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| [21] | Appl. No. | 692,441 |
| [22] | Filed | Dec. 21, 1967 |
| [45] | Patented | Jan. 19, 1971 |
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a corporation of Delaware |
| Continuation-in-part of application Ser. No.
589,952, Oct. 27, 1966, now abandoned. | | |

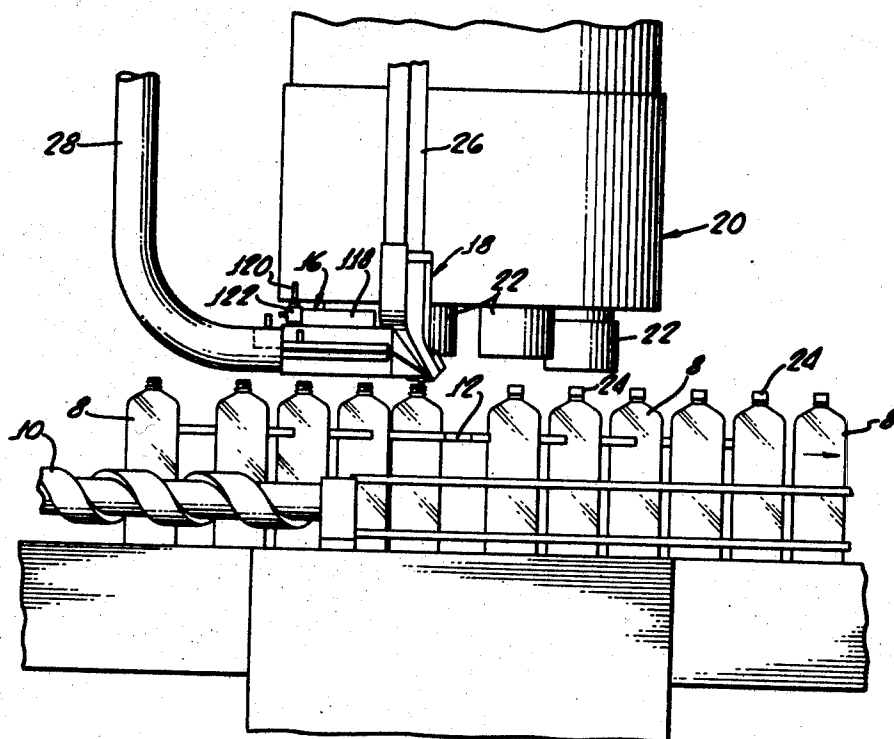
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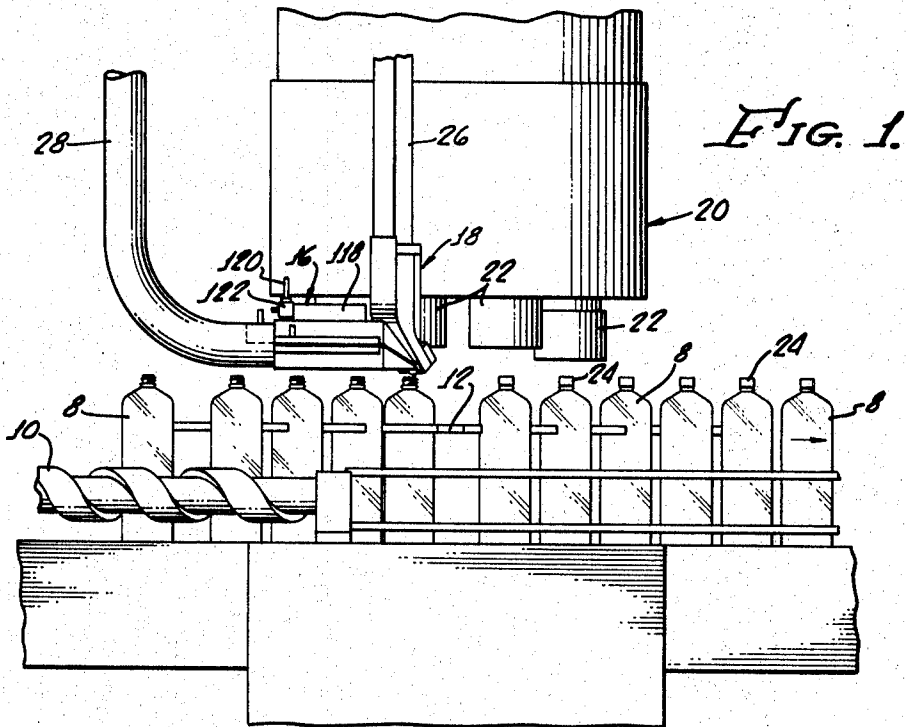
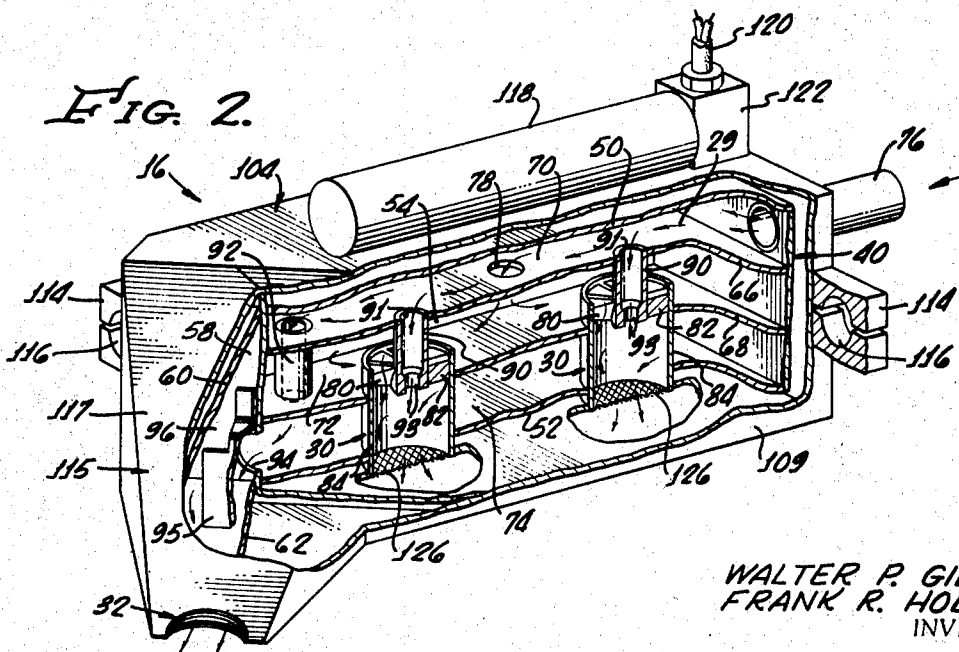
ABSTRACT: Apparatus for removing contaminant or reactive headspace gases from bottles or other containers. The apparatus provides means for directing a downward flow of cryogenic inert gas into the path of container movement. Frosting of the upper portion of the container and of the apparatus is prevented by means of enclosing the cold gas flow with a peripheral blanket of ambient anhydrous inert gas. The various embodiments of the apparatus of this invention provide means for directing the central flow of inert gas in the form of a jet or a direct stream of the gas. In one embodiment of the apparatus of this invention a nozzle is provided for directing a jet of cryogenic gas directly into the path of gas flow and means are provided for forming a puff of cryogenic gas around the jet. In this embodiment a heating mechanism is mounted on the nozzle to prevent frost formation thereon. In another embodiment means are provided for directing a central flow of cryogenic inert gas downwardly and for surrounding this cryogenic inert gas with a peripheral flowing blanket of ambient substantially dry inert gas to prevent frosting. This peripheral flow of ambient inert gas surrounds the central flow of cryogenic inert gas and substantially isolates the central flow from the atmospheric air. The apparatus may also be provided with a sloping rear wall for accommodating a cap chute and with means for purging reactive gases from the cap immediately prior to positioning the cap on the container and sealing thereof.

- [54] APPARATUS FOR EXCHANGING ATMOSPHERE
IN THE HEADSPACE OF A CONTAINER
25 Claims, 15 Drawing Figs.**
- [52] U.S. Cl.**..... **141/69,**
53/112, 99/189
- [51] Int. Cl.**..... **B65b 31/04**
- [50] Field of Search**..... 53/87, 110,
112; 99/189; 147/11, 37, 63, 69, 70, 64, 91, 100

[56] **References Cited**
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| 3,406,079 | 10/1968 | Gibble | 99/189X |





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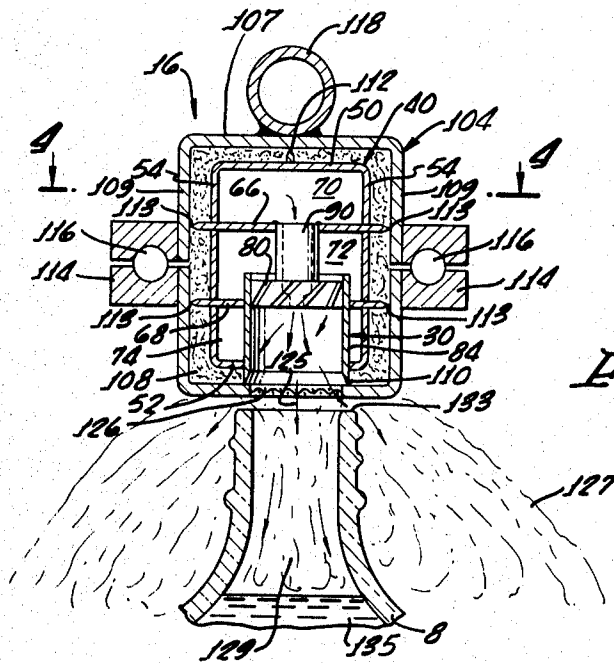


FIG. 3.

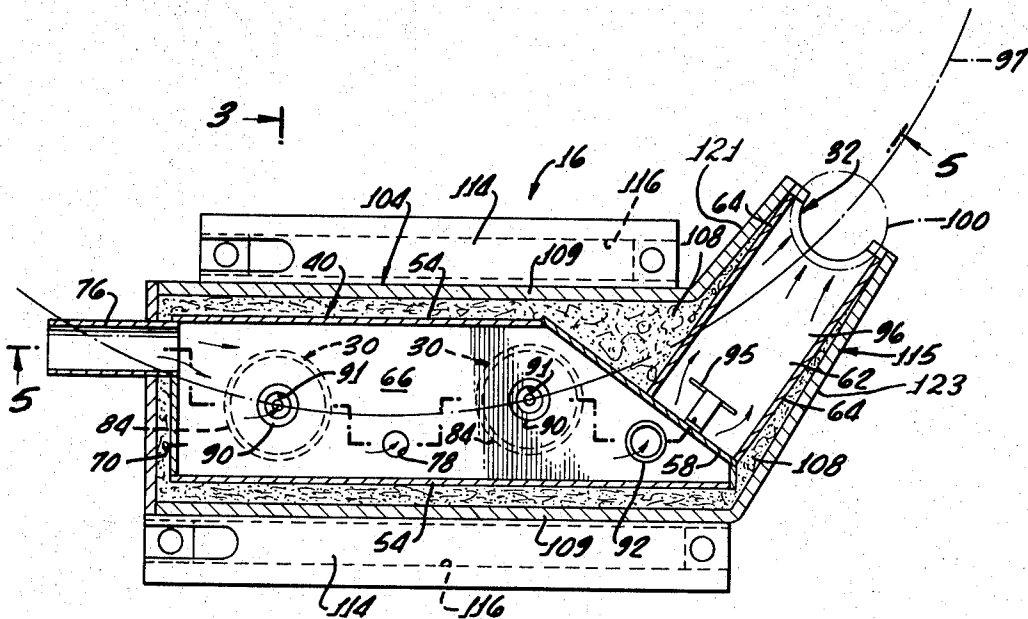


FIG. 4.

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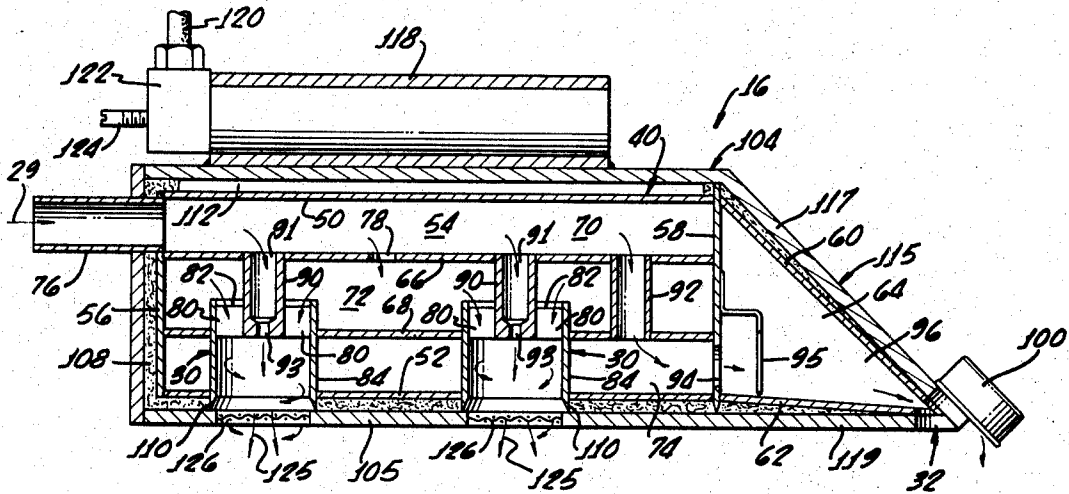


FIG. 5.

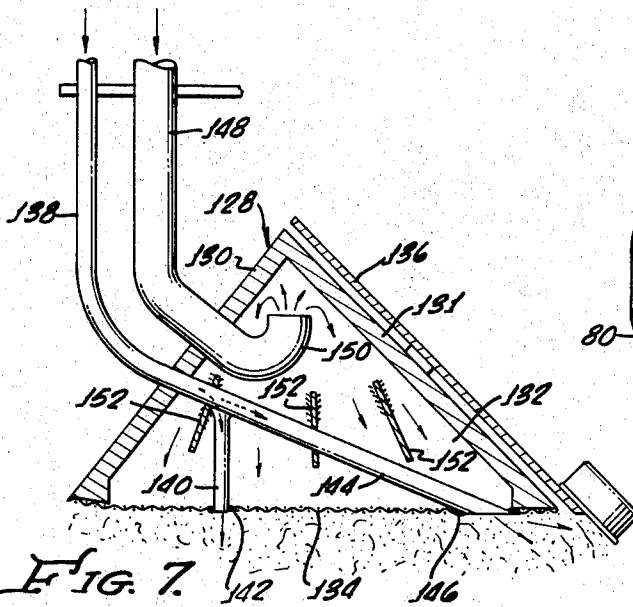


FIG. 7.

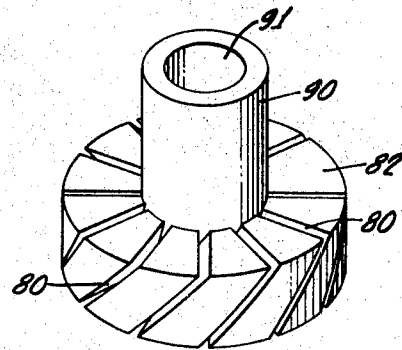


FIG. 6.

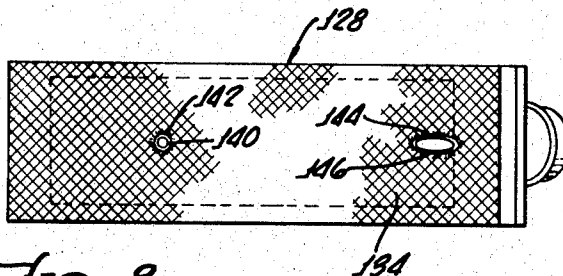
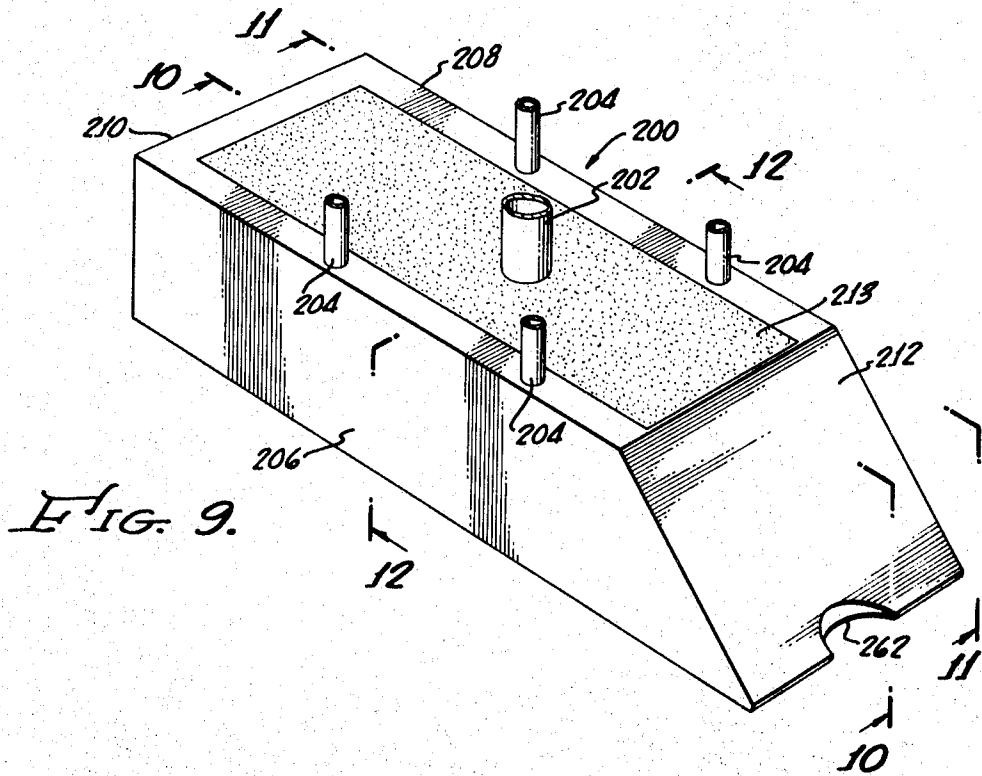
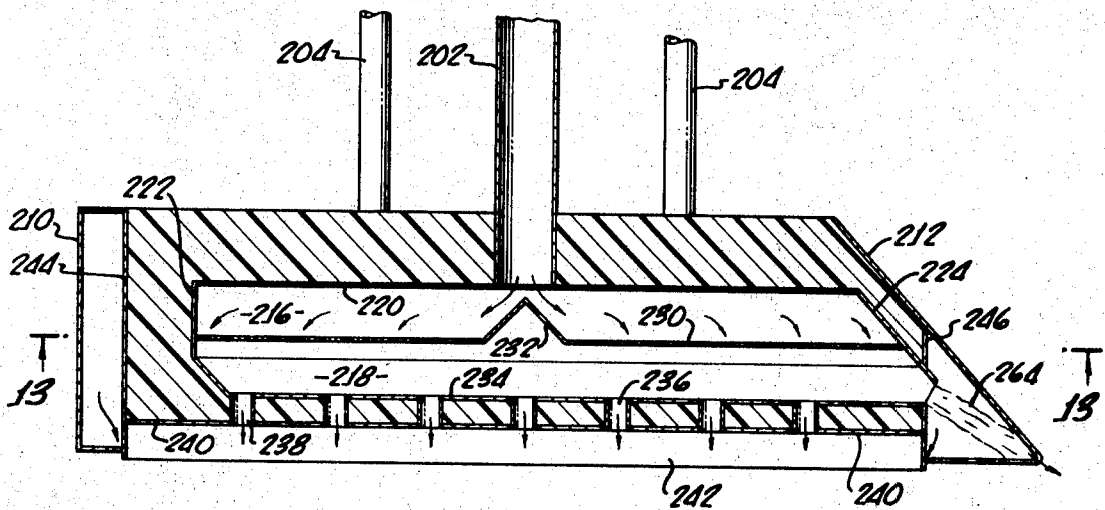


FIG. 8.

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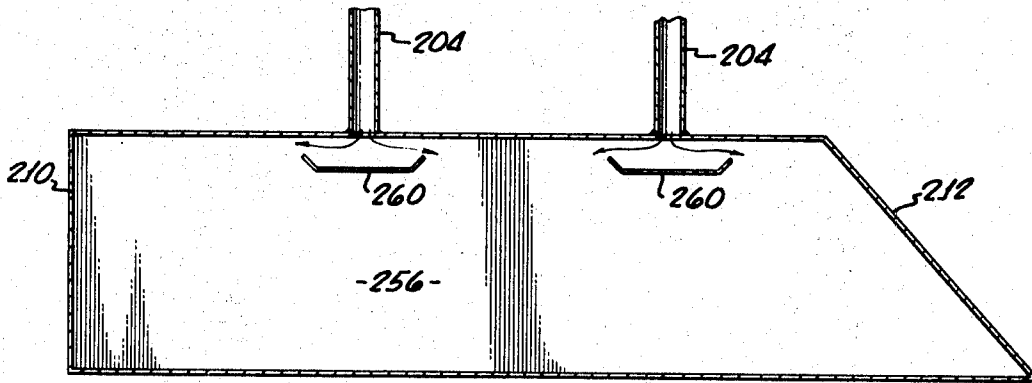


FIG. 11.

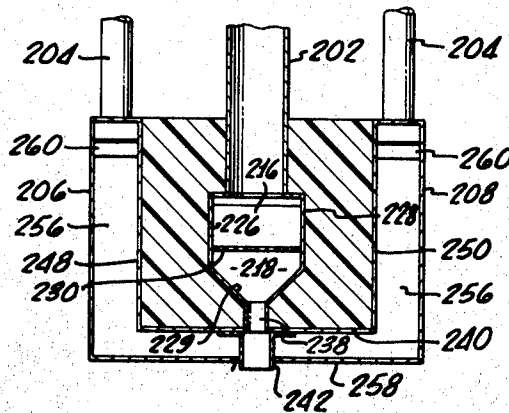


FIG. 12.

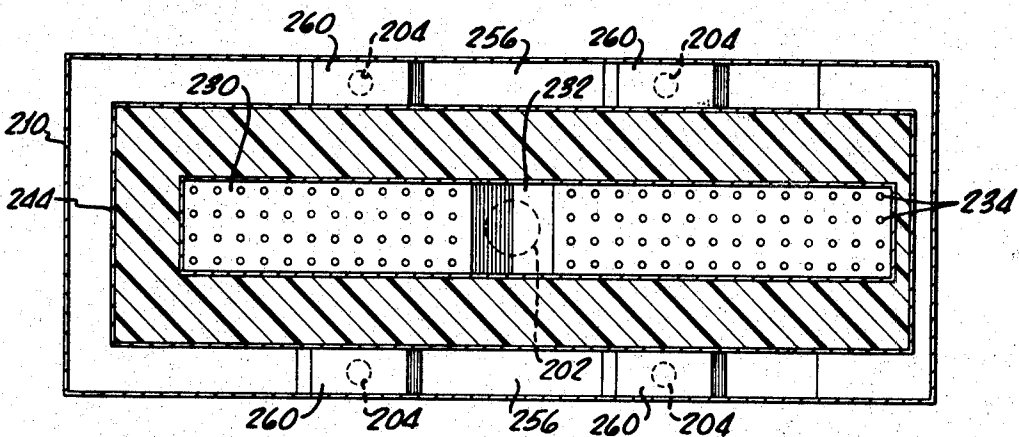


FIG. 13.

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FIG. 14.

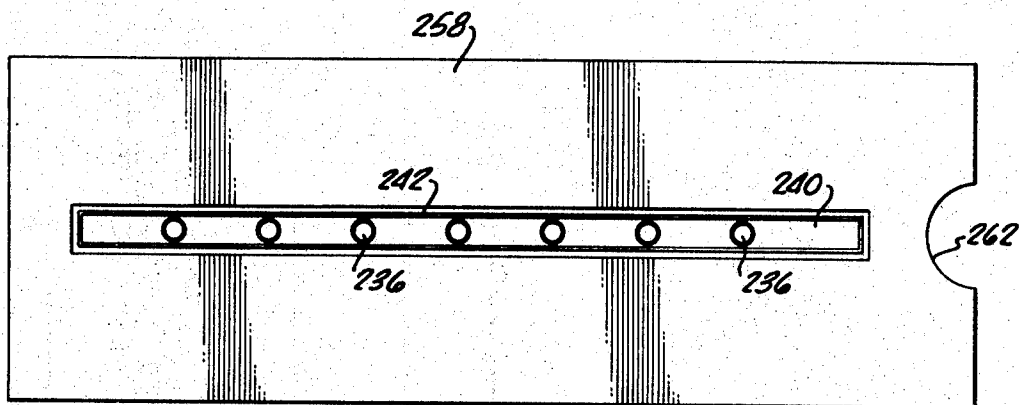
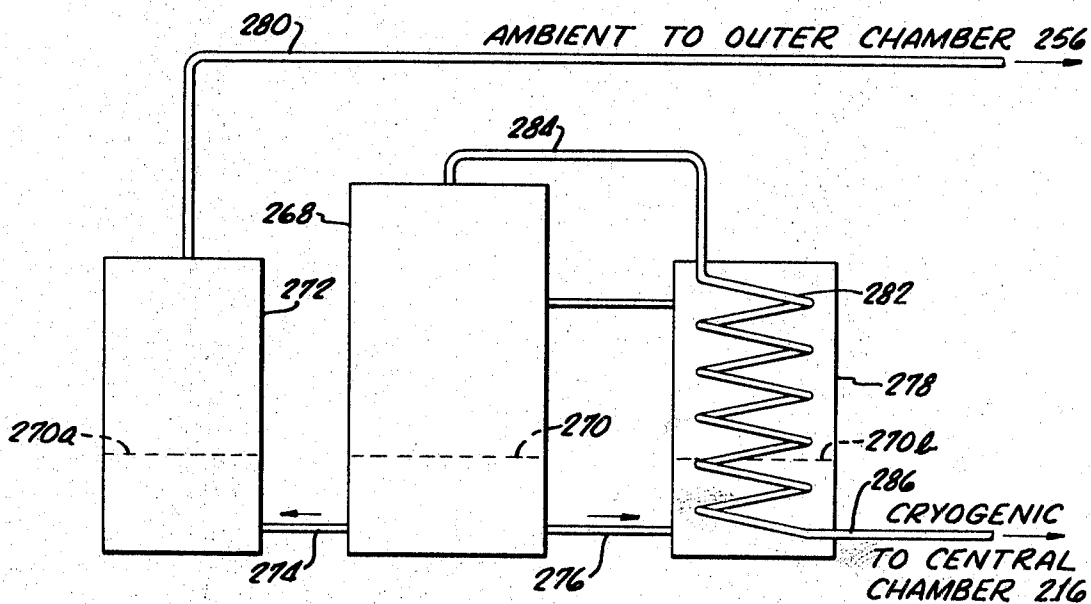


FIG. 15.

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APPARATUS FOR EXCHANGING ATMOSPHERE IN THE HEADSPACE OF A CONTAINER

RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 589,952 filed Oct. 27, 1966 entitled "Apparatus and Method for Exchanging Atmosphere in Headspace of Container" by Walter P. Gible and Frank R. Holmes and now abandoned and is related to U.S. Pat. No. 3,406,079 filed Apr. 2, 1965, entitled "Packaging of Salad Oils and the Like" by Walter P. Gible.

BACKGROUND OF THE INVENTION

The present invention relates to methods and apparatus for exchanging the atmosphere in the headspace of a filled container preliminary to sealing.

In many industries, consumer products are packaged in containers not quite filled so that a headspace remains. This headspace is usually occupied by air, and may contain substances which in themselves or by extraneous activation can cause deterioration of the contents. For example, the oxygen or moisture content of the trapped air can transform the stored contents to a condition unacceptable to the consumer by hydrolysis, oxidation or polymerization which can occur under ambient conditions or may be initiated or promoted by external energy sources, such as heat or light. It is apparent that with products such as mineral or vegetable oils or solids such as coffee which contain ethylenically unsaturated bonds and hydrolyzable groups that shelf life in terms of deterioration of flavor, odor, texture and nutritive value of the food product can be seriously diminished by action of the contaminating headspace gases.

The prior art has recognized this problem and has proposed several methods for replacing or exchanging the deleterious headspace gas with an inert gas. In most of the prior art methods, the inert gases utilized had a density near or less than the gas occupying the headspace and the techniques suggested were not effective since the deleterious or contaminant headspace gas was only temporarily displaced and partially returned in the interval between the gas exchange and sealing of the container. Generally, the prior art methods further ignored the problems of establishing a flow pattern for the removed headspace gas, and the inert gas introduced tended to draw with it some of the surrounding atmosphere which was usually the undesired gas such as air. The newly drawn in air then remained since its density was near that of the added inert gas.

Conducting the whole operation of exchanging and sealing in a system enclosing the gas introducing means, containers and sealing operations would reduce this effect but it raises numerous complexities in entry, exit and conveying and substantial amounts of gas are wasted. In high speed conveyor operations, rapid movement of the container between the filling and sealing stations also contributes to expelling the introduced inert gas from the headspace and to the introduction of fresh noninert gas.

One prior art method suggests inserting a tube at least partially through the product and then injecting sufficient inert fluid to expel the headspace atmosphere. This method is not adaptable to viscous, granular or solid products because such products could foam or be transported upwardly by the submerged jet. Moreover, they are not readily portable and could clog the tube. Again this method is not acceptable in high speed, mass production techniques since it requires precision timing to insert the tube, inject gas and withdraw the tube from narrow-mouthed breakable containers in properly timed sequence. On the occasion of any part of the line stopping, breaking down or going out of coordination, special stopping circuits must be provided or glass containers and tubes and other parts and accessories of the equipment will jam and break. Furthermore, additional time must be allowed for the withdrawal of the tube from its depth in the container, thereby

creating an interval during which the surrounding atmosphere may reenter the container.

Copending application Ser. No. 445,027 filed Apr. 2, 1965 recognized many of those problems of the prior art and taught the use of a dense inert gas which when directed into the headspace replaced the less dense resident gas. This invention is an improvement to the method and apparatus disclosed in that application in several aspects.

SUMMARY OF THE INVENTION

This invention is directed to an apparatus for displacing an inert gas from the headspace of an open, partially filled container. The apparatus provides a central flow of inert gas denser than the reactive gas. This denser inert gas is directed into the headspace of the container for displacing the reactive gases therefrom. A peripheral flow of inert gas is provided about the central flow for sweeping away displaced reactive gas and preventing reentry thereof into the container headspace.

One way in which this invention improves on the method and apparatus of the aforementioned application Ser. No. 445,027 is in directing a downwardly moving blanket of the inert gas past the bottle opening while directing a higher pressure jet of the dense gas into the headspace. The high-pressure jet forces the less dense air out of the headspace, and the downwardly moving blanket sweeps all air away from the opening to prevent reentry of any air or other contaminant gas into the headspace.

Another aspect of this invention is the use of a combination nozzle which includes a central jet nozzle for creating the high speed jet stream and a coaxial fogging nozzle for creating the blanket of inert gas. Preferably, the container is subjected to a plurality of such vertically directed gas patterns to further reduce the presence of the original atmosphere. To further avoid reintroduction of deteriorating substances, the closure member is laved or purged with inert gas before the container is sealed.

The inert gas is defined as a gas which will not intrinsically or upon activation cause deterioration or contamination of the contents on storage. For a liquid food product such as cottonseed oil or a solid product such as ground roasted coffee, the gas can be nitrogen, carbon dioxide, nitrous oxide or one of the noble gases, e.g. helium, neon, argon, or a gaseous organic compound such as "Freon (C-318)" which is octafluorocyclobutane. For nonfood packaging, butane, isobutane or propane are exemplary inert gases. Replacement efficiency increases with relative density between the incoming and purged gases and of course, this difference can be accentuated by cooling the incoming gas.

If the gas is cooled below the ambient frost point, heavy frost buildup on the exterior surface of the exchange nozzle can be a serious problem.

One embodiment of the apparatus of this invention provides a simple, inexpensive manner of preventing frost buildup at the container top and the metal surfaces of the exchanger gas outlets which includes providing a central stream of inert gas at cryogenic temperatures on the order of -150 to -250° F.: which is sheathed with a peripheral blanket of relatively warm, dry, inert gas having a temperature above the frost point of the ambient air. The containers are moved along a path beneath the exchanger so that the cryogenic inert gas flows into the container headspace after the container has passed through a layer of the peripheral blanket.

The headspace gas exchanger of this embodiment includes an elongated central chamber of generally rectangular configuration and an outer peripheral chamber which is insulated from and generally surrounds the central chamber. The exchanger is mounted above the path of container movement so that both the central and peripheral chambers communicate with the container path. Cold, dense, inert gas flows through an inlet into the central chamber. The warmer dry inert gas flows through inlets into the outer chamber. These

gases flow downwardly from the exchanger in a generally rectangular pattern having a cold, dense inert gas core surrounded by a peripheral blanket of the warmer gas. The central gas chamber in this embodiment is divided horizontally into an upper chamber section and a lower chamber section by a horizontal baffle plate. The baffle plate has a plurality of through-apertures therein which provide communication between the upper and lower chambers and maintain an even flow of gas from the upper chamber into the lower chamber. The bottom wall of the lower chamber is provided with a plurality of spaced axially aligned, outlet ports adapted to be mounted above the path of container movement. The outer chamber communicates with cryogenic gas flowing from these ports to surround these gases with a blanket of ambient temperature inert gas.

The peripheral gas stream and the central low temperature gas stream contain little moisture therein since they are both derived from the same liquified gas source. The peripheral blanket of dry ambient gas prevents moisture from the surrounding atmosphere from condensing in the vicinity of the cold gas impingement on the container. It has been found that ambient temperature dried gas is an excellent sheathing gas for frost prevention so that extensive apparatus is not required for heating the peripheral flow of gas to an elevated temperature.

The apparatus may also be provided with a sloping rear wall for mounting adjacent a cap chute surface and with means for purging reactive gases from the cap and positioning the cap on the container immediately prior to sealing thereof.

In another embodiment of this invention the exchange nozzle includes an inner shell and an outer casing which are thermally insulated from each other. The outer casing is electrically heated to prevent frost buildup. However, the outlet edge of the combination nozzle presents a cold gas/moist atmosphere/metal interface which favors frost formation. At this juncture, the cold gas absorbs the heat given by the condensation and freezing of the atmosphere moisture and is raised in temperature as frost builds up. It was found that the thermocouple demand for heat had to be set quite high, above about 180° F. to prevent frost buildup in this area. Too high a temperature is objectionable because the interior shell may be heated which would reduce the density of the cold gas.

A great many expedients were proposed and constructed in attempts to eliminate this problem and finally it was discovered that a screen barrier for the combination nozzle outlet in heat conducting relation with the outer casing prevented frost buildup when the thermocouple demand for heat is set at a much lower temperature on the order of 100° F.

This embodiment of the gas exchanging means of the invention provides a combined downwardly directed flow pattern including in each case, a central jet or puff and a surrounding lower pressure fog blanket or swirl of inert gas. The resident headspace gas is forced out of the bottle along the lower gas pressure circumference and is removed by the surrounding downwardly moving fog blanket or swirl of inert gas.

Since all embodiments of the apparatus can be mounted completely above the containers, the problems encountered with enclosed tunnels are eliminated. The design of the gas feeding means of the invention makes it capable of ready addition to any existing installation between the filling and capping stations.

BRIEF DESCRIPTION OF THE DRAWINGS

A more thorough understanding of the invention may be obtained by a study of the following detailed description taken in connection with the following drawings where like reference numerals designate like parts throughout and in which:

FIG. 1 is an elevation view of a continuous apparatus for consecutively exchanging the headspace in filled bottles, purging the cap and then capping the bottles;

FIG. 2 is an enlarged perspective view illustrating one embodiment of the inert gas exchanging means constructed in ac-

cordance with this invention with portions cut away for clarity;

FIG. 3 is a cross-sectional view taken generally along lines 3-3 of FIG. 4 with the exchanging means shown in relation to the head and neck of a filled bottle;

FIG. 4 is a view in section taken generally along lines 4-4 of FIG. 3;

FIG. 5 is a view in section taken generally on lines 5-5 of FIG. 4;

FIG. 6 is a perspective view of the combined jet and fog nozzle removed from the exchanging means;

FIG. 7 is a sectional view illustrating another embodiment of the invention;

FIG. 8 is a bottom view of the embodiment of FIG. 7;

FIG. 9 is a perspective view of another embodiment of the inert gas exchanging apparatus of this invention;

FIG. 10 is a longitudinal sectional view of this gas exchanging apparatus embodiment taken substantially along line 10-10 of FIG. 9;

FIG. 11 is another longitudinal sectional view taken substantially along line 11-11 of FIG. 9;

FIG. 12 is a transverse sectional view of the gas exchanging apparatus taken substantially along line 12-12 of FIG. 9;

FIG. 13 is another horizontal sectional view of the heat exchanging apparatus of FIG. 9 taken substantially along line 13-13 of FIG. 10;

FIG. 14 is a bottom horizontal view of the heat exchanging apparatus of FIG. 9; and

FIG. 15 is a diagrammatic view of the gas supply system for the gas exchanging apparatus embodiment of FIG. 9.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to FIG. 1, a row of filled bottles 8 are conveyed in sequence past the gas exchanging, cap purging and capping stations. Uncapped, filled bottles 8 conveyed by means of a screw conveyor 10 and an indexing rotary conveyor 12 pass under the inert gas multiple nozzle 16, cap feeding means 18 and cap closing means 20. The cap closing means can be any of many types or designs and in the exemplary embodiment is a rotary, multiple head, roll-on sealing machine such as an Alcoa Model RB-8 or Model 16.6-8 head model, which contains rotary spinning sealing heads 22 which simultaneously seal the cap 24 and form grooves mating those in the bottle by rolling pressure. The capped bottles are then conveyed to further stations for labeling, printing, marking and packaging. The cap feeding means contains a chute 26 fed by a hopper, not shown, and the multiple nozzle is supplied with gas through an insulated hose 28 fed from a source of pressurized gas, also not shown.

Referring to FIGS. 2 and 5, the multiple nozzle 16 is constructed to separate the flow of the incoming gas indicated by arrows 29 to supply inert gas to distinct parts of each nozzle 30 and to the cap purging outlet 32.

The multiple nozzle includes an inner shell 40 having a rear chamber defined by a main body portion formed of a top plate 50, a horizontal bottom plate 52, two side plates 54, an inlet end plate 56 and an outlet end plate 58. The end plate 58 forms one side of a cap purging shell portion which is further enclosed by a steeply inclined top plate 60, a slightly inclined bottom plate 62 and a pair of triangular side plates 64 to define a forward chamber. Thus, the shell is closed except for various entry and exit ports as will be described below.

The interior rear chamber is divided into three tiered chambers by means of two spaced horizontal partitions 66 and 68. An upper chamber 70 is formed between the top plate 50 and the upper partition 66. An intermediate chamber 72 is formed between the partitions 66 and 68. The lower partition 68 and the bottom plate 52 define the lower chamber 74.

The upper chamber 70 receives the inert gas through the inlet pipe 76 which supports the entire multiple nozzle structure. The upper chamber 70 acts as a manifold to distribute the gas to the other chambers. In one flow pattern, this gas

moves from the upper chamber 70 through a port 78 in the upper partition 66 into the intermediate chamber 72 and then through the slots 80 of a pair of cylindrical discs or fogging nozzles 82. Each cylindrical disc is mounted in the upper portion of a cylindrical housing 84 which extends through the partition 68 and the bottom plate 52. A jet nozzle 90 which extends through the upper partition 66 is inserted in the disc 82 in coaxial relationship (see also FIG. 6). The jet nozzle has a stepped bore therethrough with a relatively large diameter upper portion 91 and a relatively small diameter lower portion 93. When gas from the upper chamber simultaneously enters the jet nozzle 90 and the slots 80, a combined central puff and peripheral fog gas pattern is formed in the interior of each combination nozzle housing 84. As shown in FIG. 6, the disc slots 80 can be spiral to increase the velocity of the peripheral or surrounding fog.

A tube 92 is connected at its opposite ends to the two partitions 66 and 68 and gas flows through this tube from the upper chamber 70 into the lower chamber 74 bypassing intermediate chamber 72. The gas leaves the chamber 74 through an opening 94 in the outlet end plate 56 and strikes a baffle 95 mounted on the plate 56 in a manner to present a direct barrier perpendicular to the direction of flow. The gas diffuses around the baffle 95 into the cap purging or laving chamber 96 and passes out of the cap flushing semicylindrical port 32.

As is shown in FIG. 4, the two combination nozzles 30 and the cap purging outlet are disposed at axially spaced locations along the line of movement 97 of the bottles, which in the exemplary embodiment is arcuate.

The shell 40 and its interior parts are themselves an operable apparatus for performing the invention with gases at ambient temperatures, but when the multiple nozzle is fed cold gases at below the frost point of the ambient air, problems of exterior frosting and internal heating of the gas are encountered. It has been found that both effects are virtually eliminated by disposing the inner shell 40 in an outer casing 104 which provides a space which preferably is filled with a solid insulation 108 such as asbestos sheet or powder or a foam such as polystyrene or polyurethane.

Referring to FIGS. 3 and 5, the shell 40 is spaced above the outer casing 104 by knife edge extensions 110 of each combination nozzle housing 84 and of outlet end plate 58 which bear on the bottom plate 105 of the casing 104. A central knife edge 112 attached to the upper plate 50 and bearing on the top plate 107 of the outer casing 104 spaces those plates and horizontal positioning is provided by knife-edge extensions 113 of the partitions 66 and 68 which extend past the side plates 54 and bear on the sides 109 of the exterior casing. Thus, there is only line contact between the shell and casing, thereby reducing heat transfer.

The cap purging shell portion is also enclosed in an outer insulated casing 115, the slanting top 117 of which forms the terminal portion of the cap feeding slide. The bottom member 119 of the exterior cap purging case can be connected to the bottom plate 105 of the main casing 104, and the side plates 121 and 123 can also be connected to the side plates of the main casing 104.

To further minimize frosting problems, the exterior case is thermostatically heated by means of rectangular heat sinks 114 attached to each side of the exterior casing having central cylindrical recesses 116 receiving heating elements, not shown, which are controlled by a thermostatic element 118 which emits control signals through conductors 120 mounted in a block 122 and held in position by a setscrew 124. A suitable heating element in a Watlow Cartridge Heater, Part No. NEG3JX29A which is three-eighths inch O.D. and 3 inches long and is rated at 250 watts and 115 volt AC. A Fenwall NE 17200 Cartridge Block Head Thermoswitch which has a control range of -110°F. to 400°F. and an open action on temperature rise is perfectly suitable for use with the present apparatus.

It has further been discovered that even with a heated exterior there is a tendency to frost at the lip of the combined

nozzle housing 84 and this being in the direct line of bottle movement, can cause breakage or shutdown. However, when a metal screen 126 is attached to the nozzle casing, the heat is conducted from the exterior casing to the screen and this surprisingly avoids any frost buildup in that area.

As is shown in FIG. 3, a continuous jet 125 of inert gas is emitted from the jet nozzle 90 and a continuous surrounding blanket 127 of the gas moves downward from the disc 82. As a bottle 8 passes in continuous movement under the combination nozzle 30 with contaminant gas such as air in the headspace 129 over the liquid 135 which partially fills the bottle, the jet of inert gas is forced down into the headspace. The inert gas is denser than the air so that the air rises up and over the lip 133 of the bottle where it is swept down and away by the downwardly moving blanket 127 of inert gas. The displacement or exchange of gas is aided by the fact that the gas jet 125 is at a higher pressure than the blanket 127 so that the air is also sucked out of the headspace.

Referring now to FIG. 5, a cap 100 slides down the inclined plate 117 of the casing and the air trapped under the cap is purged and replaced by the inert gas flowing out of the port 32. The cap feeding mechanism is timed relative to the bottle so that the cap is picked off of the lower edge of the plate 117 by the bottle as it moves to the sealing station.

The apparatus of FIGS. 1-6 was utilized with compressed nitrogen being delivered to the nozzle at a rate of 400 standard cubic feet per hour measured at 60°F. and 1 atmosphere. The feed rate of the bottles filled with cottonseed oil was about 200 bottles per minute. The nitrogen gas was at a temperature of about -160°F. and the thermostat was set to maintain the exterior casing at a temperature of about 100°F. and this prevented any frosting. Bottles filled with cottonseed oil at a rate of 200 bottles per minute passed successively past each of the combined puff and fog nozzles and then directly to the cap laving station and the cap was applied and then roll sealed. Analysis of the headspace of the final capped bottles showed the average residual oxygen content was about 0.6 percent. Statistically, under those conditions, very few bottles will contain over 1 percent oxygen. Samples of those capped bottles, after nearly one year, still show no sign of deterioration. Of course, there is no need to use dark-colored, light-filtering bottles when the headspace contains so little oxygen.

At a nitrogen temperature of -90°F. , the average residual oxygen content is about 1 percent; at -150°F. , it is about 0.7 percent; at -170°F. , it is about 0.3 percent. Even at room temperature, the residual oxygen is about 3 percent, which is acceptable for many industries such as wine making where 2 to 5 percent residual oxygen does not cause deterioration on storage. When it is desired to improve the exchange efficiency by cooling, nitrogen gas at a temperature from -50°F. to -250°F. can be utilized with the apparatus of the invention with sustained and efficient operation. The experiment was rerun under the same conditions with the exception that the swirling nozzle of FIG. 6 was utilized without the screen, the thermostat was set to maintain the exterior casing at about 180°F. and the nitrogen temperature was -150°F. The headspace oxygen was reduced to about 0.6 percent O_2 and appreciable amounts of frost did not collect on any part of the casing. However, when the thermostat was reset to 100°F. , the frost built up to a hindering level after several minutes.

Referring now to FIGS. 7 and 8, another apparatus capable of carrying out the method of this invention includes an outer casing 128 enclosing a single gas chamber. The casing is formed by two oppositely inclined rectangular end plates 130 and 131 connected along their upper edges and two triangular side plates 132. The bottom may again be covered by a heat conducting screen 134. The slanting outlet side 131 of the chamber may itself form or have attached thereto a cap guide slide 136 which will form the terminal portion of the cap feeding means. Exchanging gas is separately delivered to the chamber through different conduits. The first conduit 138 enters the chamber and branches into at least one vertical extension 140 which acts as a bottle purging nozzle which ter-

minates and is connected to the screen at 142 and a second branch 144 extends to the forward bottom apex of the triangular chamber and is there connected to the screen at 146 forming a cap purging nozzle. The high density gas is also delivered to the chamber through a second conduit 148 which bends upward at 150 after entering the chamber to provide a general distribution of the deflected exchanging gas which is then channeled on its downward journey by baffles 152 connected to the side plates 132 to form a fog or blanket of exchanging gas around the bottle travelling under the higher pressure gas puffing nozzle 140 and continues to maintain this fog around the head and shoulders portion of the bottle, as it passes to the succeeding branches. Again if required, the exterior of the casing can be heated to prevent frosting.

Referring now to the embodiment of the headspace gas exchanger nozzle apparatus 200 shown in FIG. 9, it will be seen that this exchanger is of a generally rectangular external configuration similar to that discussed with respect to FIGS. 1 through 5. This exchanger nozzle, however, is provided with a relatively large diameter, central, vertically extending inert gas inlet 202 for receiving a reduced temperature inert gas and with two pairs of laterally spaced, longitudinally aligned, smaller diameter inlets 204 for receiving an ambient temperature relatively dry inert gas.

Generally, the exchanger nozzle 200 is housed by a pair of longitudinally extending sidewalls 206 and 208 and a pair of end walls 210 and 212 attached to the opposite ends of the sidewalls. The sidewalls 206 and 208 and the leading end wall 210 are substantially vertical. The rear end wall 212 of the nozzle is slanted at an angle similar to the exchanger shown in FIG. 5. The upper portion of the headspace exchanger nozzle may be tightly packed with an insulating material 213 such as asbestos sheet or powder, or foam such as polystyrene or polyurethane or some other such insulating material. As shown in FIG. 10, the insulating material 213 encloses a pair of central horizontally extending upper and lower chambers 216 and 218, respectively, defined by an upper wall 220, a vertical end wall 222, a slanted end wall 224 and a pair of substantially parallel sidewalls 226 and 228. The bottom portions of the end walls and sidewalls are slanted inwardly as shown in FIG. 10 to form a generally truncated trough 229.

The upper chamber 216 is separated from the lower chamber 218 by means of a horizontally extending divider plate 230 having a central, transversely extending, inverted-V baffle portion 232 across the central portion thereof as shown in FIG. 10. The baffle portion 232 of divider plate 230 is aligned substantially beneath the large diameter central conduit 202. The horizontal portions of the divider plate 230 contain a plurality of through-apertures 234 as shown in FIG. 13. The total surface area of the apertures 234 is slightly less than the surface area of the inlet from conduit 202 into the upper chamber 216 so that a positive pressure is developed in the upper chamber 216 causing gases passing from the upper chamber into the lower chamber 218 to have a constant pressure across the surface of the divider plate 230 at each of the apertures therethrough. Divider plate 230 may be welded or otherwise suitably mounted in the central chamber.

The lower chamber 218 is bounded by the truncated portion 229 and the straight portions of the end walls 222 and 224 and the sidewalls 226 and 228 below the divider plate 230 as shown in FIG. 10. The lower wall 234 of the chamber 218 is provided with a plurality of longitudinally spaced, aligned gas outlet ports 236. Seven of these gas outlet ports are shown in FIG. 10, any number may be used, however, depending upon the capacity of the container in which the headspace gas is being replaced.

As shown in FIG. 10, the insulating material 213 extends substantially entirely about the horizontal central chambers 216 and 218. The gas outlet ports 236 communicate with short length conduits 238 which extend through a lower level of the insulating material 213 and through a bottom wall 240 of the gas exchanging apparatus of FIG. 10. A depending, generally rectangular, skirt 242 extends downwardly from bot-

tom wall 240 about the gas outlets from conduits 238 as shown in FIGS. 10 and 14 to further direct the gas flow from outlets 236 into a container path below the headspace gas exchanger 200.

The insulating material 213 is generally encased by a pair of central upstanding end walls 244 and 246 and sidewalls 248 and 250 and a horizontally extending lower wall 240 as shown in FIGS. 10 and 12. This encasing structure for the insulating material 213 is spaced from the outer sidewalls 206 and 208 and end walls 210 and 212 to form an outer chamber 256 therebetween which extends substantially entirely about the central chambers 216 and 218 in insulated relationship therewith by means of the encased insulating material 213, as shown in FIGS. 10, 12, and 13. The chamber 256 is enclosed by a bottom wall 258 which is substantially parallel but spaced away from the bottom wall 240 of the insulating material encasing structure. As shown in FIGS. 12 and 14, the bottom wall 258 extends inwardly toward the depending skirt 242 but is spaced therefrom by a small distance for a reason to be explained.

As shown in FIGS. 11 through 13, the outer chamber 256 includes four baffle plates 260 mounted therein. Each of the baffle plates 260 is in substantial alignment with one of the gas inlets 204. As shown in FIG. 12, the baffle plates are mounted by fixing their opposite edges to the outer sidewalls and the sidewalls of the insulating material encasement. This may be accomplished by welding the baffle plates in position or by other suitable fluidtight mounting brackets. The baffle plates serve to direct gas flowing through the gas inlets 204 so that it flows throughout the entire outer chamber 256.

As shown in FIG. 10, the end wall 224 of the inner chambers 216 and 218 is substantially parallel to the slanted outer end wall 212 of the exchanger nozzle apparatus 200. The outer end wall 212 is provided near its lower edge at the central portion thereof as shown in FIG. 9, with a cap purging orifice 262. The central stream of gas flowing from the gas purging outlet 262 flows along a tubular path, generally designated 264, from the lower central chamber 218. Similarly the peripheral region of gases flowing through the cap purging outlet 262 flows from inlets 204 through the outer chamber 256. An insulated tube may be provided to direct the central stream of gas if desired.

The headspace exchanger nozzle apparatus may be constructed from a rigid low temperature withstanding material such as stainless steel. The entire structure may be formed by welding stampings from such material into the described nozzle configuration.

FIG. 15 shows a closed inert gas supply system which is adapted to be connected to the headspace gas exchanging nozzle apparatus shown in FIGS. 9 through 14. It can be seen that this gas supply system generally comprises a cryogenic gas container 268 which contains a cryogenic liquid gas such as liquid nitrogen shown generally as 270. The lower portion of container 268 is connected to a second cryogenic vessel 272 by means of a line 274 so that the liquified gas can flow into container 272 from container 268. The liquified gas in vessel 272 is generally designated 270a. Container 268 is also connected in the same manner through a line 276 to a third cryogenic vessel 278 which also contains a portion of the inert liquified gas designated 270b. Thus, each of the vessels has a portion of liquified gas therein. It is possible to vary the levels of the liquid in the various vessels, of course, by varying the relative levels of the containers. As the liquified gas vaporizes, it accumulates in the upper portions of each of the vessels and rapidly approaches the ambient temperature of the air surrounding the vessel.

The upper portion of vessel 272 is connected by means of a gas conduit 280 to the outlets 204 of the outer chamber 256 of the gas exchanging apparatus 200 to provide a flow of substantially ambient temperature gas into the outer chamber 256. A pump (not shown) may be provided for pumping the ambient temperature inert gas into the outer chambers 256.

The third cryogenic vessel 278 has a cooling coil 282 arranged therein with its axis longitudinally disposed in the vessel as shown in FIG. 15. The cooling coil 282 is connected to the upper portion of the cryogenic vessel 268 by means of a gas conduit 284 so that substantially ambient temperature gas is drawn off the top of the vessel 268 through the conduit 284 and passes through the cooling coil 282 in vessel 278. The cooling coil 282 partially extends through the liquified gases in the lower portion of vessel 278 so that gases passing therethrough are cooled to substantially cryogenic temperatures. This cooled gas is then conducted by means such as a pump (not shown) through a conduit 286 to the central inlet 202 of the headspace gas exchanging apparatus 200.

Thus, a cryogenic temperature inert gas flows through conduit 202 into the upper central chamber 216 and is directed by means of baffle plate 232 to flow into upper chamber 216. This low temperature gas is of a relatively high density and flows downwardly through the apertures 234 into the lower chamber 218. As explained previously, since the total area of the apertures 234 is less than that of the central conduit 202 a positive pressure is maintained in upper chamber 216. This pressure causes the gases to flow evenly through the apertures 234 into the lower chamber 218. The low temperature gas then flows downwardly into the trough 229 and through outlet ports 236 into the headspace of containers moving below the skirt 242. At the same time, ambient temperature inert gas flows into inlets 204 into contact with baffle plates 260 and evenly throughout the outer chamber 256. As best shown in FIG. 12, these gases flow downwardly through the side portions of outer chamber 256 and then inwardly toward the skirt 242 which extends longitudinally along the center of the lower portion of the chamber 256 and depends downwardly through the lower wall 258 in spaced relation therewith as shown in FIG. 14.

It has been found that the spacing between the interior edge of the lower wall 258 of the outer chamber and the skirt 242 is extremely critical to permit the proper proportions of ambient temperature inert gas to surround the cryogenic temperature inert gas flowing downwardly from within the skirt 242. In particular when the inert gas is nitrogen and the central gas temperature is about -185°F. , it has been found that a spacing of from one thirty-second to three-sixteenths of an inch is necessary to maintain an adequate amount of the dry ambient temperature inert gas as a downwardly flowing blanket about the central cryogenic temperature inert gas. If the spacing between the lower wall 258 and the skirt 242 is greater than three-sixteenths of an inch, the cryogenic temperature inert gas flowing downwardly from within the skirt 242 is heated before it enters the headspaces of containers passing below the skirt and thus is not of a sufficient density to efficiently replace the container headspace gases. If, however, the spacing between the lower wall 258 and the skirt 242 is less than one thirty-second of an inch an insufficient quantity of dry ambient temperature inert gas is provided to form a blanket about the central cryogenic temperature inert gas and severe frosting of the container tops and the skirt 242 are experienced. It has been found that when this close tolerance of from one thirty-second to three-sixteenths of an inch is maintained highly satisfactory results can be achieved. This is especially so when the central flow of inert gas is dry nitrogen having a cryogenic temperature of from -150°F. to -200°F. the outer flow is dry nitrogen at a temperature of about 70°F.

It has been found essential to use the insulating material 213 to completely surround the cryogenic temperature central chambers 216 and 218 to prevent heating of the cryogenic gases in these chambers and cooling of the ambient temperature gases in the outer chamber 256 either of which would reduce the efficiency of the apparatus in exchanging headspace gases from containers moving thereunder.

The cap purging outlet 262 is provided with a central flow of low temperature cryogenic gas from lower chamber 218 and a peripheral flow of ambient gas through the outer chamber 256 so that frosting of the cap is prevented as it is

purged of contaminant gases immediately before it comes into contact with the top of the container moving under the gas exchanging apparatus. The caps may be slid down a conventional cap chute (not shown) which is substantially parallel to the end wall 212 and arranged adjacent thereto. Immediately prior to engagement with the moving container each cap is momentarily suspended a small distance from the cap purging outlet 262 so that the sheathed cryogenic gas is directed into contact therewith prior to pickup by containers moving under the apparatus 200. The spacing between the central conduit 264 of the cap purging outlet and the edges of the purging outlet has not been found to be as critical as that between lower wall 258 and the skirt 242 and in fact large variations in the spacing between the central tubing 264 and the edges of the cap purging outlet 262 can be tolerated with relatively good results in purging the caps prior to pickup by the containers. This is thought to be so because of the relatively small volume of contaminant gases necessary to be purged from the caps before they are mounted on the containers.

This embodiment of the headspace gas exchanging apparatus substantially eliminates frost formation without the use of intricate, complex heating devices and control mechanisms. Since both the central gas flow and the peripheral ambient temperature gas flow are derived from the same anhydrous cryogenic gas source, the central flow of low temperature gas is shielded from the atmospheric moisture necessary for frost formation. As a container moves below the exchanger 200, it first passes through a blanket or layer of the dry ambient temperature inert gas which sweeps moisture from the container top portion prior to contacting the cryogenic temperature gas to assist in reducing frost formation. The peripheral gas flow in this embodiment which surrounds the elongate central flow also sweeps away the displaced headspace gases.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

We claim:

1. An apparatus for displacing a reactive gas from the headspace of an open, partially filled container comprising:

means for providing a central flow of inert gas denser than said reactive gas into the headspace of said container; and means for providing a moving blanket of inert gas of a different density than the central inert gas flow intimately surrounding said central flow of inert gas and flowing around said central flow to sweep away displaced reactive gas and to prevent reentry thereof.

2. An apparatus for displacing a reactive gas from the headspace of a container as described in claim 1 wherein said means for providing a central flow of inert gas provides said central flow as a continuous stream of gas into said headspace as said container is moved past said apparatus.

3. An apparatus for displacing a reactive gas from the headspace of an open, partially filled container comprising:

means for providing a central flow of inert gas at a cryogenic temperature and denser than said reactive gas into the headspace of said container, said central flow providing means including a plurality of centrally aligned ports; and

means for providing peripheral flow of an inert gas of a different density than the central inert gas flow about said central flow for sweeping away displaced reactive gas and preventing reentry thereof, said peripheral flow providing means including an elongated downwardly extending skirt surrounding said ports and a bottom horizontally extending wall portion having an elongated central opening therein through which said skirt extends, the edges of said bottom wall portion surrounding said opening being a

spaced distance from said skirt to direct ambient temperature inert gas flow into contact with said depending skirt and downwardly for surrounding said central flow of inert gas with a blanket of inert gas at substantially ambient temperature thereby preventing frost formation on said apparatus and the top portion of said container.

4. An apparatus as defined in claim 3 wherein said spaced distance from said skirt is from one thirty-second to three-sixteenths inches.

5. An apparatus for displacing a reactive gas from the headspace of an open, partially filled container comprising:

means for providing a central flow of inert gas denser than said reactive gas into the headspace of said container;

means for providing peripheral flow of an inert gas of a different density than the central inert gas flow about said central flow for sweeping away displaced reactive gas and preventing reentry thereof; and

means for maintaining said central flow of inert gas at a lower temperature than said peripheral flow of inert gas.

6. An apparatus as defined in claim 5 including means for supplying said peripheral flow providing means with a flow of substantially dry inert gas at a temperature above the frost point of the ambient air.

7. An apparatus for displacing a reactive gas from the headspace of an open, partially filled container comprising means for providing a central flow of inert gas denser than said reactive gas into the headspace of said container; and means for providing peripheral flow of said inert gas in the form of an ambient temperature gas blanket completely surrounding said central flow of inert gas.

8. For use in combination with an apparatus for continuously filling and sealing partially filled conveyed containers, means for exchanging the headspace atmosphere in each of said moving containers preliminary to sealing comprising, a plurality of gas nozzle means disposed along the line of movement of said containers and above their openings for sequentially directing a plurality of downwardly moving patterns of inert gas toward each container, each said nozzle means including both a central nozzle for supplying a jet of inert gas denser than the headspace gas directed into the headspace and a peripheral nozzle means for supplying a moving blanket of inert gas of a different density than the central jet directed past the opening of the container to surround the periphery thereof.

9. Nozzle means for use in association with a continuous machine for filling and sealing partially filled containers, said nozzle means being adapted to exchange the headspace gas therein and comprising:

at least one combination central jet and peripheral fogging gas nozzle disposed coaxially with one another above the line of movement of the partially filled containers between the filling and sealing thereof; and

a closure purging nozzle disposed downstream from said combination nozzle along said line of movement so that as the partially filled containers move past said nozzle means they are each subjected to at least one jetting and fogging gas purge and then to a closure purging before sealing thereof.

10. An apparatus for exchanging the atmosphere in the headspace of an open, partially filled container during transport of the container between the filling and sealing stations of the operation comprising nozzle means mounted above the line of travel of the container for providing a downwardly directed flow of inert gas at a temperature substantially below the frost point of the ambient air into each container and means for maintaining the exterior surface of the nozzle means substantially free of frost.

11. An apparatus according to claim 10 wherein said means for maintaining the surface free of frost includes thermal insulating material between the inert gas in the nozzle means and said exterior surface and means for heating the exterior surface of the nozzle means to a temperature above the frost point.

12. An apparatus according to claim 11, wherein said heating means comprises an externally heated casing including metal screen means mounted in heat conducting relation to said casing and covering the outlet from said nozzle means.

13. An apparatus as defined in claim 10 wherein said means for maintaining said surface free of frost comprises means for supplying a blanket of dry inert gas at a temperature substantially above the frost point of the ambient air, and completely surrounding said inert gas which is at a temperature substantially below the frost point of the ambient air.

14. An apparatus for exchanging the atmosphere in the headspace of open, partially filled containers during transport of the containers between the filling and sealing stations comprising:

a shell member;

means dividing the interior of said shell into a plurality of communicating chambers;

gas introduction means communicating with one of said chambers;

at least one gas jetting nozzle providing an outlet from one of said chambers for directing a gas stream into the headspace of each container as it passes thereunder; and

at least one gas fogging nozzle surrounding the jetting nozzle providing an outlet from another of said chambers for directing a lower pressure blanket of gas around said stream.

15. An apparatus for exchanging the atmosphere in the headspace of open, partially filled containers in accordance with claim 14 wherein the fogging nozzle is a slotted cylindrical disc mounted coaxially about the jetting nozzle.

16. An apparatus for exchanging the atmosphere in the headspace of open, partially filled containers in accordance with claim 15 wherein the slots in the disc are spiral.

17. An apparatus for exchanging the atmosphere in the headspace of open, partially filled containers in accordance with claim 14, and further comprising a closure purging nozzle providing an outlet from a third one of said chambers for directing gas under each container closure immediately prior to sealing.

18. An apparatus for exchanging the atmosphere in the headspace of open, partially filled containers during transport of the container between filling and sealing stations, comprising:

an external casing member;

an internal shell mounted therein with its major portion spaced and thermally insulated from the casing;

gas introduction means communicating with the interior of said shell for delivering cold gas thereto;

gas nozzle means communicating with the interior of said shell for directing the cold gas downward into the headspace of each container; and

means positioned externally of said casing member for heating the casing exterior of said member without appreciably heating said cold gas.

19. An apparatus for exchanging the atmosphere in the headspace of open, partially filled containers in accordance with claim 18 wherein said means for heating the casing includes a thermoelectric temperature sensing element mounted in heat sensing relationship with said casing and at least one heating element disposed in heat exchange relationship with said casing and controlled in response to a signal from said thermoelectric element.

20. An apparatus for exchanging the headspace gas in a plurality of moving containers conveyed beneath the apparatus comprising:

a shell including a first partition dividing its interior into a forward chamber and a rearward chamber;

the portion of the shell defining said forward chamber having a downwardly and forwardly inclined upper wall, a horizontal bottom wall and a forward outlet disposed at their forward intersection over the path of the containers; the portion of said shell defining the rearward portion having a horizontal bottom wall including two nozzle apertures therethrough over the path of the container;

second and third partition walls dividing the rearward chamber into upper, lower, and middle chambers;
 an inlet to said upper chamber for supplying cold nitrogen thereto;
 a tubular member interconnecting the upper and lower chambers for delivering cold nitrogen to the lower chamber;
 an opening through the first partition for delivering cold nitrogen from the lower chamber to the forward chamber;
 a pair of nozzle housings interconnecting the middle chamber and the nozzle apertures;
 an opening through the second partition for delivering cold nitrogen from the upper chamber to the middle chamber;
 a fogging nozzle disposed interior of each housing and having a plurality of openings therethrough to form a relatively low pressure fog of the cold nitrogen directed from the middle tiered chamber downward toward the conveyed containers;
 a jetting nozzle mounted coaxially with each fogging nozzle for directing a high pressure stream of cold nitrogen from the upper tiered chamber toward the conveyed containers;
 a baffle plate mounted interior of the forward chamber in the path of incoming nitrogen to divert the direct flow of nitrogen through the forward chamber;
 a casing enclosing the shell in spaced-apart relationship therefrom, said casing including a lower plate having a pair of nozzle apertures aligned with the nozzle housings, an inclined front plate for guiding container closures downwardly onto the containers passing below, and a semicircular closure purging aperture at the lower end of the inclined plate aligned with the forward outlet of the shell;
 a metal screen covering each nozzle aperture in heat exchange relationship with the casing;
 a plurality of elongated members spacing the casing from the shell and having a sharp edge in contact with the casing;
 thermoinsulating material between the casing and shell; and
 electrical means for heating the casing to prevent frost buildup.
21. A headspace gas exchanger apparatus comprising:
 means defining a central longitudinally extending chamber;
 means connected to said central chamber defining an inlet for directing flow of cold, inert gas into the said central chamber;
 means in said central chamber for providing flow of said cold gas downwardly out of a plurality of longitudinally spaced outlets from said central chamber at substantially equal pressures;
 means providing an outer chamber substantially surrounding said central chamber;
 means providing flow of an inert gas at a temperature above

the frost point of the ambient air into said outer chamber; and
 means for providing flow of said inert gas having a temperature higher than the frost point of the ambient air downwardly from said outer chamber to substantially surround said downward flow of said cold gas.
22. An apparatus as defined in claim **21** wherein said means for providing flow of gas having a temperature above the frost point of the ambient air comprises a plurality of spaced gas inlets communicating with said outer chamber and with a source of dry, ambient temperature inert gas.
23. A headspace gas exchanger as defined in claim **21** wherein said central chamber comprises an upper horizontal chamber and a lower horizontal chamber, said upper chamber communicating with said lower chamber through a plurality of spaced through-apertures having a total area less than the area of said inlet to said central chamber.
24. Apparatus for exchanging the headspace gas in a partially filled container comprising:
 a housing having first end walls, first sidewalls, an upper wall, a central wall and a lower wall defining a longitudinally extending upper chamber and lower chamber bounded by said sidewalls and end walls, said lower wall having a plurality of spaced ports therein and forming a cover section for a container conveyor path;
 a plurality of apertures in said central wall for providing fluid communication between said upper chamber and said lower chamber;
 a second pair of sidewalls spaced from said first sidewalls and connected to said upper wall and said lower wall for defining side chambers intermediate said first sidewalls and said second sidewalls;
 a second pair of end walls spaced from said first end walls and connected to said second pair of sidewalls to connect said side chambers and define a continuous outer chamber about said upper and lower chambers;
 means for thermally insulating said outer chamber from said upper and lower chambers;
 means for supplying a cold inert gas to said upper chamber;
 means for supplying a warmer, dry inert gas to said outer chamber;
 means in said lower chamber defining a plurality of gas outlets for directing cold inert gas downwardly from said lower chamber into the path of container flow; and
 means connected to said outer chamber for providing peripheral flow of a blanket of said warmer, dry inert gas about said downward flow of cold inert gas.
25. An apparatus as defined in claim **24** wherein one of said end walls is slanted in the direction of container movement along said path and defines the rearward edge of said cover, said slanted end wall having means thereon for directing inert gas into a container cap before it is positioned on a container for removing contaminant gases from said cap.

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