.

The outlet valve 12 may advantageously be a valve of the electrical level responsive type to evacuate the mixture of cold water and condensed water from the bottom of the autoclave and may advantageously maintain the level of the water within the autoclave constant.

Thus in a time which is shorter when the flow through the pressure means 14 is higher, the recycling water passed through the valve 13 cools and progressively attains a temperature near 10°C.

In accordance with the invention there is obtained, in addition to the previously cited advantages, a greater

homogeneity between the successive layers of bottles within chamber 3 because of the fact that the flow of water over these bottles is greater than the flow of cold water from the source 15. The fan 5 may also be actuated for a certain time while cooling water is being supplied, thus reducing the thermal-shock by mixing the air around the containers when the atmosphere in the autoclave is still hot. In an advantageous manner the fan may stop between 30 seconds and three minutes after the beginning of the cooling, said time being modified in dependence upon the desires of the user.

The apparatus shown in FIG. 2 differs from that shown on FIG. 1 by the presence of an external source 19 of cold fluid, such as water, which supplies through a valve 20 spray means 21 inside the autoclave 1.

The operation of the apparatus according to FIG. 2 is identical to that described with reference to FIG. 1 with respect to the step of decreasing the temperature at a substantially constant pressure. The spray cooling is obtained by starting the pressure means 14 and opening the valves 8 and 20. The pressure means 14 recycles the water from the bottom of the autoclave, said water being returned to the autoclave through the valve 8 and the spray duct 10 while the cold water arriving from the source 15 through the valve 20 and the spray duct 21 constantly decreases the temperature of the circulating water, and the valve 12 evacuates the excess water, thus maintaining the level of the water within the autoclave constant.

The apparatus shown on FIG. 3 is distinguished from the one shown on FIG. 2 by the presence of a supplemental valve 22 positioned between the external source of cold liquid 19 and the duct for evacuating the condensed liquid in the bottom of the autoclave, upstream of the pressure means 14.

The operation of the apparatus of FIG. 3 is the same as the operation of the apparatus according to FIG. 2. It has the advantage of making it possible to add to the fluid cooling circuit a certain quantity of cold water which has the effect of accelerating the speed of cooling of the fluid moving through the autoclave and thus the cooling of the containers, said operation being brought about by opening valve 22. The valve 22 is advantageously equipped with a regulating system of the clockwork type which permits its opening at the same time as the opening of the valves 20 and 8 upon starting of the pressure means 14, or this opening of the valve 22 may be brought about at any predetermined time after the start of the pressure means.

FIGS. 4, 5, and 6 illustrate another embodiment of the invention and differ respectively from those of FIGS. 1, 2, and 3 by the presence of a coil 11' surrounding the jacket 3 holding the containers and opening into the bottom of the autoclave 1. This coil is associated with the valve 9 and replaces the perforated spray tube 11 of the embodiment of FIGS. 1, 2, and 3.

The operation of the apparatus according to FIGS. 4-6 is the same as that according to the FIGS. 1 to 3 except for the fact that, on each opening of the valve 9 by the thermostat 17, the water is no longer sprayed into the interior of the autoclave without coming into contact with the containers, but runs instead through the coil 11 which defines a cold wall producing condensation of the vapor within the autoclave, the movement of the vapor within the autoclave being then assured by starting of the fan 5.

As a modification of the embodiments of FIGS. 5 and 6 it is possible to eliminate the spray tubing 21 and to connect the valve 20 to the coil 11 downstream of the valve 9. This embodiment is not shown in the drawings.

It is also possible to eliminate one of the valves 20 and 9, with the remaining valve serving the function of both of these two valves by being connected to both the source of cold liquid 19 and to the coil 11'.

It will of course be apparent that the invention is not limited to the specific embodiments described and may be modified as to detail without thereby departing from the basic principles of the invention.

What is claimed is:

1. Process of rapidly cooling containers located in a chamber having an at least partially vaporous atmosphere, said process comprising the steps of introducing into said chamber a cooling liquid which does not come into contact with the containers and a compressed gas which maintains the pressure within the chamber substantially constant while the vapor condenses, and then spraying into the chamber, while still controlling the pressure therewithin, a cooling liquid which does come into contact with the containers and the temperature of which decreases progressively.
2. Process as claimed in claim 1 in which the liquid which does not come into contact with the containers is sprayed into the chamber.
3. Process as claimed in claim 1 in which the liquid which does not come into contact with the containers is introduced into a coil inside the chamber.
4. Process as claimed in claim 1 in which the liquid produced by condensation of the vapor in the chamber is recycled to form part of the cooling liquid.
5. Processes as claimed in claim 1 in which the atmosphere within the chamber is mixed before introducing the atomized water.
6. Device for rapidly cooling containers which comprises an autoclave having an internal jacket in which containers are located, said autoclave being provided with vapor inlet valve means to produce an at least partially vaporous atmosphere within the autoclave, liquid inlet valve means connected to introduce liquid to said autoclave outside of said jacket to cool the autoclave and consequently indirectly cool the containers, compressed gas inlet valve means which is controlled to maintain the pressure in the autoclave substantially constant during the cooling of the autoclave, circuit means for spraying cooling liquid into said autoclave against said containers, valve means for evacuating the mixture of condensed liquid and sprayed liquid, and valve means for connecting the autoclave to atmosphere.
7. Device as claimed in claim 6 in which the liquid inlet valve is connected to means for spraying liquid

within said autoclave but outside said jacket.

8. Device as claimed in claim 6 in which the liquid inlet valve is connected to a coil located within said autoclave but outside said jacket.

9. Device according to claim 6 in which the circuit for spraying cooling liquid into said autoclave comprises a recycling valve for liquid condensed within the autoclave, pressure means, a valve for admitting liquid, and spraying means.

10. Device according to claim 6 in which the circuit for spraying cooling liquid into the autoclave comprises two distinct sections, the first of which comprises a duct for evacuating condensed liquid from the autoclave, pressure means, a valve for admitting liquid into the autoclave, and spray means, while the second comprises an external source of cold liquid and a valve for admitting cold liquid into the autoclave.

11. Device according to claim 10 which comprises spray means connected to the valve for admitting cold liquid into the autoclave.

12. Device according to claim 8 in which said valve for admitting cooling liquid is connected to the coil outside the inner jacket of the autoclave.

13. Device according to claim 6 in which the circuit for admitting cooling liquid comprises a duct for evacuating liquid condensed inside the autoclave, pressure means, a valve for admitting liquid into the autoclave, spray means, an external source of cold liquid, and a valve for admitting said cold liquid into the autoclave, said external source of cold liquid being connected to a duct for evacuating condensed liquid upstream of the pressure means through a supplementary valve.

14. Device as claimed in claim 13 which comprises spray means associated with the valve for admitting cooling liquid to the autoclave.

15. Device as claimed in claim 8 in which said valve for admitting cooling liquid is connected to the coil positioned outside the inner jacket of the autoclave.

16. Device as claimed in claim 6 in which the outlet valve is of the electrical level-responsive type and maintains the level of liquid in the autoclave constant.

17. Device as claimed in claim 6 which also comprises a fan connected to stir the atmosphere within the autoclave before actuation of the circuit which sprays liquid directly into the autoclave against the containers.

18. Device as claimed in claim 6 which also comprises a thermostat and a pressure control device for controlling pressure in the autoclave during the cooling of the autoclave.

19. Device as claimed in claim 18 in which said thermostat and pressure control means are program controlled.

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