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Lee, Jr.

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[54] **DRYING METHOD**

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[73] Assignee: **The Reynolds Metals Company**, Richmond, Va.

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Related U.S. Application Data

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[52] **U.S. Cl.** **34/21,** 34/33, 34/105, 34/225, 134/152

[51] **Int. Cl.**.....**F26b 7/00**

[58] **Field of Search**.....34/21, 33, 104, 34, 34/105, 225; 134/70, 72, 152

[56] **References Cited**

UNITED STATES PATENTS

2,669,788	2/1954	Drum et al.	34/21
3,096,162	7/1963	Jepson	34/33
3,262,460	7/1966	Huddle et al.	134/131 X
3,381,391	5/1968	Yunghahn	34/105

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[57] **ABSTRACT**

An apparatus for and method of drying articles such as tubular containers each having a bottom wall, an adjoining side wall, and an open end wherein said containers are supported in an inverted position and a drying gas moved therepast in such a manner that it circulates around and within the containers and provides efficient drying of both the interiors and exteriors thereof.

7 Claims, 6 Drawing Figures

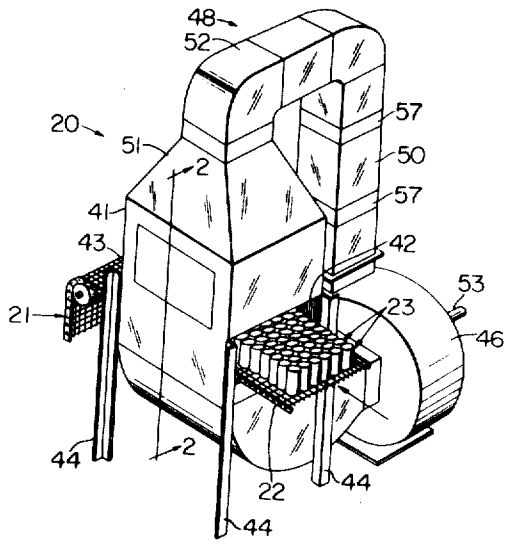


FIG-1

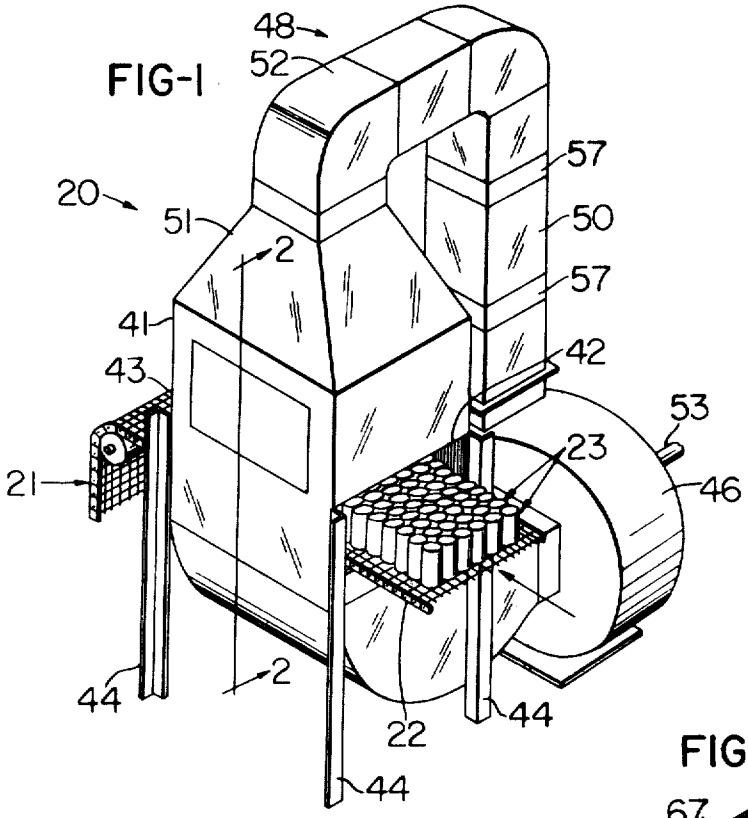


FIG-3

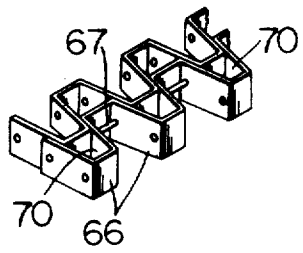
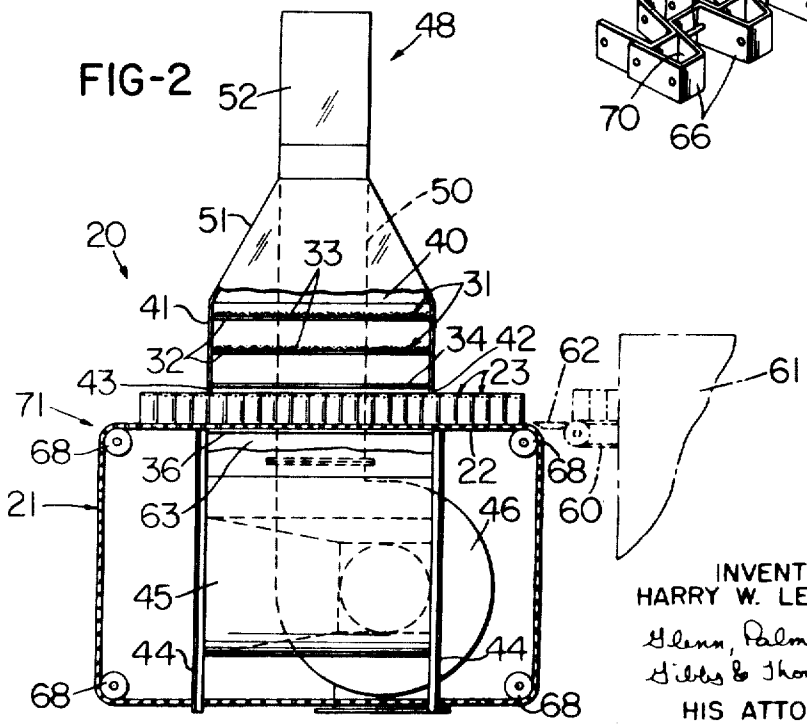


FIG-2



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FIG-4

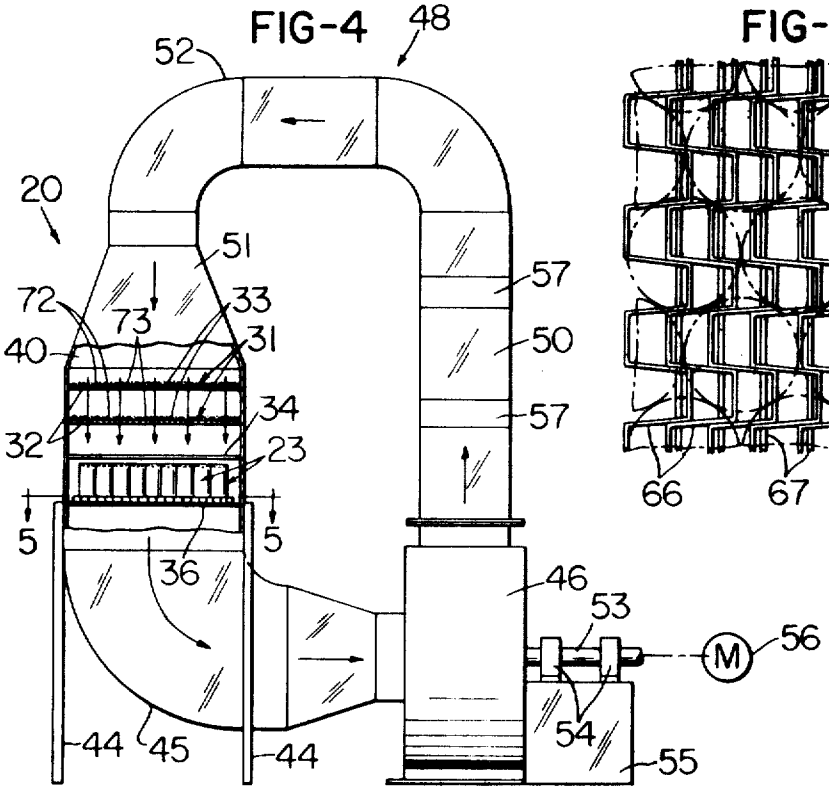


FIG-5

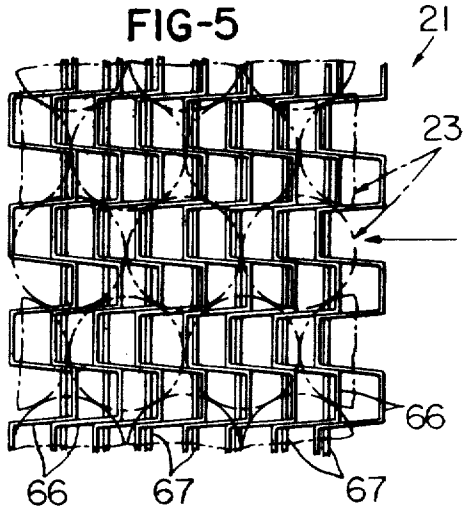
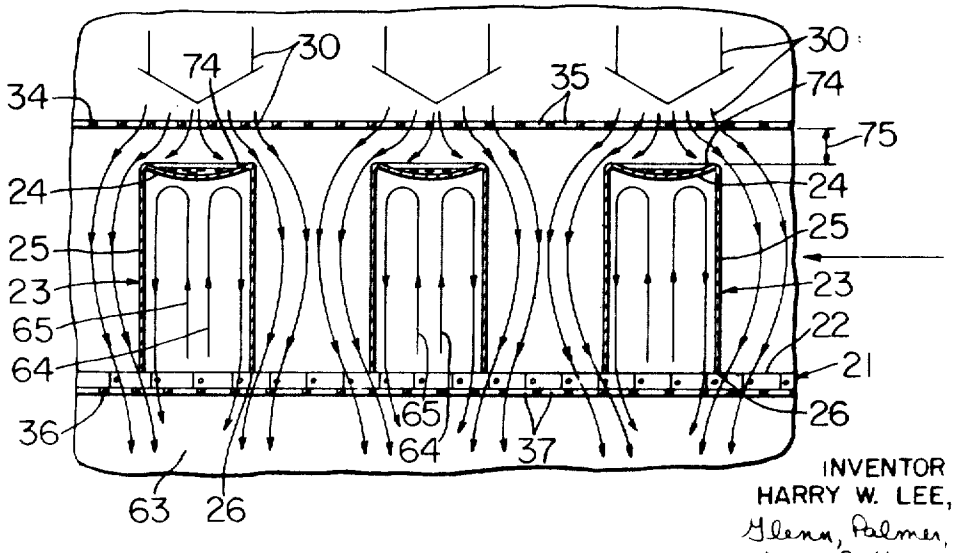


FIG-6



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DRYING METHOD

CROSS REFERENCE TO RELATED APPLICATION

This application is a divisional patent application of its co-pending parent application, Ser. No. 818,215, filed Apr. 22, 1969, now U.S. Pat. No. 3,574,952 issued Apr. 13, 1971, and is assigned to the same assignee to whom the parent application is assigned.

BACKGROUND OF THE INVENTION

Many apparatus and methods have been proposed heretofore for drying tubular containers, such as cans each having one open end, for example, by passing a drying gas thereover. However, such previously proposed apparatus and methods do not provide efficient drying of the interiors of such cans because of their inability to circulate the drying gas inside each can.

SUMMARY

This invention provides an improved apparatus for and method of drying articles such as tubular containers each having a bottom wall, an adjoining side wall, and an open end wherein said containers are supported in an inverted position and a drying gas circulated therepast in such a manner as to provide efficient drying of the exteriors thereof while simultaneously providing circulation of such drying gas within each container to also provide efficient drying of the interiors thereof.

Other details, uses, and advantages of this invention will become apparent as the following description of the exemplary embodiment thereof presented in the accompanying drawings proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings show a present exemplary embodiment of this invention, in which

FIG. 1 is a perspective view with parts broken away illustrating one exemplary embodiment of the apparatus of this invention used to dry tubular containers each having only one open end;

FIG. 2 is a view taken essentially on the line 2—2 of FIG. 1;

FIG. 3 is a greatly enlarged fragmentary perspective view of a portion of the conveyor comprising the apparatus of FIG. 1;

FIG. 4 is a side elevation with parts broken away of the apparatus of FIG. 1 particularly highlighting the method utilized to circulate a drying gas over the containers;

FIG. 5 is a greatly enlarged fragmentary view taken essentially on the line 5—5 of FIG. 4; and

FIG. 6 is a greatly enlarged fragmentary view with an exaggerated spacing between containers particularly illustrating the manner in which a drying gas is circulated past a plurality of inverted containers to provide rapid and efficient drying of both the interiors and exteriors thereof while providing circulation of gas within each inverted container.

DESCRIPTION OF ILLUSTRATED EMBODIMENT

Reference is now made to FIGS. 1—3 of the drawings which illustrate one exemplary embodiment of the apparatus and method of this invention which is

designated generally by the reference numeral 20. The apparatus 20 comprises an endless chain conveyor 21 which has a maximum open area which allows substantially unobstructed flow therethrough of a drying gas in a direction perpendicular to its supporting surface. The conveyor 21 has a horizontally extending portion 22 which is adapted to support a plurality of elongated tubular articles shown as a plurality of tubular containers or cans 23 each having a bottom wall 24 and an adjoining side wall 25 terminating in an end edge 26 defining an open end, see FIG. 6.

The cans 23 are supported on the horizontally extending portion 22 of the conveyor 21 with their axes arranged vertically and in parallel relation. A system is provided for circulating a drying gas or fluid, heated air in this example of the invention, around the cans 23 so as to provide efficient simultaneous drying of both the interiors and exteriors of such cans.

The apparatus 20 has means for directing the drying air, indicated in the drawings by a plurality of arrows 30, so that the air is directed toward the cans 23 at high velocity and in a plurality of closely spaced jets, with the spacing between such jets assuring that at least one jet is directed normally toward each of the cans 23 and in particular substantially toward the central portion of the bottom wall 24 of each can 23. The apparatus 20 has means for dampening any turbulence in the heated air as it approaches the cans 23 and in this example of the invention the dampening means comprises a plurality of sets 31 of screen and plate assemblies arranged parallel to the horizontal portion 22 of the conveyor 21 and with each set being defined by a perforated plate 32 adjoined by a screen 33 arranged upstream thereof. The apparatus 20 also has a planar sheet 34 which has a plurality of spaced openings 35 provided therein and the openings 35 define the previously mentioned jets which assure that heated air is directed toward the cans 23 at high velocity.

The apparatus 20 also has a flow control device arranged beneath the horizontal portion 22 of conveyor 21 which is used to create a negative pressure beneath the conveyor and cans 23 and in this example of the invention such flow control device comprises a plate 36 having a plurality of apertures 37 therein. The plate 36 with its apertures 37 operates to restrict air flow in a controlled manner creating a venturi effect which causes heated air to circulate inside the inverted cans 23 and provide an efficient drying of the can interiors. It will also be appreciated that the construction of the conveyor 21 may be such that it cooperates with the plate 36 to provide controlled flow producing the above-mentioned venturi effect.

The apparatus 20 has what will be referred to as a drying chamber 40 defined by a housing 41 which has openings 42 and 43 at opposite ends thereof which allow the conveyor 21 with the cans 23 supported thereon in an inverted manner to pass through the chamber 40 in a continuous manner to enable high speed drying thereof. The housing portion 41 and hence drying chamber 40 is supported on an associated supporting floor by a plurality of spaced vertical legs 44.

The apparatus 20 also includes a duct assembly 45 arranged beneath the housing portion 41 and the assembly 45 has an upstream end fastened in sealed rela-

tion to the housing portion **41** and a downstream end fastened in sealed relation to the inlet of a centrifugal fan **46**. The apparatus **20** also has a duct assembly **48** which includes a vertically extending portion **50** which is fastened in sealed relation to the discharge of the fan **46**, a vertical downwardly flaring frusto-pyramidal section **51** fastened in sealed relation to the top portion of the housing **41** and a substantially U-shaped transition section **52** connecting the vertical sections **50** and **51**.

The fan **46** has a shaft **53** extending therefrom which is supported by a pair of antifriction bearings **54** carried on a support **55** and the shaft **53** is driven by a suitable drive motor **56**. The apparatus **20** has a plurality of heaters **57** which may be in the form of electrical heaters which are provided with electrical power from any suitable power source and are utilized to heat the air which is used to dry the cans **23**.

As will be apparent particularly from FIG. **4** of the drawings, the air circulating system for the apparatus **20** comprises a closed loop system which circulates heated air past the containers **23** in the drying chamber **40**. The air is then recirculated past the heaters **57** to remove any moisture that may be present therein. In addition, suitable air temperature control devices may be arranged downstream of the heaters **57** and used to control such heaters and hence the temperature of the heated air to provide optimum drying efficiency.

The cans **23** which are to be dried are moved from a can washer, for example, in an inverted position and placed on the horizontally extending portion **22** of the conveyor **21** so that they may be moved through the drying chamber **40**. Any suitable technique may be utilized to place the cans **23** on the conveyor **22** such as by manual or automatic means. For example, an endless conveyor **60** may be used to move washed cans from a can washer **61**, see FIG. **2**, to a transfer mechanism such as a horizontally reciprocating plate assembly **62** which transfers the cans onto the horizontal portion **22** of the conveyor **21**. It will also be appreciated that the conveyor **21** may also be provided so that the horizontally arranged portion **22** extends completely through the washer thus eliminating the need to provide a separate conveyor from the washer **61** and a device to transfer the cans from the washer conveyor to the conveyor **21**.

As the cans **23** are moved through the drying chamber **40** the high velocity jets of air defined by the openings **35** in the sheet **34** impinge downwardly against the bottom walls **24** of the cans **23** while sweeping past the side walls **25** at a sufficiently high velocity to provide efficient transfer of heat to and hence drying of the side walls. As the air sweeps past the cans **23**, the plate **36** with its apertures **37** helps control the air flow and causes a negative pressure in a chamber **63** defined beneath the plate **36** so as to provide the previously mentioned venturi effect causing circulation of the heated air within each can **23** and as indicated in a somewhat exaggerated manner by the arrows **64** and **65** in FIG. **6** of the drawings.

Thus, it will be seen that the high velocity heated air bathes the outside of each can **23** while the components of the apparatus **20** cooperate to provide circulation of heated air within each can **23** whereby efficient drying of both the interiors and exteriors of the cans **23** is provided. In addition, the air flow is such that the cans **23** are maintained in their upright positions as they pass through the drying chamber **40**.

The conveyor **21** comprising the apparatus **20** has been described as a chain conveyor having a maximum open area which enables substantially unobstructed air flow therethrough. The conveyor **21** comprises a plurality of links **66** each having an undulating configuration essentially as shown in FIG. **3** with each pair of adjoining links being held together by an elongated rod **67** which may extend across the full width of the conveyor **21**. The individual links **66** and their rods **67** may be made of any suitable corrosion resistant material such as stainless steel or a plastic material. Yet, the construction of the conveyor **21** is such that it may be moved in a continuous endless path.

The conveyor **21** is supported by a plurality of toothed rollers **68** which have cooperating teeth which are received within openings **70** defined between adjacent chain links **66**. One of the rollers **68**, shown as the upper left hand roller in FIG. **2** and indicated at **71** is driven by a suitable drive motor to enable movement of the conveyor **21** in an endless path.

The plate **36** with its apertures or openings **37** is supported beneath the horizontal portion **22** of the conveyor **21** in any suitable manner. However, in this example of the invention the plate **36** is in the form of a support plate which is suitably fixed to the legs **44** and has a top surface which supports the horizontal portion **22** for sliding movement thereacross with minimum frictional drag while assuring that each can **23** is supported on its associated end edge **26** with optimum stability.

To minimize the frictional drag between the conveyor and the plate the conveyor **21** and/or plate **36** may have their rubbing surface portions either made of or treated with suitable antifriction materials. In addition, elongated narrow strips made of an antifriction material may be fixed on the plate **36** to reduce the rubbing area.

As previously mentioned a plurality of dampening assemblies **31** is provided for dampening any turbulence in the heated air as it approaches the cans **23** and each dampening assembly is comprised of a plate **32** adjoined by a screen **33**. Each plate **32** preferably has a plurality of openings **72** provided therein while each screen **33** is in the form of a large mesh screen defined by a plurality of crisscrossed undulating wires **73** which, due to the undulating character thereof, help minimize any turbulence in the flow of heated air as it approaches the planar sheet **34** and thereby assures the provision of uniformly spaced high velocity jets of air exiting the lower surface of the plate **34** toward the cans **23**, see FIG. **4**.

As will be apparent from FIG. **6** of the drawings, each bottom wall **24** of each exemplary can **23** has an outwardly concave recess or depression **74** defined therein and with the cans moving into the drying apparatus **20** from an associated washer in an inverted position washing fluid, such as water, for example, is contained in each depression **74**. However, the area of each opening **35** and the spacing between openings is correlated with the diameter of the cans **23** to assure that at least one jet of heated air is directed substantially normally, i.e., perpendicularly, toward the bottom wall **24** of each can **23**. Thus, with the presence of

a washing fluid, such as water, within a depression **74** it will be seen that the jet of air impinging thereagainst displaces the washing fluid from within the depression and downwardly along the associated side wall **25** whereupon the high velocity heated air provides rapid drying of the bottom wall **24** and side wall **25**.

As previously indicated, the cooperating arrangement of the openings **35** in sheet **34** and the apertures **37** in the plate **36** together with the circulation of heated air as provided by the fan **46** results in the provision of a positive pressure ranging roughly between one-fourth and one-half inch of water in the drying chamber **40** immediately above the sheet **34** whereby a negative pressure ranging roughly between one-half inch and 2 inches of water is provided in the chamber **63** immediately beneath plate **36**. This pressure distribution and the cooperating arrangement of components is such that the cans **23** are maintained in a stable upright manner, yet an efficient drying is provided by air flowing inside of and around such cans.

The sheet or plate **34** is positioned a controlled distance above the bottom walls **24** of the cans **23** and as indicated at **75** in FIG. **6**. Suitable means may be provided in the housing **41** to assure that the sheet **34** may be moved to accommodate cans of different heights and thereby assure impingement of air at high velocity against the bottom walls of the cans **23** as well as high velocity flow along the side walls of such cans. It will also be appreciated that with the apparatus and method of this invention the cans **23** may be packed tightly with their side walls **23** substantially in adjoining relation during movement thereof by the conveyor **21** through the drying chamber **40**. With the cans tightly packed there is less area between adjacent cans which causes higher velocity air flow along the side walls of the cans **23** whereby more efficient heat transfer is provided and hence more rapid and efficient drying of the particular cans. In particular, using the standard **12** fluid oz. beverage can of circular cross-sectional configuration the effective area between cans is roughly **10** percent of the total available supporting area of the horizontal portion **22** of belt **21** which is within the chamber **40**, for example. This **10** percent area assures high velocity flow and efficient heat transfer.

The presentation of FIG. **6** has been made with the cans **23** arranged in widely spaced relation to demonstrate the action that takes place whereby air is circulated at high velocity around the exteriors of the cans and within the inverted cans to provide efficient high speed drying. An efficient high speed drying action takes place which is made possible by both convection and conduction and irrespective of whether the cans are widely spaced as much as or more than shown in FIG. **6** or are packed tightly together.

While a present exemplary embodiment of this invention, and method of practicing the same, has been illustrated and described, it will be recognized that this invention may be otherwise variously embodied and practiced by those skilled in the art.

What is claimed is:

1. A method of simultaneously drying both the inside and outside of tubular containers each having a bottom wall and an adjoining side wall terminating in an end edge defining an open end; said method comprising the steps of; placing each of said containers in an inverted manner with its end edge resting on a horizontal portion of a perforated conveyor having a supporting surface and which allows substantially unobstructed flow of a drying gas therethrough in a direction perpendicular to its supporting surface; supporting a control device for said drying gas beneath said horizontal portion; said control device having a plurality of spaced apertures therein; directing said drying gas toward said containers at high velocity using an associated directing device and in a plurality of closely spaced jets with the spacing between jets assuring that at least one jet is directed normally toward each of said containers; and circulating said drying gas against the bottom wall of each container, against and around its side wall, through said conveyor, and toward said control device; said circulating step enabling said flow control device and spaced jets to cooperate to assure each container is maintained in an upright manner with said drying gas being circulated around the outside thereof at high velocity to thereby provide efficient transfer of heat to the walls of each container and said circulating step also simultaneously enabling said flow control device and spaced jets to provide a negative pressure beneath each container and circulation of said drying gas within each container to provide said simultaneous drying.

2. A method as set forth in claim **1** and comprising the further step of introducing a dampening screen upstream of said directing device to reduce any turbulence in said drying gas.

3. A method as set forth in claim **1** in which said circulating step comprises circulating heated air.

4. A method as set forth in claim **1** in which said negative pressure is caused by a venturi effect upon circulating said drying gas over said containers and through said flow control device during said circulating step, said negative pressure ranging between roughly one-half inch and 2 inches of water which assures each of said containers is held in a stable upright manner while providing said simultaneous drying.

5. A method as set forth in claim **3** in which each bottom wall of each container has an outwardly concave depression defined therein, and comprising the further step of moving said containers from a washer in an inverted position with washing fluid contained in each depression and with at least one jet of air being directed normally toward each container the washing fluid is displaced from within its depression by the action of the associated jet of drying air while the associated container is maintained in an upright manner.

6. A method as set forth in claim **1** in which said drying gas comprises heated air and said circulating step comprises recirculating said heated air in a closed loop path while simultaneously heating the air downstream of said containers to dry any moisture picked up thereby due to drying of said containers whereby said recirculation enables said simultaneous drying in a more efficient and economical manner.

7. A method as set forth in claim **6** and comprising the further step of supporting a plurality of sets of screen and plate assemblies upstream of said directing device to reduce any turbulence in said heated air, each of said sets being defined by a perforated plate and an adjoining screen arranged upstream thereof with each screen being defined by a plurality of crisscrossed undulating wires.

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