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Filed June 11, 1938

2 Sheets-Sheet 1

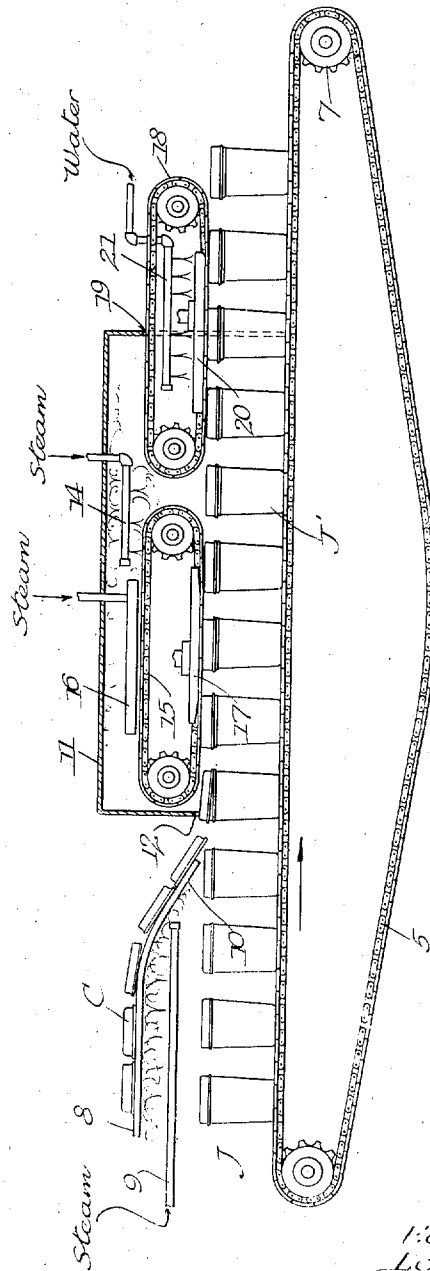


Fig. 1.

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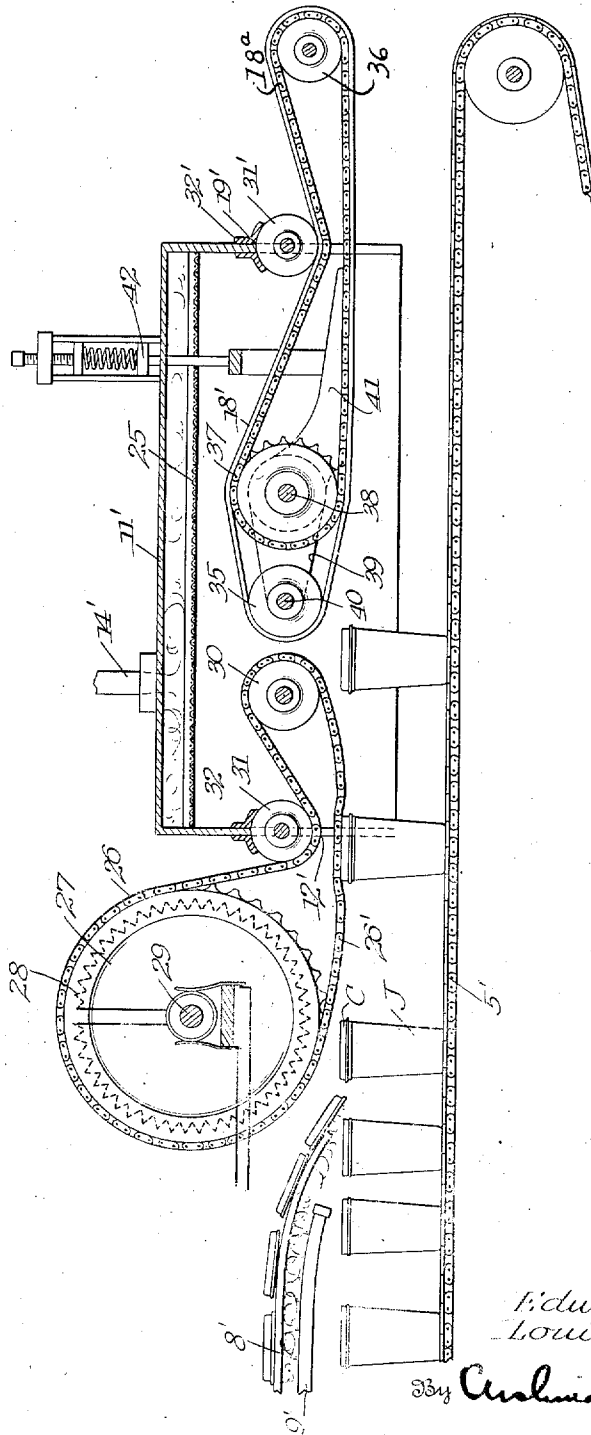


Fig. 2.

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UNITED STATES PATENT OFFICE

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APPARATUS AND METHOD OF VACUUMIZING CONTAINERS

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16 Claims. (Cl. 226-82)

The present invention relates to an apparatus and method for vacuumizing containers.

In numerous packing operations it is desirable to establish a vacuum condition within a filled container either for the purpose of holding a cap or other closure upon the container or to prevent spoilage of the container contents.

Two methods have heretofore been customarily used in vacuumizing containers. By the first method, the filled containers are placed in a vacuum chamber, so that a vacuum may be established in the container and the container sealed. Such a method is quite positive in action toward establishing a vacuum of whatever degree is desired, but necessitates a vacuum pump and an air-tight chamber construction having doors or gates in the chamber wall for passage of containers and capable of maintaining the chamber sealed. The feeding of containers and the operation of the doors must be carefully synchronized and the result is that the apparatus used for this method is extremely complicated, particularly if it is capable of meeting rapid production requirements.

The second method heretofore used was developed to eliminate the necessity of a pump and chamber and also the necessity of a carefully timed operation. Generally, it has involved moving caps and containers into a steam chamber and directing jets of steam into the head space of the filled container, or into the cap to be placed upon the container, then seating the cap upon the container and permitting the steam to condense so that a vacuum will be formed. Such a method, while very simple and generally efficacious, has involved a number of variable factors not encountered in the use of a vacuum pump and sealing chamber. For example, the method requires very careful control of steam conditions to prevent the presence of too much moisture in the container when the steam has condensed. Unless the steam in both the chamber and at the jets is maintained in an extremely dry state, a substantial proportion of moisture may be present in the container when condensation is completed, and moisture naturally has a very harmful effect upon numerous products, particularly food products.

Another difficulty is that if steam is merely blown into the upper portion of an open container, all of the air present in the top of the container may not be excluded therefrom, and the resultant vacuum may not be as complete as is necessary to maintain the product in proper

condition, or to hold the container cap upon the container.

The difficulty last mentioned above will be more fully appreciated if it is borne in mind that when steam is merely blown into the upper portion of a container, or into the space defined between the upper portion of a filled container and a cap loosely positioned thereon, all of the air will not necessarily be forced from this space. At least, the effect of the steam toward driving the air from the space is merely variable since no positive force to expel the air will be acting upon every portion of the space. While air directly in the path of the jet of incoming steam may be driven from the top portion of the container, it is impossible to have jets so directed into the container head space that all of the air will be positively expelled from every container, particularly if the containers are moving, and air at atmospheric pressure may remain in the head space of all or some of the containers, thereby preventing a proper vacuum.

An important object of the present invention is to provide a method and apparatus for vacuumizing containers without the use of a vacuum pump and which will insure that every container will have a desired vacuum condition in its head space.

Another object of the invention is to provide a method and apparatus for vacuumizing a container, preferably by condensation of steam, and whereby air present in the container will be positively expelled therefrom.

A further object is the provision of a method and apparatus for obtaining a vacuum in a container by expanding fluid within the container headspace so that a portion of the fluid or atmosphere will be forced from such space, and then sealing the container so that a vacuum condition will be provided when the remaining fluid or atmosphere later condenses or contracts to a normal state.

Another object of the invention is to provide an apparatus and method of the type described whereby the presence of moisture in the container after vacuumization will be entirely prevented.

A still further object of the invention is to provide a vacuumizing apparatus and method which is extremely simple but which nevertheless eliminates all of the principal difficulties of previous apparatus and methods.

Other objects and advantages of the invention will be apparent from the following specification and drawings.

In the drawings, Figure 1 is a side elevation.

partly in vertical longitudinal section, of a machine embodying our apparatus invention, and Figure 2 is a similar view of a modified form of apparatus.

Referring to Figure 1, the jars or other containers to be vacuumized are indicated at J, the container caps being designated by the letter C. The containers J are delivered to the left hand or infeed end of an endless container supporting conveyor 5 by any suitable means, the containers J having been filled to a suitable height before delivery to the conveyor. A cap delivery chute 8 is provided above the infeed end of the conveyor 5, and a steam line 9 is positioned beneath a portion of the chute. Steam line 9 has jets in its upper portion through which steam may be directed into the interior of the caps, the steam preferably being jetted directly against the underside of the top wall of each cap. The bottom wall of the chute 8 may be cut away to permit the jets of steam to reach the interior of the caps C.

The steam impinging upon the caps will be condensed and very minute particles of moisture will thus be formed upon the underside of the top wall of each cap. In some instances, a line to supply a very fine spray of water or other vaporizable liquid may replace the steam line 9. In such event, the spray is preferably so regulated that the moisture deposited on the cap will be in the form of very small particles, since if the spray is not sufficiently fine, an unbroken film and drops of liquid may form in the cap by capillary action.

Suitable well-known means may be provided to support or hold successive caps at the lower end 10 of the chute so that the passage of a container J beneath the lower end of the chute will cause a cap to be removed and dropped to a loosely seated position upon the container mouth.

A steam chamber 11 extends over the central portion of the upper run of the supporting conveyor 5, this chamber having an opening 12 at its infeed end of such width and height that it will permit the entrance of containers positioned upon the conveyor. Chamber 11 is kept filled with steam by jets 14, the pressure of the steam from jets 14 merely being sufficient to insure that the atmosphere within the chamber is rarefied or expanded.

If desired, chamber 11 may be heated by means other than free steam, as by closed steam coils or electric heaters, so that the air then within chamber 11 will be in an expanded state.

In the embodiment of the apparatus shown in the drawings, a cap heating element 15 consisting of an endless metal link chain or belt is provided within the steam chamber 11, the element 15 moving about spaced pulleys, one of which serves as a drive. The links of the chain are preferably of such width transversely of the runs of the chain as to enable the chain to bear upon the entire surface of a cap and thus heat the full area of the latter. A steam pipe 16 provided with jets is shown positioned adjacent the upper run of the element 15, but it will be understood that this heating element may be an electric heater, or that a gas flame may be used. A pressure member or shoe 17 is provided to urge the lower run of the element 15 downwardly, and this shoe may be held downwardly by some resilient means, as, for example, by springs, not shown. The lower run of element 15 is preferably inclined slightly down-

wardly toward its outfeed end, or at least to the right-hand portion of the shoe 17, thereby insuring that a cap C, while still loosely seated on a container mouth, will move for some distance with element 15 with the upper surface or portion of the cap in contact with the underside of the lower run of element 15 and that the cap will not be forced to fully seated or sealed position upon the container until it has been adequately heated, as hereinafter described, by the heating element 15.

A cap cooling element 18 of endless form is also provided over the upper run of the supporting conveyor 5, the left hand or infeed end of this element extending into an outlet opening 19 of the steam chamber 11. Element 18 is of substantially the same width as element 15 and is supported upon pulleys or sprockets in a manner similar to the element 15 and is driven by one of the sprockets. A pressure member or shoe 20 is provided above the lower run of the element 18 to hold such run downwardly, springs, not shown, preferably being provided to maintain the member 20 and the lower run of element 18 downwardly. The lower run of element 18 and pressure member 20 are so arranged with respect to supporting conveyor 5 that a container cap C will be forced to or held in fully seated or sealed position upon a container J from a moment shortly after contacting with element 18, and will be held in such sealed position until it reaches the outfeed end of element 18. It is to be emphasized that a cap must be in fully seated and sealed position upon a container from a time prior to the egress of the cap and container from chamber 11, until the cap has been cooled sufficiently to obtain the condensing or contracting action hereinafter referred to.

In order to obtain a quick cooling of a cap by cooling element 18, a spray of cooling water is directed from a water line 21 upon the upper surface of the pressure member or shoe 20, and also upon the lower run of the endless element 18 to keep the same cool over its portion exteriorly of the steam chamber 11. It will be obvious that means other than a water line may be used for quick cooling.

In the carrying out of our method by the apparatus illustrated in Figure 1, when a cap C, loosely seated upon the mouth of a container J, and with very fine particles of water or other vaporizable liquid upon the undersurface of the top wall of the cap, is moved beneath the heating element 15, the cap, at least, will be quickly heated to such a degree that the moisture upon the undersurface of the cap top will be converted into steam or expanded fluid or atmosphere, the head space of the filled container thus being filled with fluid at a relatively high pressure and high state of expansion.

It will be noted that the jetting of steam against the caps by the jets in line 9 serves to heat the caps so that quick heating will occur beneath element 15. Such heating by these jets also acts to expand fluid or atmosphere, either liquid or gas, or both, within a cap and to keep this fluid expanded so long as the cap is still hot. Continuing its movement with the elements 5 and 15, the container will come beneath the lowermost portion of the bottom run of element 15 and the cap C will be forced to fully seated or sealed position on the container. When the container leaves element 15 and moves to the position indicated at 'J', that is, a position be-

tween the outlet end of the cap heating element 15 and the inlet end of the cap cooling element 18, if the pressure of the fluid, that is, steam or air (gas) in the head space of the container is so high as to prevent the cap C from remaining in completely sealed position upon the container, the cap will be slightly lifted by such pressure, and the surplus pressure will be expelled from the head space, thereby also expelling air or other surplus fluid from this space. This sniffting action will, of course, leave the top space of the container filled with steam or highly heated and expanded air or gas at the same pressure as the steam within the steam chamber 11. The presence of steam or a rarefied or expanded atmosphere in chamber 11, that is, at a point surrounding the upper portion of the container, will prevent air at atmospheric pressure from flowing into the head space of the container during or just after venting.

In some instances, as when only an extremely small quantity of vaporizable liquid is deposited in the interior of a cap C by action of the steam jets in line 9, or if the temperature of the cap heating elements 15 is relatively high, the water upon the interior of a cap C will be converted into fluid, that is, steam or gas of an adequately high pressure before the cap has been moved downwardly to a seated and sealed position with respect to a container by the lowermost portion of element 15. In such event, air and other surplus fluid will be expelled from the head space of the container prior to the downward movement of the cap to a sealed position, or at least simultaneously with the movement of the cap to such position. In such instances, the cap will remain in sealed position upon the container during the remainder of the movement of the container beneath the cap heating element 15, during the movement between elements 15 and 18, and also during movement beneath the cap cooling element 18. Thus, in such cases, the element 15 will function as a sealing element as well as a heating element.

In any event, it will be understood, from the above that the point of expulsion of air and surplus steam or other fluid from the container head space can be controlled as desired by regulating the amount of moisture placed upon the underside of the top wall of the container cap C and also the degree of heat applied to the top wall of the container, and that sniffting, e. g., the expulsion of air and surplus steam or other fluid pressure, will occur whenever there is sufficient pressure created in the head space of the container to overcome the pressure existing outside of the container and immediately adjacent thereto, and if at that moment the cap is free to slightly lift.

During travel beneath cooling element 18, the vapor or other fluid or atmosphere within the head space of the container will of course be condensed or contracted, with the result that the fluid will be at substantially less than atmospheric pressure. This vacuum condition will serve to hold the container cap in firmly seated and sealed position upon the container mouth.

Obviously, when a container snifts at point J', that is, a point between elements 15 and 18, element 18 serves as a sealing element as well as a hold-down or cooling element. The infeed end of the element 18 is positioned within the steam chamber 11 so that if a cap has lifted by sniffting action adjacent point J', it will again be moved to sealed position with respect to its con-

tainer by the element 18 before passing through the exit opening 19 of steam chamber 11. Thus, the entire portion of the path of travel of a container during which sniffting may occur is surrounded by expanded or rarefied fluid or other atmosphere, as by the steam chamber 11, and the element 18 is so positioned with respect to the chamber and also the container supporting conveyor 5 that cap C will be in securely seated and sealed position upon a container at the time that it leaves the steam chamber 11 beneath the cooling element 18.

The positioning of the cooling means 21 above the lower run of the element 18 will insure that the fabric or flat metal links or other cap-contacting members of which the element may be formed will be cooled immediately after leaving the steam chamber 11, and that the temperature of the lower run of the element will be progressively reduced by the cooling spray or other cooling means as it moves away from the steam chamber outlet 11. Also, the cap holding and cooling element 18 will have its lower run of such length that all fluid or atmosphere within the head space of a container J will be condensed or contracted before the container moves from beneath the right-hand or outlet end of element 18. Contraction of the fluid will of course act to draw a cap more closely against the container mouth.

It will be observed that when steam and its resultant condensate is used to obtain a vacuum by the method of the present invention, no moisture will remain within the head space of a container after movement beneath cooling element 18, because if too much water condensate is placed within a cap C by the spray means 9, the surplus steam formed from such moisture by the cap heating elements 15 will be expelled either beneath the element 15 or during the passage of the container between element 15 and the cap holding and cooling element 18. Hence, a surplus of water cannot be left in the head space of a container. Obviously, any process which permits a greater pressure of steam than is necessary to obtain an adequate vacuum to be left in a container, involves greater possibilities of having moisture in the container when the steam is subsequently condensed or contracted. Since the steam within steam chamber 11 is provided primarily for the purpose of preventing access of air to the head space of the container during sniffting, it is not ordinarily necessary that the steam within this chamber should be dry steam.

It will be noted that the application of heat to a cap as described above, results in expanding the fluid or other atmosphere, either in liquid or gaseous form or both, within the cap and container head space; so that a portion of such fluid or atmosphere is expelled, the contraction or condensation of the remainder resulting in a rarefied or vacuum condition.

Figure 2 discloses a modification of the invention particularly designed to permit the use of an electrically heated heating element.

Referring to Figure 2, the numeral 5' designates a container supporting conveyor and the numeral 8' indicates a cap supporting conveyor, both of the same type as described above in connection with Figure 1. As in the Figure 1 form of apparatus, a steam supply line 9' is provided beneath the cap conveyor 8'. A steam chamber 11' is positioned above the top run of the container supporting conveyor 5', steam being delivered to the chamber 11' through a steam line 75

14'. A screen 25, for example, of fine wire mesh, is preferably positioned in the upper portion of the steam chamber 11' so that steam issuing from the pipe 14' will move downwardly into the main body of the chamber in a cloud effect, that is, will be evenly distributed to lie in a quiet state throughout the length of the chamber.

The heating element of Figure 2 comprises an endless chain 26 of a width at least as great as the diameter of the container caps and formed of relatively short and narrow links joined in close lateral contact so that the chain will have maximum heat conducting qualities. Element 26 moves about and is driven by a drum 27 having an electric resistance element 28 in or closely adjacent its periphery so that the chain 26 will be heated during its movement about the drum. It will be observed that the drum 27 is of relatively large diameter with the result that any given portion of the chain 26 will be in contact with the drum for a substantial length of time. Current is supplied to the resistance unit 28 by fixed brushes contacting with spaced contact rings which rotate with the drum.

The opposite portion of element 26 moves about an idler drum 30 journaled within chamber 11'. As indicated in Figure 2, the lower run 26' of element 26 sags slightly so that this run normally hangs to a point slightly below the top of the containers and caps moving through the machine. The result is that a container J with a cap C thereon moving beneath the element 26 will support the entire weight of the lower run 26' of the element 26 so that a maximum contact of the lower run 26' with the cap C will result. The upper run of the element 26 between roll 30 and heating roll 27 moves beneath an idler roll 31 positioned in the upper portion of the inlet opening 12' of chamber 11'. By having the upper run of the element 26 depressed and brought closely adjacent its lower run 26', the inlet opening 12' of chamber 11' may be of minimum height so that steam can not readily escape from the chamber 11'. Wipers indicated at 32 may be positioned to bear upon the upper surface of the roll 31 to prevent steam from escaping from the chamber at this point.

In the Figure 2 forms of the invention, the cooling and sealing element comprises a fabric belt 18' which is supported over its major portion by a metal link chain belt 18a of the same type as belt 26. The metal belt 18a moves about a roll 36 outside the steam chamber and a larger sprocket wheel 37 within the steam chamber, and the greater portion of the fabric belt 18' overlies the metal belt. The extreme inner portion of fabric belt 18' moves about a roll 35 spaced inwardly of the sprocket wheel 37 and adjacent the roll 30 which supports the inner end of the heating belt 26. Roll 35 is supported upon a shaft 40 which serves as the pivot for a shoe 39 carrying the shaft 38 which supports the large inner sprocket wheel 37. Shoe 39 includes a portion 41 extending past sprocket wheel 37 toward the exit opening 19' and the lower run of metal belt 18a contacts with this portion of the shoe. A spring-pressed plunger 42 bears upon the free end of the portion 41 to hold it downwardly at adjusted pressure sufficient to seal a cap C to a container J. An idler roll 31' is provided at the outlet 19' of the steam chamber and against the upper run of the belts to prevent escape of steam, wipers 32' being posi-

tioned to contact with the upper surface of this roll.

The portion of the element 18' between the extreme free end of shoe 41 and roll 36 is substantially horizontal so that the cap will be held in sealed position upon the container during the remainder of its movement between the element 18' and until the steam within the head space of the container has condensed or contracted sufficiently to provide a rarefied atmosphere within the container.

The use of a fabric belt 18' to contact with the container tops prevents marring of the tops under high pressure and permits the caps to adjust themselves to seat properly on the container mouths. Also, since the belt 18' is of non-heat conducting material, it will not be heated by the steam within the chamber 11' and hence the caps will readily cool in the open atmosphere while moving beneath this belt. The use of the metal belt 18a gives a more positive drive to the fabric belt 18' and since the metal belt 18a bears upon the shoe portion 41, friction is reduced. That is to say, if the fabric belt contacted with the shoe portion 41, substantial friction would be encountered at this point.

In the carrying out of our method by the apparatus illustrated in Figure 2, when a cap C, loosely positioned upon the mouth of a container J, and with very fine particles of water or other vaporizable liquid upon the under surface of the top wall of the cap, is moved beneath the lower run 26' of the heating element 26, the lower run 26' will be slightly lifted by the container and cap so that the chain, by its own weight, will thus be in close contact with the top wall of the cap. The fact that the lower run 26' of the element is gently inclined downwardly at its entrance and will cause a cap which is slightly tilted upon a container mouth to be properly positioned upon the container mouth. Such action may be desirable in some cases since it tends to isolate the head space of the cap during the heating action. However, it will be understood that the caps are not ordinarily sealed upon the container by the element 26.

During its movement beneath the element 26, the moisture upon the interior of the cap will be converted to steam as described in connection with the Figure 1 apparatus and immediately the container moves from beneath the element 26, and prior to its movement beneath the sealing and cooling element 18', surplus steam will be expelled from the head space of the container. When the container moves beneath the roll 37 and the extension 41 of shoe 39, the cap will be forced to a properly seated or sealed position upon the container. The fact that the lower run of belt 18' is slightly downwardly inclined from roller 35 to roller 37 will cause a cap tilted during venting to be properly positioned upon the container mouth before it is moved to sealed position. Throughout the remainder of the travel of the container beneath the element 18', the cap will be held in firmly sealed position and will also be cooled so that the steam within the head space of the container will be condensed. This cooling action will be particularly marked after the container has moved through the exit opening 19' of chamber 11'.

Since the element 18' is preferably of fabric, it will not absorb heat from the steam chamber 11' and hence a cap and container beneath the lower run of the element 18' may readily cool.

It may also be stated that the steam within the chamber 11', as is the case of that within chamber 11 of Figure 1, is not at sufficient pressure to give a high heating effect, but is only at sufficient pressure to maintain a rarefied atmosphere within the steam chamber.

Referring to Figure 1, in practice, the steam in line 16 of Figure 1 must be at somewhat greater pressure than that in line 14, because the steam in line 16 is relied upon for heating, that is, heating the heating element 15. For example, steam in line 16 must be at about twenty pounds pressure, while that in line 14, and also line 9, need only be at about five pounds pressure. With the Figure 2 apparatus, the use of an electric heating element eliminates the necessity of all steam except the very low pressure steam in lines 9' and 14'. The heating element 26 of Figure 2, like the heating element 15 of Figure 1, is preferably heated to a range of from 212° F. to 300° F.

The type of caps to be used with the method and apparatus of the present invention may be of a number of well-known types. Generally speaking, any cap of such design that it will be held firmly seated and sealed by a vacuum condition in the container head space gives highly satisfactory results, and if conditions are so regulated that sniffing will occur prior to any sealing of the cap as occurs, for example, with the Figure 2 apparatus, the invention may be practiced with a cap of the type wherein retaining means, alone, is relied upon to maintain the cap seated and sealed. The caps must be of a material having the characteristic of reasonably high heat conductivity, though in some instances the method may be practiced with the deposit of moisture upon an inner portion of a container, and in such case, heat conductivity of the container material may be relied upon.

The phraseology used in the specification is for the purpose of description and is not intended to limit the invention, the scope of the invention being indicated in the claims.

We claim:

1. A method of vacuumizing a filled container having a cap loosely applied thereto and liquid within and upon the wall of the interior of the cap, comprising applying heat to the exterior of the head space of the capped container to convert such liquid into steam and thereby expel air from the head space, moving the cap to sealing position, and subjecting the capped container to cooling to condense the steam and thereby establish a vacuum condition in the container.

2. In an apparatus for vacuumizing filled containers, means to apply liquid to a filled container headspace and substantially close the same with a closure, means to apply heat to the container closure to convert the liquid into steam and to seal the container, and means to hold the closure in sealed position until the steam has condensed to establish a vacuum condition in the container.

3. In an apparatus for vacuumizing containers, means to apply liquid to the interior of a container cap, means to position the cap on the container, and means to apply heat to the container cap to convert the liquid in the same into steam and thereby expel air from the container and to seal the cap upon the container.

4. In an apparatus for vacuumizing containers, means to apply liquid to the interior of a container cap, means to position the cap on the container, means to apply heat to the container

cap to convert the liquid in the same into steam and to thereby expel air from the container, said means applying pressure to the container cap to seal it to the container, and means to maintain the cap in sealed position upon the container until the steam has condensed to create a vacuum within the container.

5. In an apparatus for vacuumizing containers, means to apply liquid to the interior of a container cap, means to position the cap on the container, means to apply heat to the container cap to convert the liquid in the same into steam to thereby expel air from the container and to seal the cap upon the container, and a steam chamber substantially surrounding said last-named means.

6. In an apparatus for vacuumizing containers, means to apply liquid to the interior of a container cap, means to position the cap on the container, means to apply heat to the container cap to convert the liquid in the same into steam to thereby expel air from the container and to seal the cap upon the container, a steam chamber substantially surrounding said last-named means, and means to move the container from the steam chamber while holding the cap in sealed position thereon.

7. In an apparatus for vacuumizing containers, a conveyor to support a container having a closure loosely applied thereto, a steam chamber surrounding a portion of said conveyor, an endless and heated closure engaging element above said conveyor, an endless element within the outlet end of said chamber and extending outwardly of said chamber, said element being adapted to urge the closure to sealed position on the container.

8. A method of vacuumizing a filled container having a cap loosely applied thereto and liquid within the head space defined by the contents, container mouth, and interior of the cap, comprising applying sufficient heat to the cap to rapidly convert such head space liquid into steam and thereby expel air from the head space, and subjecting the capped container to cooling to condense the steam and thereby establish a vacuum condition in the container.

9. In an apparatus for vacuumizing containers, a container supporting conveyor, cap-feeding means spaced above said conveyor, means to apply liquid to the interior of caps while the latter are supported by said last-named means, an endless cap heating element extending above and along said supporting conveyor from a point adjacent the outlet of said cap-feeding means, a steam chamber surrounding the opposite end of said heating element, and an endless cap cooling and sealing element spaced from the latter end of said heating element, with its receiving end within said steam chamber and its outfeed end exteriorly of said steam chamber.

10. The improved method of vacuumizing a filled container which comprises applying thereto a cap having sufficient liquid thereon to be vaporized and appreciably increase the pressure within the headspace when the exterior of the cap is subjected to heat, heating the cap while the same is held on the container to convert the liquid on the interior of the cap into steam and thereby expel air from the headspace and then positively sealing the cap on the container.

11. The improved method of vacuumizing a filled container which comprises applying thereto a cap having sufficient liquid thereon to be vaporized and appreciably increase the pressure

- within the headspace when the exterior of the cap is subjected to heat, heating the cap while the same is held on the container to convert the liquid on the interior of the cap into steam and thereby expel air from the headspace and then positively sealing the cap on the container while subjecting the container to a reduced temperature to condense the steam and thereby establish a vacuum condition in the container.
- 10 12. A method of vacuumizing a filled container having a cap loosely applied thereto and liquid within and upon the wall of the interior of the cap, comprising applying heat to the exterior of the cap to convert such liquid into steam and
- 15 thereby expel air from the headspace, and applying pressure to the cap to seal it to the container.
- 20 13. A method of vacuumizing a filled container which comprises introducing steam-convertible liquid into the headspace of and loosely applying a cap to the container, applying heat to the exterior of the headspace to convert the liquid into steam and thereby expel air from the headspace while the cap is loosely positioned
- 25 thereon, and subjecting the container to a reduced temperature to condense the steam while maintaining the cap in sealing position on the container.
- 30 14. A method of vacuumizing a filled container which comprises introducing steam-convertible liquid into the headspace by applying to the container a cap having sufficient liquid thereon to be vaporized and appreciably increase the pressure within the headspace when the exterior of the cap is subjected to heat, applying sufficient heat to the exterior of the cap to convert the liquid into steam while the cap is yield- 5 ingly held in position to permit the air to be expelled by the created pressure, and then maintaining the cap under a mechanical sealing pressure while the container is subjected to a reduced atmosphere to thereby establish a vacuum 10 condition within the container.
- 15 15. A method of vacuumizing a filled container comprising placing liquid within the headspace of a container and sealing the same by a closure, applying sufficient heat to the container 15 headspace to rapidly convert the liquid into steam to expel gas from the container by lifting the closure, and holding the closure against lifting while permitting the steam to condense so that the closure will be held in sealed position by a 20 vacuum condition in the container.
- 25 16. A method of vacuumizing a filled container comprising placing liquid within the headspace of a container and sealing the same by a closure, applying sufficient heat to the container 25 closure to rapidly convert the liquid into steam to expel gas from the container by lifting the closure, and then holding the closure in sealed position until the steam has condensed to establish a vacuum condition in the container. 30

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