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PROCESS FOR STERILE FOOD PACKAGING

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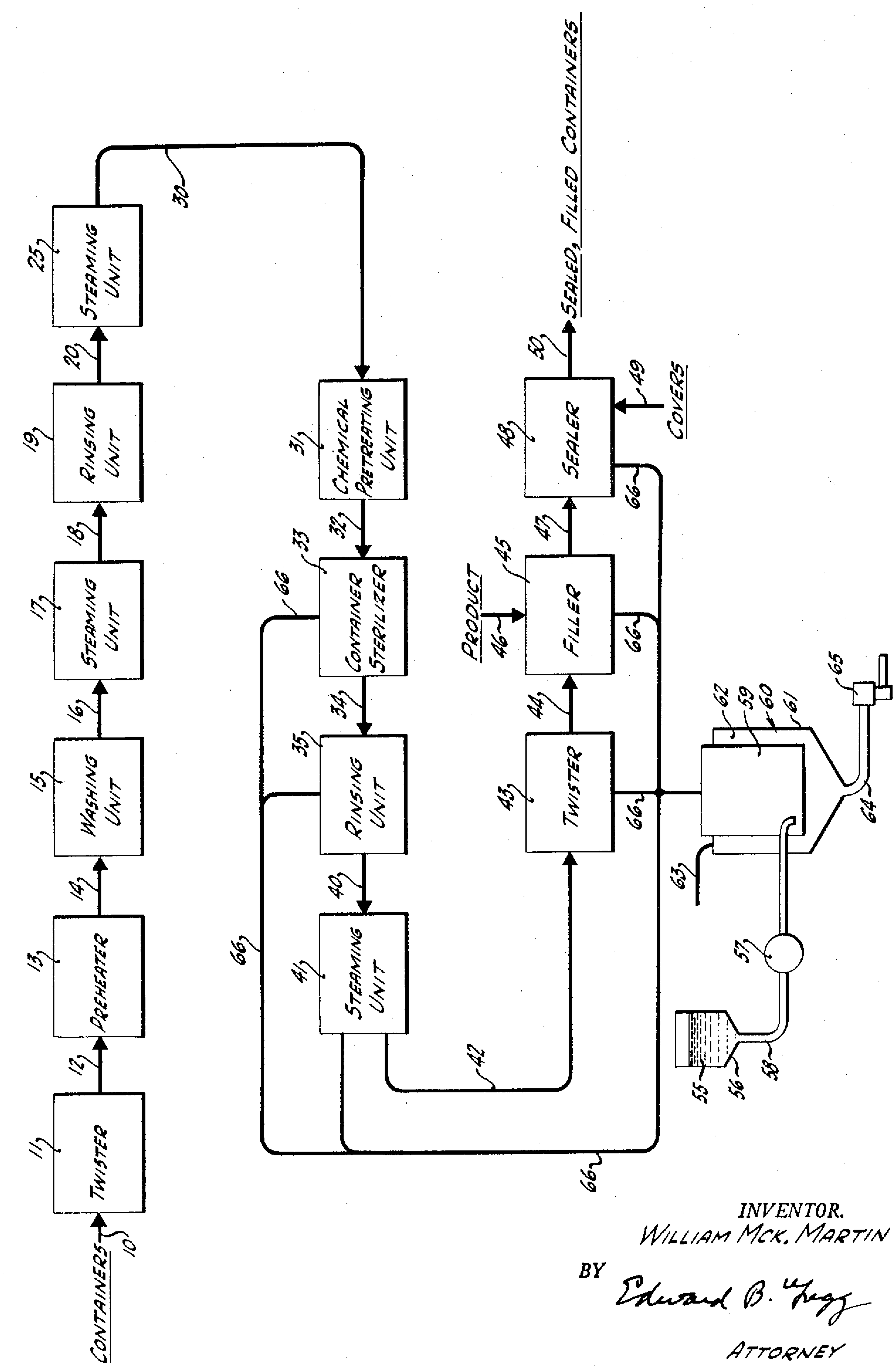

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PROCESS FOR STERILE FOOD PACKAGING

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This application is a continuation-in-part of my copending application Serial No. 556,141, filed December 29, 1955, which in turn is a continuation-in-part of my application Serial No. 478,996, filed December 31, 1954, and now abandoned.

This invention relates to process and apparatus for sterile or aseptic canning of foods and the like.

By the terms "sterile canning" and "aseptic canning" is meant the packaging of food products in sealed glass, metal or other containers under conditions wherein the containers and their covers or closures, are presterilized, the food product is also presterilized, the sterile food product is placed in the sterile containers, the sterile covers are then applied to the filled containers, and the filling and closing operations are carried out in a sterile atmosphere. If these precautions and conditions are observed, then it is unnecessary to post-sterilize the canned food, as by heating in a retort. The process and apparatus of the invention, therefore, relate to pre- rather than post-sterilization of food products.

The process and apparatus of the present invention are, of course, applicable to the sterile canning or packaging of products other than foods, e.g., the sterile packaging of biological preparations. The invention is also applicable to the sterilization of equipment used for sterile canning.

Several methods of sterile canning have been proposed heretofore, some of which are at present or have in the past been in commercial use, and all of which employ heat to sterilize the containers and covers. One such method is described in Dunkley U.S. Patent No. 1,270,798, hereinafter referred to as "Dunkley method." The Dunkley method employs steam as a heating medium to sterilize containers and covers and to maintain sterile conditions during the filling and closing operations. High pressure steam is injected into the containers as they pass through a chest in which the container sterilizing, filling and closing operations are carried out. The chest is open to the atmosphere at both ends. Hence the injected steam expands to atmospheric pressure. If the steam employed is high pressure, dry saturated steam, it is feasible to achieve steam temperatures in the chest which are considerably above 212° F.; e.g., temperatures of about 280° F. have been measured at the outlet nozzles. Even so, it has been amply demonstrated that the Dunkley method is not operable unless excessively long exposure times are employed. The reason for this is that, at such temperatures resistant food spoilage organisms such as *B. stearothermophilus* (NCA No. 1518), *B. polymixa* and other resistant bacterial spores are not killed unless exposed for excessively long periods of time.

A second and later method is the Ball method of Ball U.S. Patent No. 2,029,303. The Ball method employs steam as the heating and sterilizing medium but it employs high pressure, hence high temperature steam. As a consequence of high pressure Ball must employ sealing and valving means to permit the introduction of empty containers and of covers and the efflux of filled, sealed containers without loss of pressure and temperature from the system. The Ball method is operable and can be made to accomplish sterilization in much shorter time than the Dunkley method. However, the valving and sealing means employed are expensive and cumbersome. For

this and other reasons the Ball method is not a desirable method of carrying out aseptic or sterile canning.

A third method which is at present in large scale commercial use is that of Martin Patent No. 2,549,216, hereinafter referred to as the "Dole aseptic canning system" or the "Dole method." This method employs steam as in the case of Dunkley and Ball, but it combines the high temperature (hence short sterilization time) of Ball with the desirable atmospheric pressure feature of Dunkley. This is accomplished by imparting external sensible heat to the steam at atmospheric pressure by means of a heat exchanger, to yield dry steam at a high temperature (e.g., 400° F. or higher) and at atmospheric pressure.

Yet another method is that of my copending application Serial No. 478,996, above referred to, wherein flame and/or hot combustion gases generated in situ within the sterilizing apparatus are employed. Such method is referred to hereinafter as the Martin flame method.

While the latter methods (i.e., the Dole and the Martin flame methods) provide practical processes for sterile canning wherein atmospheric pressures can be employed and sterilization times are relatively short, they have, nevertheless, certain short-comings and disadvantages, as follows: Both these methods employ sterilizing temperatures of about 350 to 500° F. That is, the containers and covers are heated and maintained at such temperatures for a sufficient time to accomplish sterilization. With ordinary tin cans employing double end seams and soldered side seams, failure may occur, particularly at the soldered side seams and the double end seams, by reason of softening of the solder or sealing compound. In the case of glass containers excessive breakage has occurred because of thermal shock, as when hot glass containers from the sterilizer are filled with relatively cool product. Also, such high temperatures have a deleterious effect upon the sealing compound and gasket material of covers for metal and glass containers.

It is an object of the present invention to provide a means for sterile canning which is capable of employing substantially lower temperatures than presently used, yet which will effect sterilization in a short time comparable to that of the Dole method and the Martin flame method.

It is a particular object of the present invention to provide a method of aseptic canning whereby the temperature can be lowered substantially from that employed by present day commercial methods without, however, suffering a proportionate increase in time required, preferably, with no increase in time required.

It is a further object of the present invention to provide improvements upon the Dunkley method of sterile canning which will obviate the time difficulty inherent in that method.

A further object is to provide means whereby atmospheric steam can be employed as in the Dunkley process, without the necessity of long contact periods (as in the Dunkley method) and without the necessity of adding superheat to the steam.

Yet another object is to provide improvements upon high temperature sterilization methods whereby lower temperatures may be employed without a serious sacrifice of speed and with consequent advantage with respect to container failure.

These and other objects of the invention will be apparent from the ensuing description and the appended claims.

One embodiment of the invention is illustrated diagrammatically and by way of example in the drawing, which will be described hereinafter.

In accordance with my present invention I pretreat containers to precondition and predispose the microorganisms which contaminate them to the action of heat. By this I mean that the containers, prior to the time they are subjected to heat sterilization, are subjected to a suitable conditioning treatment to render the bacteria and other microorganisms which it is desired to kill, more susceptible to the lethal effect of heat. Stated another way, I pretreat containers in such manner as to render heat sterilization more efficient. I then subject the pretreated containers to sterilizing heat but under milder conditions (i.e., at a lower temperature and/or a shorter exposure time) than in present commercial methods.

Such pretreatment is preferably given to the covers also, although this is optional. That is, my present invention may be applied to containers with or without application to covers. In the latter case (not application to covers), the covers will be sterilized by prior or conventional methods.

Pretreatment may take any of several forms, some of which are preferred and some of which are better suited for certain conditions than others.

Preferably the containers are pretreated with an added agent which is effective to accelerate or facilitate the lethal effect of heat on bacteria and other microorganisms. Such pretreatment may take any of several forms such as the following:

(1) Application of a film of water to the surfaces of containers, etc.; i.e., wetting or moistening the containers, covers or the like. Such film of water renders thermal methods of sterilization more efficient and consequently permits the use of a lower temperature during the thermal sterilization step. This procedure wets bacterial spores, causes penetration of water into the spores, predisposes the spores to the lethal action of heat and acts as an efficient heat conductor.

(2) Pretreatment of such surfaces with a bactericidal agent such as an acid (e.g., acetic acid), an alkali, chlorine, formaldehyde, ethyl alcohol, methyl alcohol or propyl alcohol, preferably in admixture with or dissolved in water or alcohol, such toxic agent being effective to kill the contaminating microorganisms or to reduce their resistance to heat and therefore render them more susceptible to being killed by heat during the high temperature sterilization stage of the process. Alcohol is preferred as a bactericidal agent because of its low cost, its toxicity to bacteria and its lack of toxicity to human beings.

(3) Pretreatment of such surfaces to adjust their pH to a range wherein the microorganisms thereon are more susceptible to being killed by heat.

It will be understood that these techniques may be applied, not only to containers but also to covers, to processing equipment and the like. For convenience container surfaces will be referred to frequently herein but it will be understood that other surfaces are also contemplated.

Preferably the third method is employed, i.e., surface treatment to modify pH. The modifying agent may be an aqueous acid solution of suitable pH, e.g., 0 to 4, preferably 1 to 3, or it may be an aqueous alkali solution of suitable pH, e.g., 10 to 14. Suitable acids include hydrochloric, sulfuric and acetic acids, and suitable alkalis include sodium and potassium hydroxides, 5% lye solutions such as customarily used in washing glass containers in canneries, and trisodium phosphate.

Preferably the containers are treated with a surfactant solution prior to the pH modification, although surfactants compatible with the pH modifier may be used in conjunction with the pH modification, i.e., may be incorporated in the acid or alkali solution. The advantage of using a surfactant is that it penetrates and wets contaminating material including bacterial spores and renders them more accessible to the acid or alkali. Examples of suitable surfactants are alkyl benzene sulfonates (such as the Nacconols and Oronite Detergent) and such nonionic surfactants as Antaron L–520 (a tall oil-ethylene oxide polymer).

The containers are preferably sprayed with surfactant solution, then with acid or alkaline solution; they are preferably held in inverted position to allow drainage of excess moisture; and the sprayed containers are then held for a sufficient time to cause the sprayed surfaces and adhering particles and microorganisms to be thoroughly wetted and permeated. The containers, with their surfaces still wet with acid or alkaline solution, are then subjected to heat sterilization by any suitable means, such as steam at 212° to 270° F. and atmospheric pressure as in the Dunkley method, steam at superatmospheric pressure as in the Ball method, superheated steam at atmospheric pressure as in the Dole method or flame and combustion gases as in the Martin flame method.

The time and temperature of exposure to sterilizing heat will, of course, be regulated to achieve sterilization, but it will be found that substantially less rigorous conditions (e.g., lower temperatures in the Ball, Dole and Martin methods and shorter contact times in the Dunkley method) are required because of and by reason of pretreatment of the containers in accordance with the present invention.

It will be apparent to those skilled in the art that pretreatment in accordance with the present invention may be carried out in a variety of ways and by a variety of techniques. One such technique, which is preferred, is illustrated diagrammatically in FIGURE 1 to which reference is made now.

Referring to the drawing, glass or metal containers are conveyed at 10 to a twister 11 in which they are inverted so that they are upside down and have their open ends at the bottom. The inverted containers are then conveyed at 12 to a preheater 13 wherein they are preheated to, say, 140° F. This preheating step is particularly advantageous with glass containers because it insures a more gradual heating of the glass, thereby reducing thermal shock and breakage caused by thermal shock when the glass containers are heated to sterilizing temperature at a later stage in the process. The preheating step may, however, be omitted. The containers are next conveyed at 14 to a washing unit 15 in which a hot cleaning solution is sprayed onto the exterior and interior surfaces of the containers to wash them and remove gross impurities such as large dust particles, grease, etc. The cleaning solution may be of any suitable type, e.g., an aqueous soap, lye, synthetic detergent or trisodium phosphate solution. Such solutions, besides cleaning in a sanitary sense, also have a bactericidal effect. Moreover, this washing with solution of detergent or surfactant facilitates subsequent wetting and penetration by the acid, alkali, or bactericidal agent used in the chemical pretreatment step described hereinafter.

The washed containers are next conducted at 16 to a steaming unit 17 in which they are sprayed with steam to remove excess cleaning solution by mechanical action of the steam and by condensation of steam upon the container surfaces and resulting flow of condensed steam downwardly over the container surfaces. The containers are next conveyed at 18 to rinsing unit 19 wherein hot water, preferably at 200 to 210° F., is sprayed onto the interior and exterior surfaces to rinse the containers thoroughly. The containers are then conveyed at 20 to a steaming unit 25 in which steam jets are played onto the interior and exterior surfaces of the containers to remove adhering films or droplets of water; i.e., to remove excess moisture.

At this stage the containers will have been thoroughly cleansed and will, in fact, have been pretreated in accordance with one embodiment of the invention. That is, bacterial spores, etc. will have been thoroughly wetted and penetrated by moisture, hence are more susceptible to the lethal effect of heat, particularly dry heat such as used in the Dole, Dunkley and Martin methods. The containers can, therefore, be conducted directly to the high temperature sterilization unit. However, it is preferred to continue the pretreatment by adjusting the pH of the surfaces of the containers by spraying them with acid or alkaline solution of appropriate pH, or with a bactericidal agent such as alcohol. This is accomplished by conducting the containers at **30** to a chemical pretreating unit **31** wherein a suitable liquid is sprayed onto the interior and exterior surfaces of the containers. Such liquid may be, for example, an aqueous solution of acid such as acetic, hydrochloric or sulfuric acid, an aqueous solution of chlorine, an aqueous solution of an alkali such as sodium or potassium hydroxide, alcohol or formaldehyde and, in general, any chemical which is bactericidal and/or which predisposes bacteria to the lethal effects of heat. Aqueous acid or alkaline solutions are preferred, the most advantageous being hydrochloric acid and acetic acid solutions of a pH about 0 to 3, and a sodium hydroxide solution of pH about 10 to 14. The chemically pretreated containers are then conveyed at **32** to a container sterilizer **33**. The latter may be of the Dunkley, Ball, Dole or Martin type referred to hereinabove, wherein heat is employed as the sterilizing medium. That is, the heating medium may be atmospherc steam at 212° F.–270° F., superheated high pressure steam, superheated atmospheric steam, flame or combustion gases. It will be found that substantially lower temperatures, e.g., as much as 200° F. lower, suffice in the container sterilizer **33** than are required in the prior high temperature methods wherein containers are sterilized by dry heat but without pretreatment as described hereinabove. Thus, sterilizing temperatures of 200 to 300° F. may be employed instead of 400 to 500° F., without corresponding increase of exposure time. Alternatively, higher temperatures (400–500° F.) but shorter exposure times may be employed. Where container failure and breakage are the chief difficulty, the temperature will be lowered, but in the case of containers and covers where high temperature is not a disadvantage, the exposure time may be shortened to speed up the process.

Temperatures of about 270° F. are obtainable in the Dunkley process provided dry, saturated, high pressure steam is expanded into the containers. Steam at about 100 p.s.i. gauge, such as commonly used in canneries, is adequate for the purpose. As noted above, in the Dunkley process temperatures of this order require excessive contact times. It is a particularly important advantage of the process of this invention that the Dunkley process is made operable with short contact times. The Dunkley process, thus modified is the preferred embodiment of the present invention and it avoids the necessity of adding superheat by external means, and the high temperatures and container failure which characterize the Dole method.

The sterile containers are then conveyed at **34** to a rinsing unit **35** similar to the rinsing unit **19** wherein sterile water (e.g., steam condensate) is sprayed onto the exterior and interior surfaces of the containers to wash the chemical fluid from the containers. This rinsing operation may be omitted if a volatile chemical agent such as acetic acid, hydrochloric acid, formaldehyde or alcohol is used.

The sterile containers are next conveyed at **40** to a steaming unit **41** similar to the steaming unit **25** and are then conveyed at **42** to a twister **43** wherein they are turned to upright position and are then conveyed at **44** to a filler **45**. Sterile product enters at **46** and the containers are filled. The filled sterile containers are then conveyed at **47** to a sealer **48**. The sealer **48** is supplied with sterile covers at **49** which are applied in the sealer to the filled containers. The sealed, sterile filled containers are removed from the system at **50**.

It will be understood, of course, that certain parts of the system will be enclosed, although not necessarily air tight. Thus, the container sterilizer **33**, the lines or conduits shown at **34**, **40**, **42**, **44** and **47**, the rinsing unit **35**, the steaming unit **41**, the twister **43**, the filler **45**, and the sealer **48** will be enclosed, not necessarily to prevent

communication with the atmosphere but to provide a jacket or chest which can be kept filled with sterile medium. Thus steam, hot combustion gases, or other suitable sterile gas may be introduced into the enclosures of the aforesaid ducts and conveyors and units to maintain a sterile atmosphere and to prevent ingress of nonsterile air from outside. It will also be understood that the covers supplied at **49** will be sterilized by the same or some other suitable method, and that the various washing and chemical pretreatment steps described hereinabove may be applied to the covers.

It will also be understood that the entire system, commencing with container sterilizer **33**, and including conveyor equipment, the interior surfaces of enclosures, etc. will be presterilized before sterile canning is commenced. In presterilizing the equipment, any suitable means may be employed, e.g., superheated steam or hot combustion gases, and the time required for presterilization may be reduced by first pretreating the equipment, as by wetting it with water or aqueous acid solution. A preferred method of presterilization is illustrated in the drawing.

Before describing this method of presterilization, it is desired to comment as follows on a modification of the present invention which is particularly well adapted to glass containers. Referring again to FIGURE 1, if the wash liquid used in the washing unit **15** is bactericidal, e.g., a 5% lye solution such as commonly used to wash glass containers, it suffices to hold the washed containers sufficiently long to insure sterility, then drain them and give them a sterile rinse, then conduct the filling and closing operations under sterile conditions. This procedure, which eliminates the chemical pretreatment and heat sterilization carried out at **31** and **33**, is better adapted to glass containers than to metal containers.

Referring again to the drawing, a presterilization technique is there shown which will now be described. A volatile chemical sterilizing or bactericidal medium, e.g., an aqueous solution of acetic or hydrochloric acid of pH about 0 to 3, or an aqueous solution of formaldehyde, or ethyl alcohol is maintained at **55** in a tank **56** and is pumped at a metered rate by a pump **57** through a line **58** into the inner chamber **59** of a vaporizer **60**. The vaporizer **60** has a jacket **61** providing an annular space **62** into which high pressure steam is introduced at **63**, steam and condensate being removed through a line **64** and steam trap **65**. The temperature of the steam jacket and the rate of flow of chemical fluid into the chamber **59** are such that the chemical fluid is completely vaporized and passes through lines **66** to the elements **33**, **35**, **41**, **43**, **45** and **48** of the system, also, of course, into the ducts and conveyors connecting these elements.

The vapors of chemical fluid will condense upon the cold surfaces of these elements thereby forming a film of liquid of substantially the same composition and pH as that in the tank **56**. As vapors continue to enter these elements they will heat the exposed surfaces and will sterilize them. This presterilization of the system is accomplished at relatively low temperatures of the order of 200° to 250° F. This is advantageous because higher temperatures of the order of 400° to 500° F. cause distortion of mechanical parts and cause lubrication difficulties.

It may be desirable, after presterilization has been accomplished, to pass steam through the elements **33**, **35**, **41**, **43**, **45** and **48** to vaporize and drive off the chemical medium, e.g., acetic acid, hydrochloric acid, etc.

It will, therefore, be apparent that a method and apparatus have been provided which, among other things achieves sterilization of containers, covers processing equipment and the like at lower temperatures than employed in present commercial methods, such as the Dole method; which renders the Dunkley method operable; and which is effective to achieve sterile or aseptic canning at high speeds and with fewer difficulties, such as container failure, resulting from the use of high temperatures.

I claim:

1. In a method of canning sterile foodstuffs involving the use of sterile containers therefor, the improvements consisting of placing the containers in an inverted position; preheating the containers to a temperature of about 140° F.; spraying a hot cleaning solution consisting essentially of water and a material selected from the group consisting of soap, lye, synthetic detergent, and trisodium phosphate onto the exterior and interior surfaces of the containers, to wash them and remove gross impurities therefrom; spraying the washed containers with steam to remove excess cleaning solution by mechanical action of the steam and by condensation of the steam upon the container surfaces; spraying water at a temperature of between 200° F. to 210° F. onto the exterior and interior surfaces to rinse the containers thoroughly; spraying the interior and exterior surfaces of the containers with jets of steam to remove adhering films or drops of water; spraying onto the interior and exterior surfaces of the containers an aqueous bactericidal agent; sterilizing the treated containers by subjecting them to steam at a temperature of between 200° F. to 500° F. for a shorter interval than heretofore required for steam sterilization at said temperature; rinsing the sterilized containers with a spray of sterile water to remove the bactericidal agent therefrom; returning the containers to an upright position; filling the containers with sterile food material; and sealing the filled containers with sterile covers.

2. In a method of canning sterile foodstuffs involving the use of sterile containers therefor, the improvements consisting of placing the containers in an inverted position; preheating the containers to a temperature of about 140° F.; spraying a hot cleaning solution consisting essentially of water and a detergent material onto the exterior and interior surfaces of the containers, to wash them and remove gross impurities therefrom; spraying the washed containers with steam to remove excess cleaning solution by mechanical action of the steam and by condensation of the steam upon the container surfaces; spraying water at a temperature of between 200° F. to 210° F. onto the exterior and interior surfaces to rinse the containers thoroughly; spraying the interior and exterior surfaces of the containers with jets of steam to remove adhering films or drops of water; spraying onto the interior and exterior surfaces of the containers an aqueous acid solution of pH 0–3; sterilizing the treated containers by subjecting them to a temperature of between 200° F. to

500° F. for a shorter interval than heretofore required for steam sterilization at said temperature; rinsing the sterilized containers with a spray of sterile water to remove the acid therefrom; returning the containers to an upright position; filling the containers with sterile food material; and sealing the filled containers with sterile covers.

3. In a method of canning sterile foodstuffs involving the use of sterile glass containers therefor, the improvements consisting of placing the containers in an inverted position; preheating the containers to a temperature of about 140° F.; spraying a hot cleaning solution consisting essentially of water and a detergent material onto the exterior and interior surfaces of the containers, to wash them and remove gross impurities therefrom; spraying the washed containers with steam to remove excess cleaning solution by mechanical action of the steam and by condensation of the steam upon the container surfaces; spraying water at a temperature of between 200° F. to 210° F. onto the exterior and interior surfaces to rinse the containers thoroughly; spraying the interior and exterior surfaces of the containers with jets of steam to remove adhering films or drops of water; spraying onto the interior and exterior surfaces of the containers an aqueous alkali solution of pH 10–14; sterilizing the treated containers by subjecting them to a temperature of between 200° F. to 500° F. for a shorter interval than heretofore required for steam sterilization at said temperature; rinsing the sterilized containers wtih a spray of sterile water to remove the alkali therefrom; returning the containers to an upright position; filling the containers with sterile food material; and sealing the filled containers with sterile covers.

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