

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



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SOLICITUD  
**PATENTE DE INVENCION**

ENTRADA EN FASE NACIONAL

21. EXPEDIENTE No.

05-116273

54. TITULO METODO Y APARATO PARA ENDURECER VIDRIO

51. CLASIFICACION INTERNACIONAL

71. SOLICITANTE THE COCA - COLA COMPANY

DOMICILIO ATLANTA, GEORGIA 30313, ESTADOS UNIDOS DE AMERICA

74. APODERADO JUAN PABLO CADENA SARMIENTO

22. SANTAFE DE BOGOTA, D.C.

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## FORMULARIO ÚNICO DE SOLICITUD DE PATENTE PCT ENTRADA EN FASE NACIONAL

|                                                                                                                                                  |                                                                                                                                                                                                                                               |                                                                                                                                                                                                    |                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1 SOLICITUD DE:                                                                                                                                  |                                                                                                                                                                                                                                               |                                                                                                                                                                                                    |                          |
| <input checked="" type="checkbox"/> Patente de Invención.                                                                                        |                                                                                                                                                                                                                                               | <input type="checkbox"/> Patente de Modelo de Utilidad.                                                                                                                                            |                          |
| <input type="checkbox"/> Capítulo I.                                                                                                             |                                                                                                                                                                                                                                               | <input checked="" type="checkbox"/> Capítulo II.                                                                                                                                                   |                          |
| 2 SOLICITANTE (71)                                                                                                                               | Nombre: THE COCA - COLA COMPANY<br>Dirección: One Coca-Cola Plaza, N.W. Atlanta, Georgia 30313, Estados Unidos de América<br>Nacionalidad o Domicilio: Estados Unidos<br>Lugar de Constitución: Estados Unidos<br>Teléfono: Fax:<br>E-mail    | IDENTIFICACION<br>C.C. <input type="checkbox"/> NIT <input type="checkbox"/><br>C.E. <input type="checkbox"/> Otro <input type="checkbox"/><br>Cual _____<br>Número _____                          |                          |
| 3 REPRESENTANTE O APODERADO                                                                                                                      | Nombre: JUAN PABLO CADENA SARMIENTO<br>Dirección: Cra. 7 No. 16-56 Piso 9<br>Teléfono: 380-2200 Fax: 380-2700<br>E-mail:                                                                                                                      | IDENTIFICACION<br>C.C. <input checked="" type="checkbox"/> NIT <input type="checkbox"/><br>C.E. <input type="checkbox"/> Otro <input type="checkbox"/><br>Cual _____<br>Número 80.410.337 TP 57492 |                          |
| 4 INVENTOR (ES) (72)                                                                                                                             | Nombre: Dennis Postupack, William Lacourse<br>Dirección: 560 Waterview Trail, Alpharetta, GA 30022 (US); 15 Reynolds Street, Alfred, NY 14802 (US) (Respectivamente)<br>Nacionalidad o Domicilio: Estados Unidos de América (Respectivamente) |                                                                                                                                                                                                    |                          |
| 5 PCT (86)<br>Solicitud Internacional No. PCT/US2004/009716 Fecha 31-03-2004<br>Publicación Internacional No. WO 2004/094329 A1 Fecha 04-11-2004 |                                                                                                                                                                                                                                               |                                                                                                                                                                                                    |                          |
| 6 Título (54): METODO Y APARATO PARA ENDURECER VIDRIO                                                                                            |                                                                                                                                                                                                                                               |                                                                                                                                                                                                    |                          |
| 7 Clasificación Internacional (51) C 03 C 21 / 00                                                                                                |                                                                                                                                                                                                                                               |                                                                                                                                                                                                    |                          |
| 8 Prioridad                                                                                                                                      | (33) Pais de Origen                                                                                                                                                                                                                           | (32) Fecha                                                                                                                                                                                         | (31) Número de Solicitud |
| SI <input checked="" type="checkbox"/> NO <input type="checkbox"/>                                                                               | US                                                                                                                                                                                                                                            | 22-04-2003                                                                                                                                                                                         | 60/464.356               |
|                                                                                                                                                  | US                                                                                                                                                                                                                                            | 31-03-2004                                                                                                                                                                                         | NO ASIGNADO              |
| 9 Compromiso de pago No. 05-72969                                                                                                                |                                                                                                                                                                                                                                               | Fecha 16-11-2005                                                                                                                                                                                   |                          |

Instrucciones para el diligenciamiento del presente formulario, ver reverso de esta página.

10

ANEXOS

- ☒ Comprobante de pago de la tasa de presentación de la solicitud. \$443.000
- ☒ Documento que acredite la existencia y representación legal cuando el solicitante sea persona jurídica.
- ☒ Poderes, si fuere el caso. Fotocopia autenticada
- ☒ Documento de cesión del inventor al solicitante o a su causante
- ☐ Declaraciones
- ☒ Copia de la solicitud internacional. (Resumen, descripción, reivindicaciones, dibujos)
- ☒ Traducción de la solicitud internacional al castellano. (Resumen, descripción, reivindicaciones, dibujos)
- ☒ Copia del examen preliminar efectuado por la IPEA
- ☒ Traducción del examen preliminar efectuado por la IPEA.
- ☐ De ser el caso, copia del contrato de acceso
- ☐ De ser el caso, documento que acredite la licencia o autorización de uso de conocimientos tradicionales de las comunidades indígenas
- ☐ De ser el caso, certificado de depósito del material biológico
- ☐ Arte final 12x12
- ☐ De ser el caso, información sobre otras solicitudes de patente o títulos obtenidos en el extranjero por el mismo titular o su causante, relacionadas parcial o totalmente con la invención de esta solicitud
- ☒ Otros: Extracto para publicación Tarjeta de Archivo Temático y Tarjeta de Propietarios

11 FIGURA CARACTERÍSTICA:

12 Solicito la concesión de la patente,

NOMBRE: JUAN PABLO CADENA SARMIENTO

FIRMA:

[Firma manuscrita]  
C.C. 80.410.337 de Usaquén T.P. 57492 del C.S.J.

Instrucciones para la presentación de los anexos, ver reverso de esta página.

3

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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

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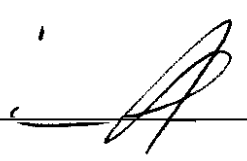
\*\*\*\*\* CONSIGNACION \*\*\*\*\*

| DEPOSITANTE           | TIPO PAGO    | BANCO         | CUENTA      | No. PAGO | FECHA PGO  | Vr. PAGO      |
|-----------------------|--------------|---------------|-------------|----------|------------|---------------|
| BRIGARD & CASTRO LTDA | CONSIGNACION | BANCO POPULAR | 050-00110-6 | 30712668 | 21/09/2005 | 19,470,000.00 |

\*\*\*\*\* C O N C E P T O \*\*\*\*\*

| CANT. RENTISTICO          | CONCEPTO                            | TOTAL CONCEPTO |
|---------------------------|-------------------------------------|----------------|
| 1 50005-01-01 SOLICITUDES | 1 TRAMITES DE SOL. DE PATENTE DE IN | 443,000.00     |
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SON: CUATROCIENTOS CUARENTA Y TRES MIL PESOS

RESPONSABLE : 

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. \_\_\_\_\_

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO  
DIVISION DE NUEVAS CREACIONES

PATENTE ☒ PCT/US2004/009716 MODELO DE UTILIDAD ☐ DISEÑO INDUSTRIAL ☐

SOLICITANTE/S. RAZON SOCIAL O APELLIDOS Y NOMBRES THE COCA - COLA COMPANY

DOMICILIO ATLANTA, GEORGIA 30313, ESTADOS UNIDOS DE AMERICA

APODERADO JUAN PABLO CADENA SARMIENTO

TITULO METODO Y APARATO PARA ENDURECER VIDRIO

CLASIFICACION

EXPEDIENTE No. FECHA DE SOLICITUD ROLLO MICROFILM

CERTIFICADO No. FECHA DE CONCESION VIGENCIA DESDE HASTA

PRORROGA CAMBIO DE NOMBRE

TRASPASO A

INVENTOR (ES) DENNIS POSTUPACK, WILLIAM LACOURSE

OTROS

OFICINA DE COMUNICACIONES

|                                                        |      |                                     |                      |
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| (21) N° de solicitud                                   |      | (22) Fecha de solicitud             |                      |
| (54) Clasificación Internacional :                     |      |                                     |                      |
| (71) Solicitante(s) THE COCA - COLA COMPANY            |      |                                     |                      |
| (72) Inventor(es) Dennis Postupack, William Lacourse   |      |                                     |                      |
| (74) Agente: JUAN PABLO CADENA SARMIENTO               |      |                                     |                      |
| (30) Prioridad                                         | (31) | No. Prioridad                       | (32) Fecha (33) País |
|                                                        |      | 60/464,366                          | 22-04-2003 US        |
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| Fecha de presentación de la solicitud: 31-03-2004      |      | No. Publicación : WO 2004/094329 A1 |                      |
| No. de solicitud PCT/US2004/009716                     |      |                                     |                      |

**FIGURA CARACTERISTICA**  
**6 x 6 cm**

(54) Título: METODO Y APARATO PARA ENDURECER VIDRIO

(57) Reivindicación(es):

1. Un método, que comprende los pasos de:  
formar un artículo de vidrio de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;  
sumergir el artículo de vidrio formado en un baño de sal fundida, comprendiendo el baño de sal iones de potasio en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de inmersión; y

CONTINUA AL RESPALDO ...

mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos, en donde el vidrio permanece a una temperatura mayor que la temperatura del punto de recocido

10. Un aparato, que comprende:

un área de operaciones;

medios de traslado de artículos de vidrio para trasladar un artículo de vidrio después de la formación del artículo de vidrio y antes de enfriar el artículo de vidrio a una temperatura por debajo de la temperatura de punto de recocido del artículo de vidrio;

un baño de sal, baño de sal que comprende sal fundida, configurándose los medios de traslado del artículo de vidrio para mover el artículo de vidrio desde el área de operaciones y sumergir el artículo de vidrio en el baño de sal, configurándose los medios de traslado del artículo de vidrio para

sumergir artículos de vidrio con temperaturas superficiales de por lo menos la temperatura de punto de recocido del vidrio, configurándose el artículo de vidrio para permanecer en el baño de sal durante menos de alrededor de un minuto; y un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

|                         |                                                       |            |           |                                                      |  |
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| (30) Prioridad          | (31) No. Prioridad                                    | 32) Fecha  | (33) Pais | (72) Inventor(es) Dennis Postupack, William Lacourse |  |
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|                         |                                                       |            |           | (74) Agente: JUAN PABLO CADENA SARMIENTO             |  |
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| (54) Título:            |                                                       |            |           | MÉTODO Y APARATO PARA ENDURECER VIDRIO               |  |

**Reivindicación(es):**

- Un método, que comprende los pasos de:  
 formar un artículo de vidrio de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;  
 sumergir el artículo de vidrio formado en un baño de sal fundida, comprendiendo el baño de sal iones de potasio en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de inmersión; y  
 mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos, en donde el vidrio permanece a una temperatura mayor que la temperatura del punto de recocido
- Un aparato, que comprende:  
 un área de operaciones;  
 medios de traslado de artículos de vidrio para trasladar un artículo de vidrio después de la formación del artículo de vidrio y antes de enfriar el artículo de vidrio a una temperatura por debajo de la temperatura de punto de recocido del artículo de vidrio;  
 un baño de sal, baño de sal que comprende sal fundida, configurándose los medios de traslado del artículo de vidrio para mover el artículo de vidrio desde el área de operaciones y sumergir el artículo de vidrio en el baño de sal, configurándose los medios de traslado del artículo de vidrio para sumergir artículos de vidrio con temperaturas superficiales de por lo menos la temperatura de punto de recocido del vidrio, configurándose el artículo de vidrio para permanecer en el baño de sal durante menos de alrededor de un minuto; y un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

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## PCT

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|                                                                   |                                                                          |                                                              |
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| Applicant<br>THE COCA-COLA COMPANY et al                          |                                                                          |                                                              |

The International Bureau transmits herewith the following documents:

- ☒ copy of the international application as published by the International Bureau on 04 November 2004 (04.11.2004) under No. WO 2004/094329
- ☐ copy of international application as republished by the International Bureau on under No. WO
- For an explanation as to the reason for this republication of the international application, reference is made to INID codes (15), (48) or (88) (as the case may be) on the front page of the attached document.

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(71) Applicant (for all designated States except US): THE COCA-COLA COMPANY (US/US); One Coca-Cola Plaza, N.W., Atlanta, GA 30313 (US).

(72) Inventors; and  
(75) Inventors/Applicants *if* US only: POSTUPACK.

Dennis [US/US]; 560 Waterview Trail, Alpharetta, GA 30022 (US) LACOURSE, William [US/US]; 15 Reynolds Street, Alfred, NY 14402 (US)

(74) Agents: BELL, Michael, J. et al.; Howrey Simon Arnold & White, L.L.P. 1291 Pennsylvania Avenue, N.W., Box 34, Washington, DC 20004-2402 (U.S).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CI, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, FR, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KR, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MY, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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[Continued on next page]

(54) TITLE: METHOD AND APPARATUS FOR STRENGTHENING GLASS

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graph TD; 310[BOTTLE FORMING] --> 315[FLAME POLISHING]; 315 --> 320[DIPPING]; 320 --> 330[HEAT TREATMENT]; 330 --> 340[COOLING]; 340 --> 350[SALT REMOVAL];
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The flowchart illustrates a six-step process for producing a glass bottle with a smooth surface. The steps are arranged vertically and connected by downward-pointing arrows. The steps are: 1. BOTTLE FORMING (310), 2. FLAME POLISHING (315), 3. DIPPING (320), 4. HEAT TREATMENT (330), 5. COOLING (340), and 6. SALT REMOVAL (350).

(57) Abstract: The invention relates to a method and apparatus for strengthening glass. A method according to one aspect of the invention strengthens glass by applying potassium ions to the surface of a glass article with the surface being at least the annealing point temperature of the glass and then keeping the temperature of the glass between the strain point temperature of the glass and about 50°C below the strain point temperature for at least about five minutes to facilitate a more efficient ion-exchange reaction. In one embodiment, the glass articles may be dipped in a salt bath to apply the ions. In an alternative embodiment, the glass articles may be sprayed with molten potassium salt to apply the ions. As a result of the methods of the invention, the treated glass articles may be strengthened by having an increased surface stress or may contain less glass with no change in strength as compared to the same untreated glass article.

**WO 2004/094329 A1**

GM, KE, LS, MW, MZ, SD, SI, SZ, TZ, UG, ZM, ZW),  
 Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), Euro-  
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 ance Notes on Codes and Abbreviations" appearing at the begin-  
 ning of each regular issue of the PCT Gazette.

## METHOD AND APPARATUS FOR STRENGTHENING GLASS

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 60/464,356, filed and April 22, 2003 (our reference: 01638.0010.PZUS00), entitled "Methods and Apparatus for Strengthening Glass," and its corresponding non-provisional application (serial number to be assigned), filed March 31, 2004 (our reference: 01638.0010.NPUS02), entitled "Method and Apparatus for Strengthening Glass," the contents of which are hereby incorporated by reference in their entirety.

### FIELD OF THE INVENTION

This invention relates to methods and apparatus for strengthening glass. More specifically, the invention relates to chemical strengthening methods in which ions are applied to glass articles, and apparatus for using these methods in bottle making.

$\text{KNO}_3$  and  $\text{K}_2\text{Cr}_2\text{O}_7/\text{KCl}$  baths, where the temperatures of the salt baths range from  $525^\circ\text{C}$  to  $625^\circ\text{C}$ , and the glass immersion times range from 8 hours to 7 days. However, such processes are impractical in a mass production manufacturing setting because they require batches of products to be submerged in the molten salt bath for extended periods, thus interrupting the smooth flow of a conveyor-type manufacturing line. U.S. Patent No. 3,751,238 discusses a two-step potassium salt bath immersion chemical strengthening method. In the first step, a glass article is immersed in a  $\text{KCl}/\text{K}_2\text{SO}_4$  salt bath for 20 minutes at  $750^\circ\text{C}$  (well above the strain point of  $581^\circ\text{C}$  and annealing point of  $631^\circ\text{C}$ ). In the second step, the glass article is immersed in a  $\text{KNO}_3$  bath for 4 hours at  $525^\circ\text{C}$  ( $56^\circ\text{C}$  below the strain point).

Other chemical strengthening methods involve cooling glass articles well below the strain point before the ion exchange material is applied, typically in the form of saturated salt solutions. The strain point of the glass is the glass temperature below which permanent strain cannot be introduced, which may be the temperature at which the viscosity is  $10^{14.5}$  poise ( $10^{13.5}$  Pa-sec). For example, in the processes described in U.S. Patent No. 4,206,253, after glass products have been produced and cooled below about  $60^\circ\text{C}$ , aqueous solutions of  $\text{KCl}$ ,  $\text{KNO}_3$ , and  $\text{K}_2\text{SO}_4$  at about  $75^\circ\text{C}$  are applied to the surfaces of the products. The products are then subjected to heat treatment at a temperature just below the strain point (about  $510^\circ\text{C}$ ).

Figure 1 shows an example of a prior art chemical strengthening process using a potassium salt solution for strengthening glass articles. The bottle-forming 110 and annealing 120 steps are performed as described above. The glass is then transferred 130 to a secondary process in which the bottles are reheated 140 to a temperature of approximately  $100^\circ\text{C}$ . A salt solution is applied 150 to the bottles, which are then heated to the ion exchange temperature, i.e.,  $460$ - $550^\circ\text{C}$ , in a strengthening lehr. The ion exchange temperature depends upon how much

time is available for the ion exchange reaction, which in turn depends on practical production considerations. The shorter the available time for ion exchange, the higher the ion exchange temperature should be. After the heat soak at the ion exchange temperature 160 the bottles are permitted to cool 170 to room temperature, at which time the residual coating, i.e., that portion of the salt that has not contributed to ion exchange within the surface of the glass, is removed, for example with a room temperature water spray. At this stage, the glass articles will preferably have cooled to about 90°C.

One purpose of the ion-exchange process is to increase the compressive stress at the surface of the glass by replacing smaller ions at the surface of the glass (e.g., sodium) with larger ions (e.g., potassium). If the glass were thereafter held at the annealing temperature for a time, the result would be that the compressive stress introduced at the surface by ion-exchange would be relieved. Thus the strengthening lehr may be within a temperature range of 460-550° C, depending upon the available ion exchange time based on practical production considerations. This temperature may, for example, be slightly below the annealing temperature, for example, 525°C. There is a balancing required in this ion-exchange step: hotter temperatures speed the ion-exchange process, but if the temperature is too hot and approaches the annealing temperature, the compressive stress introduced by the ion-exchange might be relieved through relaxation of the glass structure.

Referring back to Figure 1, a salt solution can be applied 150 to the bottles at a relatively cool temperature, well below the annealing and strain points. If the temperature of the bottles is too high during the application of a salt solution, then the application of the aqueous salt solution results in rapid quenching of the bottles, which often results in breakage. After application of the salt solution, the temperature of the bottles is raised in order to speed the ion exchange process.

This prior art method suffers from lack of adaptability to existing in-line bottle manufacturing facilities because it requires that the bottles be cooled for a time in order to avoid fractures during application of the salt solution, and requires subsequent reheating for the ion-exchange reaction. These additional steps take time and reduce the efficiency of bottle making. These processes, however, are disadvantageous in that they are not easily adapted to pre-existing in-line bottle manufacturing lines because of the additional cooling and heating cycles that standard bottle manufacturing operations are not equipped to handle. Thus, changing the industrial process to include, for example, the aforementioned glass strengthening methods may be very costly.

U.S. Patent No. 4,218,230 purports to set forth a method to adapt the ion exchange method to high-speed commercial production lines. In this method, an aqueous solution of potassium phosphate and sodium phosphate is sprayed on glass articles at a temperature between 200°C and the annealing point of the glass. The glass is held at a temperature in the range of 300°C to just below the annealing point for 5 to 30 minutes.

A method in which powdered salts are applied to hot glass articles is described in U.S. Patent No. 3,791,809. In this method, a mixture of a low-melting point salt,  $\text{KNO}_3$ , and a high-melting point salt,  $\text{K}_3\text{PO}_4$ , are ground to a powder and applied to the surface of a glass article at a temperature above the annealing point. The low-melting point salts melt and fuse, adhering the mixture to the surface of the glass. Ion exchange occurs at a temperature of at least 200°C, but preferably above the strain point of the glass.

Another approach to preventing glass breakage is flame polishing, which removes surface defects such as small chips or scratches, by melting the defects and allowing the glass in the region of the defect to harden smoothly. For example, U.S. Patent No. 4,231,778 describes a

method in which newly formed glass products are allowed to cool somewhat, then the surface is subjected to flame polishing following by a period of annealing. There are many patents describing apparatus for flame polishing glass, for example, U.S. Patents No. 4,265,651; 2,422,482; 2,338,841; and 2,331,014.

There is a need in the art for methods of glass manufacturing that produce high strength glass articles. There is a related need for improved methods of ion exchange strengthening. There is also a need for glass strengthening methods that can be adapted to existing bottle manufacturing facilities without requiring substantial refitting of those facilities.

## SUMMARY OF THE INVENTION

This invention provides methods for chemical strengthening of glass articles comprising applying a salt to glass articles at temperatures of at least the annealing point temperature of the glass and then maintaining the glass article at elevated temperatures in alehr. The elevated temperatures may be, for example, between the strain point temperature of the glass and about 150°C below the strain point temperature. The glass may be maintained at such elevated temperature for at least about five minutes. Embodiments of the invention may include methods and apparatus for flame polishing in combination with chemical strengthening. Some embodiments of the apparatus of the invention are adaptations of existing bottle making facilities to perform embodiments of the methods of the invention.

In one aspect, the invention provides a method for strengthening a glass article. The glass article may be formed from molten glass using any glass forming process. The finished formed glass article may be flame polished to melt and thus heal any surface imperfections while increasing the temperature of the surface of the glass article to at least the annealing point temperature of the glass used to form the article. In one embodiment, the glass article is a glass bottle. In another embodiment, the glass article is formed from a glass with a strain point temperature of about 530°C and an annealing point temperature of about 550°C.

One embodiment of the method the salt is applied in a step of dipping a glass article into a molten salt bath for less than about one minute, for example, about 0.5 to about 30 seconds, or preferably about 3 to about 5 seconds. In a preferred embodiment, the molten salt bath comprises potassium nitrate and potassium chloride in an equimolar mixture. Some embodiments of the salt bath include potassium nitrate and potassium chloride in mole percent mixtures in the range of 40 to 60 percent, and other embodiments include mixtures of 40-60%

12

potassium nitrate and 40-60% potassium chloride. Other embodiments include molten salt baths comprising potassium sulfate and potassium chloride. In still other embodiments, the molten salt bath comprises combinations of any two or more of: potassium nitrate, potassium sulfate, potassium chloride, potassium phosphate, and potassium dichromate. In one embodiment, the temperature of the salt bath is greater than the bottle temperature immediately preceding immersion. In another embodiment, the temperatures of the molten baths may be in excess of 25°C above the annealing point of the glass. In yet another embodiment, the salt bath can have a temperature range of between 550°C and 750°C.

In an alternative embodiment, salt is applied to the surface of a glass article by spraying the glass with a solution containing potassium ions or a powdered or molten potassium salt while the surface temperature of the glass is at least about 25°C above the annealing point of the glass. Alternatively, the spraying step may take place at a temperature of at least 50°C above the annealing point of the glass or at least 100°C above the annealing point of the glass. In one embodiment, the potassium solution or potassium salt is potassium phosphate ( $K_3PO_4$ ). In another embodiment, the potassium solution comprises about 50% potassium phosphate by weight and 50 wt.% water.

The spraying step may be conventional spraying by forcing a solution through a nozzle, or it may be flame spraying, electrostatic, or powder spraying. If conventional spraying is used, droplets of a potassium solution or potassium salt contact the hot glass article, and may cool the surface of the hot glass article slightly. If flame spraying is used, a powdered potassium salt may be fed through a powder flame spray gun where the powder is liquefied within the spray, and molten potassium salt liquid droplets contact the hot glass article. Alternatively, a potassium solution may be applied between flame polishing nozzles. If electrostatic spray is used, droplets

of the potassium solution are electrically charged and become electrostatically attracted to the glass article. Alternatively, powdered potassium salts may be used in a conventional or electrostatic spray. In yet other embodiments, potassium salts may be applied by chemical vapor deposition.

Following the step of applying salt to a glass article, whether by dipping, spraying, or other applying method, the processes of the invention include the step of heat-treating the glass article in alehr or other heat treatment apparatus. This step allows a high rate of potassium ion diffusion into a surface of the glass article by maintaining the surface at a temperature between or including the strain point of the glass and 150°C below the strain point. The glass may be maintained at an elevated temperature for at least about five minutes, preferably less than one hour, more preferably between ten minutes and one hour or between fifteen and twenty minutes.

In another embodiment, the invention provides an apparatus for producing a strengthened glass article. This apparatus may include a means for producing a molded glass article. The molded glass article may be produced by any means known to those skilled in the art, including but not limited to press-and-blow and blow-and-blow processes. The apparatus may include a thermal insulating tunnel after the forming station to minimize heat loss. The apparatus may further include flame polishing nozzles for flame polishing the surface of the glass article to remove surface flaws and to heat the surface to a temperature of at least about 25°C above the annealing point of the glass. In one embodiment, the glass article is a glass bottle. In one embodiment, the glass article is formed from glass with a strain temperature between 520°C and 540°C and an annealing temperature between 540°C and 560°C. In another embodiment, the glass article is formed from a glass with a strain temperature of about 530°C and an annealing temperature of about 550°C.

In one embodiment, the apparatus may further include a salt bath for dipping the glass article prior to heat strengthening. In one embodiment, the molten salt bath is a potassium salt bath, for example, a  $\text{KNO}_3/\text{KCl}$  salt bath, a  $\text{K}_2\text{SO}_4/\text{KCl}$  salt bath, or a  $\text{K}_2\text{SO}_4/\text{KCl}/\text{KNO}_3$  salt bath. In one embodiment, the salt bath is maintained at a temperature of at least about  $25^\circ\text{C}$  above the annealing point of the glass.

In another embodiment, the apparatus may further include spray nozzles for spraying the glass article with a solution containing potassium ions or another potassium source. In one embodiment, the spray nozzles spray the potassium source onto the surface of the glass article while the surface is maintained at a temperature of at least about  $25^\circ\text{C}$  above the annealing point of the glass. In another embodiment, the spray nozzles spray the potassium onto the surface of the glass article while the surface is maintained at a temperature of at least about  $50^\circ\text{C}$  above the annealing point of the glass. In yet another embodiment, the surface is sprayed while it is maintained at a temperature of at least about  $100^\circ\text{C}$  above the annealing point of the glass. The spray nozzles may be substituted by a flame spray nozzle spraying a powdered potassium salt. Alternatively, the spray nozzles may be substituted by an electrostatic spray nozzle spraying a potassium solution. Alternatively, the spray nozzles may be substituted by a conventional or electrostatic powder spray nozzle. In one embodiment, the potassium solution comprises 50% potassium phosphate by weight and 50% water by weight.

Whether the apparatus has salt bath dipping means, salt spraying means, or other means for applying salt, the apparatus may further include a strengtheninglehr, wherein the strengtheninglehr may be configured to keep the glass article at a temperature greater than about  $80^\circ\text{C}$  below the strain point, and the glass article is kept in the strengtheninglehr for at least about 45 minutes. Alternatively, the strengtheninglehr may be maintained at a temperature up to

the strain point of the glass. The glass article may be kept in the strengtheninglehr for a maximum time of 30 minutes. Alternatively, the glass article may be kept in the strengtheninglehr for at least about 15 minutes for higher temperature strengthening. In yet another alternative, the glass article may be kept in the strengtheninglehr for about 45 minutes for lower temperature strengthening. In another embodiment, the glass article is maintained at a temperature at or below the annealing point of the glass for at least about 5 minutes.

A preferred method of practicing the invention will vary by type of glass, due to differing annealing points and strain points, the weight of the glass, shape of the container, etc. For purposes of illustration, when a 200 ml Coca-Cola Company contour flint glass bottle having a weight of 165 grams is being strengthened, the container is subjected to about twenty minutes of ion exchange at about 520 degrees Celsius. Flint glass typically used in such bottles has an annealing temperature of 550 degrees Celsius and a strain temperature of 530 degrees Celsius.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 illustrates a prior art method of glass strengthening;

Figure 2 is a flow diagram of a method according to one embodiment of the invention;

Figure 3 is a Weibull plot illustrating the benefits of flame polishing;

Figure 4 is a strength versus time plot for both a high temperature ion-exchange glass strengthening process and a low temperature ion-exchange glass strengthening process;

Figure 5 is a flow diagram of a method according to an alternative embodiment of the invention;

Figure 6 is a bar chart comparing the benefits of various glass strengthening methods according to an embodiment of the invention;

Figure 7 is a plan view of a glass strengthening system according to one embodiment of the invention;

Figure 8A is a diagram illustrating one example of an annealing Lehr used to compare the methods of the present invention with those of the prior art;

Figure 8B is a diagram illustrating an exemplary strengthening Lehr according to an embodiment of the invention;

Figure 9 is a perspective view of a mechanism for dipping bottles in a system for strengthening bottles according to one aspect of the invention;

Figure 10 is a perspective view of a mechanism for rinsing bottles in a system for strengthening bottles according to one aspect of the invention;

Figures 11-20 are Weibull plots illustrating the benefits of the exemplary methods of chemical glass strengthening according to embodiments of the invention as compared to prior art glass strengthening methods;

Figure 21 is a plot of change in glass strength against the weight of the salt that adheres to the bottle;

Figure 22 is a Weibull plot demonstrating superior strength characteristics of glass rods manufactured by the immersion method of the invention in  $\text{KNO}_3/\text{KCl}$  baths; and

Figure 23 is a Weibull plot demonstrating superior strength characteristics of glass rods manufactured by the immersion method of the invention in  $\text{K}_2\text{SO}_4/\text{KCl}$  and  $\text{K}_2\text{SO}_4/\text{KCl}/\text{KNO}_3$  baths.

## DETAILED DESCRIPTION OF THE INVENTION

The methods and apparatus of the invention relate to glassmaking processes and devices. Specifically, the methods and apparatus are improvements to existing glass bottle making processes and devices that allow the production of glass bottles with the superior strength characteristics provided by chemical strengthening. Some embodiments do not require substantial changes to existing bottle making facilities. The benefits of using the methods and apparatus of the invention include higher strength bottles per unit weight of glass than prior art methods. Alternatively, less glass may be used to make bottles of the same strength using the methods of the invention rather than using prior art methods. While the examples and description provided herein are directed to the manufacture of glass bottles, it should be understood that the invention may be applicable to any sort of glass articles, including but not limited to: glass jars, drinking or wine glasses or any glassware, glass jugs, and glass dinnerware, prescription lenses, imaging lenses, optical fibers, and automobile and building windows, for example.

Figure 2 is a flow chart of a method of strengthening glass according to one embodiment of the invention. The bottle forming steps 310 may be performed as described above in the background section. However, it has been found that the blow-and-blow bottle formation process may form superior bottles than the press-and-blow process because of defects on the inside of the bottles caused by contact between the plunger and the interior surface of the bottles may occur when using the press-and-blow method. These defects may become the weak points in bottles strengthened by the methods of the invention, and thus the blow-and-blow process may be preferable for bottle formation. However, the strengthening methods of the invention can be beneficially used on bottles formed with the press-and-blow and the blow-and-blow processes.

Immediately after a bottle has been formed, its temperature is typically above the annealing point. In some embodiments, the bottles may then be dipped in a molten salt bath 320 after they have been formed. In some embodiments, the bottles may be flame polished prior to being dipped in the salt bath. As described in further detail below, as a bottle is passed through the flame polishing section of a glass strengthening system according to an embodiment of the invention, the flames can be moved via a mechanical means perpendicular to the direction of movement of the bottle. In some embodiments, a two-step flame polishing method may be used. The first step is performed, for example, while the glass articles are on the conveyor. This step may include flame polishing of the sides and the flutes at the top of, for example, a glass bottle. The second step may include flame polishing the bottoms of the glass articles. This may be done by lifting the glass articles off of the conveyor and running them over a flame. Flame polishing including this second step may eliminate defects in, for example, knurls (i.e., the ridges on the bottom of a glass bottle).

Figure 3 illustrates the benefits that may be achieved using a flame polishing step according to an embodiment of the invention. This plot was created using flat glass plates that were damaged with a diamond stylus to induce 50-micron defects. One set of plates were subjected to flame polishing using a methane/oxygen flame. A second set of plates were subjected to flame polishing using an acetylene/air flame. A third set of plates, the control plates, were not flame polished. A fourth set of plates were neither etched to induce defects nor flame polished. The glass plates were then subjected to stress until they fractured, and the fracture stress was recorded for each of the glass plates.

Figure 3 is a Weibull plot showing the results of these tests. The abscissa of the plot is a measure of applied stress and the ordinate is a measure of the probability of fracture. The flame

16

polished plates withstood approximately as much stress as the plates with no induced defects, and were superior in strength to the control plates. Plates polished with the methane/oxygen flame were slightly superior in strength to those polished with acrylene/air and the plates with no induced defects. The plates polished with acrylene/air were slightly inferior in strength to the plates with no induced defects.

In some embodiments of the invention, the temperature of the bottles immediately before being dipped in a salt bath may be between, for example, 500 °C and 600 °C. In an alternative embodiment of the invention, the temperature of the bottles may be above the annealing point of the glass. In yet another embodiment of the invention, the bottles may be at least about 25°C above the annealing point of the glass. In another embodiment, the temperature of the bottles may be between 510 °C and 590 °C. In yet another embodiment, the temperature of the bottles may be between, for example, 510 °C and 550 °C. In one exemplary embodiment, the temperature of the bottles immediately before dipping in the salt bath may be about 540°C. The dipping time can be much shorter than prior art dipping times. The salt bath temperature may be higher than the bottle temperature. In one embodiment, the salt bath temperature may be between, for example, 550°C and 750°C. In one exemplary embodiment, the salt bath may be at a temperature of approximately 610 °C. In another embodiment, the salt bath temperature may be at about 600°C. As discussed above, the prior art typically requires immersion for between ½ hour to 4 hours. In step 320, however, the bottles may be immersed for less than one minute. Preferably, the bottles may be dipped in the salt bath for between 0.5 seconds and 30 seconds. In another embodiment, the bottles may be dipped in the salt bath for between about 3 seconds and 5 seconds. In another preferred embodiment, the bottles may be dipped for less than 10 seconds.

In one embodiment, the molten salt bath can be a potassium salt bath with a melting point above the temperature of the strengthening lehr used during the heat treatment step 330. A preferred composition for the molten salt bath is 45 mol% potassium nitrate ( $\text{KNO}_3$ ) and 55 mol% potassium chloride ( $\text{KCl}$ ). This composition may be at liquid at a temperature of between  $550^\circ\text{C}$  to  $750^\circ\text{C}$ , thus allowing uniform coating of the bottles dipped into the bath maintained in this temperature range. This composition is semi-solid at a temperature of about  $520^\circ\text{C}$ , thus allowing the salt to remain in place as a roughly uniform coating on the bottle during the heat treatment step 330, which allows roughly uniform strengthening and prevents salt buildup within the strengthening lehr. Other suitable salt bath compositions can be determined by those of ordinary skill in the art using phase diagrams and routine experimentation. For example, other suitable salt bath compositions may include  $\text{KCl/KNO}_3/\text{K}_2\text{SO}_4$ . In general, the salt bath composition is preferably such that the bath is liquid at a temperature of about  $50^\circ\text{C}$  above the annealing point of the glass, and solid or semi-solid at the temperature of the strengthening lehr.

As illustrated in Figure 4, the strength of the glass following a strengthening treatment is dependent on temperature and the time that the glass is treated. Therefore, there are trade-offs when performing any glass strengthening methods. For example, when strengthening glass at a lower temperature, the glass may not become as strong as it otherwise would if the glass was treated at a high temperature such as, for example, the annealing temperature of the glass. When treating glass at a higher temperature, however, the maximum glass strength varies more dramatically with time, and therefore, tolerances may need to be adjusted accordingly.

Thus it is contemplated that the ion-exchange reaction can occur at or below the annealing point provided that the temperature is maintained for a time shorter than or equal to about 15 to 20 minutes. However, because both the ion-exchange reaction and the relaxation

that occurs at or above the annealing point are dynamic processes, significant deviation from this general rule can be achieved. Thus the invention should not be considered limited by any particular temperature for any particular time.

The time and temperature of the heat-treatment step may be adjusted depending on the requirements of the production facility, with greater temperatures and shorter times used when needed for more rapid production, and longer heat-treatment times used to further increase the strength of the treated glass. In another embodiment, the glass article is maintained at the strain point temperature for times in the range of 5 to 30 minutes. Increasing the exposure time at these temperatures may result in decreasing strengths of the glass article. As the exposure time increases at any temperature, the strength of the glass article may gradually increase to a maximum value, and then may decrease. This maximum strength time decreases with temperature increases.

The bottles may then be subjected to heat treatment 330 in a strengthening lehr. This heat treatment may accelerate the ion-exchange process. The temperature of the strengthening lehr is preferably less than or approximately equal to 150°C less than the strain point of the glass. More preferably, the temperature of the strengthening lehr may be set between about 130°C below the strain point of the glass and the strain point of the glass. In one embodiment, the temperature of the strengthening lehr is approximately more than 30 °C below the strain point temperature of the glass. Alternatively, the temperature of the strengthening lehr is approximately more than 10°C less than the strain point temperature of the glass. In one embodiment, the glass can remain in the lehr for a time between 15 minutes and 55 minutes. More preferably, the glass can remain in the lehr for a time between 20 and 50 minutes. In some embodiments, depending on the type of glass used, the glass may remain in the strengthening

lehr for a duration of about 30 minutes. Larger bottles may need to be processed at slower speeds, and therefore, they may be in the lehr for longer time periods. Since they may be exposed for a longer time period, the temperature may need to be reduced to optimize the strengthening process. However, the duration of the ion-exchange reaction can be more or less than that depending on the temperature selected, as described above with reference to Figure 3. After the heat treatment 330, the bottles may be cooled 340 and the salt removed 350 in the same manner as described above. As will be described in additional detail below with reference to Figure 10, the glass may be cooled slowly in the lehr.

In a one exemplary method according to an embodiment of the invention, formed glass articles emerge from the glass forming process at a temperature of approximately 650°C. The temperature may be greater or lesser depending on the particular processes and materials used, bottle design and wall thickness. In one embodiment, a minimal amount of a hot-end tin oxide coating may be applied to the glass article at a coating thickness of anywhere between, for example, 20 and 45 ctu (coating thickness units). Application of the tin oxide coating may form a texture on the surface of the glass to allow for the cold-end coating, applied later, to adhere to the surface of the glass bottle. The coating thickness unit associated with one ctu for tin oxide is about 4 angstroms. This coating may be applied using any method known in the glass-making arts, typically at a location between bottle formation and the lehr entrance. Alternatively, the tin oxide coating may be applied prior to flame polishing of the bottles, if flame polishing is used.

After depositing the tin oxide coating, the tin oxide-coated glass article may, in some embodiments, be flame polished to melt and heal any surface imperfections in the glass. Alternatively, any acceptable flame polishing rate may be used. Flame polishing may also increase the temperature of the glass article to about 25°C above the annealing point of the glass,

or even more in some situations. In another embodiment of the invention, the bottles are not coated with the tin oxide. In some embodiments, after flame polishing and deposition of the tin oxide coating, the bottle temperature may be in excess of 550°C.

Chemical strengthening can occur either directly after applying the tin oxide coating or, alternatively, after flame polishing. To perform chemical strengthening, the article may be dipped into a salt bath. In one embodiment, the bottles are dipped into, for example, a 50% KNO<sub>3</sub>/50%KCl salt bath that is at a temperature of 610°C for about 1 second. Following the brief dip in the salt bath, the bottles may be transferred to a strengthening lehr that is at a temperature of, for example, between 480°C and 530°C. In another embodiment, the bottles can be placed in a strengthening lehr, the lehr temperature being between, for example, 490 °C and 520 °C. In alternative embodiments, the strengthening lehr may have a set-point temperature between about 150°C less than the strain point of the glass and about the strain point of the glass. The temperature of the strengthened article may be reduced in a cooling section of the lehr for approximately 25 minutes to 90°C. After cooling, the glass article is subsequently dipped in a water bath at 90°C for a predetermined duration to remove the excess salt. In one embodiment, the predetermined time can be, for example, 6 seconds to remove the excess salt. Excess water may then be removed using, for example, an air curtain.

A cold-end coating such as, for example, a stearate or polyethylene coating may be applied to the warm article. Other cold-end coatings may include adding a low-temperature cold-end coating such as silicone wax, polyethylene, polyvinyl alcohol, stearic acid, or oleic acid, or any other cold-end coating known to those in the bottle making art to provide lubricity and prevent scuffing of the bottle through the inspection and filling lines. The coated article may then be transferred to a decorating line to apply a low temperature organic decorative coating. In

an embodiment using a polyethylene coating, the coating may not need to be cured. In one embodiment, a protective scuff-resistant coating may be applied to the surface of the glass article. In an alternative embodiment, a post-end coating may be applied after a caustic washing process prior to filling the process of the bottle. This post-end coating may be, for example, a polyethylene coating. In the case of refillable bottles, these coatings may be applied after each caustic wash cycle. One example of an acceptable bottle coating that may be utilized as a post-end coating is the Tegoglas 3000+ Anti-Scuff Coating offered for sale by Atofina.

It should be noted that the greater strength of the glass in bottles manufactured using the techniques described herein may allow less glass to be used while preserving equivalent bottle strength. For example, using a computer model, bottles weighing 170 grams manufactured using prior art methods can be reduced to 110 grams while preserving the strength of the bottles. It should also be noted that the superior strengthening methods of the present invention may be enhanced and bottle weight further reduced by designing bottles that exploit the high strength characteristics of the outer surfaces of bottles prepared by these methods. Bottles can be designed to take advantage of these characteristics using computer modeling, for example, finite element analysis methods known to those skilled in the art.

Figure 5 is a flow chart of a method according to an alternative embodiment of the invention. The bottle forming steps 210 may be performed as described above in the background section. Immediately after a bottle has been formed, its temperature is typically above the annealing point. For example, in one embodiment, the bottle may have a temperature of approximately 600°C. The bottle formation process frequently results in glass defects, generally by thermal shock by contact with a colder material such as a mold or a dead plate. These defects can be stress concentrators and are often the cause of low strength in glass bottles.

The bottle may then be flame polished 220 in a similar manner to that described above with respect to the salt bath dipping methods. The flame polishing can be performed by any method known in the art. For example, the flame polishing may be performed by passing the bottle past a series of nozzles emitting a combustible gas, for example, air-methane, oxy-methane, air-acetylene, or oxy-acetylene. Other components such as moisture may be added to the flame stream to accelerate the flaw blunting process. Flame polishing is useful for accomplishing either or both of two objectives: (1) healing surface flaws in the glass surface, and (2) raising the surface temperature of the glass to a temperature may be raised well beyond the annealing point, thus minimizing any breakage during the subsequent spraying process described below.

Flame polishing 220 may be accomplished by applying the flame to the bottle for 0.1-10 seconds, preferably from 0.1-5 seconds. Most preferably, the flame is placed in contact with the surface of the bottle for a time sufficient to cause any sharp cracks to melt and become rounded. The flame polishing step 220 may increase the surface temperature of the bottle well above the annealing point of the glass. In one embodiment, the bottles may be heated, for example, to a temperature above 650°C. Alternatively, flame polishing 220 may increase the surface temperature of the bottles to between 550°C and 650°C. The benefits of flame polishing have been described with reference to Figure 3, above.

In alternative embodiments for dipping, spraying, or other salt application methods, instead of, or in addition to, flame polishing, one method of the invention may use microwave surface heating to heal flaws in the glass, to introduce controlled surface residual stress, to speed up ion-exchange strengthening after a salt has been sprayed on, to strengthen by dealcalization via a sprayed-on ammonium-sulfate compound, and/or to raise the surface temperature to

accelerate a subsequent ion-exchange strengthening process. Glass surface heating by microwave irradiation may be facilitated by application of a microwave sensitive coating to the surface of the glass article. Particularly useful in ion-exchange reactions is a microwave sensitive coating that also contains exchangeable potassium ions.

In one embodiment of the invention, the bottles may then be sprayed with a salt solution while the surface temperature of the bottle is greater than the annealing temperature. In one example, the bottles may have a surface temperature of between about 550°C and 650°C when the annealing temperature is about 550°C. Preferably, the surface temperature of the glass is hot enough that spraying the salt solution does not cool the glass below the strain point (the strain point may be, for example, 530°C). Preferably, the solvent evaporates prior to or immediately on contact with the surface of the bottle. A preferred temperature range is greater than about 50°C above the annealing point of the glass. An alternative temperature range is greater than about 50°C above the strain point of the glass. In yet another alternative embodiment, the surface temperature of the glass is any temperature at which the spraying step does not result in inducing defects in the glass article.

The salt solution may be any solution known to those skilled in the art to be useful in ion-exchange glass strengthening. A preferred salt solution is a 50 wt.% aqueous solution of potassium phosphate ( $K_3PO_4$ , anhydrous). This solution is preferred because a 50 wt.% potassium phosphate solution is achievable at room temperature, thus it would be unnecessary to heat the solution. However, a 62 wt.% potassium phosphate solution may be achieved at about 50°C, and such a solution may also be used in the invention. Alternatively, the salt solution may be 45 wt.% potassium phosphate, 10 wt.% sodium phosphate ( $Na_3PO_4$ ), and the remainder may

he water. In another embodiment, the salt solution comprises a mixture of potassium sulfate ( $K_2SO_4$ ), potassium chloride (KCl), and potassium nitrate ( $KNO_3$ ).

In an alternative embodiment, the bottles may be flame sprayed rather than sprayed in a conventional manner. In the flame spray embodiment, a powdered salt, for example, potassium phosphate salt, may be sprayed upon the surface of the bottles. By using a flame spraying embodiment according to an embodiment of the invention, it is contemplated that spraying kinetics may be increased and breakage reduced with the flame spray method because this method does not require the heat of the bottle to evaporate the water in the atomized droplet. Powdered salt may be melted in a flame to form a fine molten atomized spray. In an alternative embodiment, rather than powdered salt, the flame spray may use a salt solution. The flame can be any flame known to those in the art, for example, methane, oxy-methane, acetylene, oxy-acetylene or hydrogen. Examples of flame spray devices that may be useful for use in the present invention include devices disclosed in and devices referred to in U.S. Patent Nos. 4,674,683 and 5,297,733, or any other flame spray device known to those of skill in the art.

In yet another alternative embodiment, the bottles may be electrostatically sprayed. In this embodiment, an electric potential is applied to the sprayer, for example, a negative potential, and the bottle is grounded. Droplets of salt solution or molten salt become negatively charged and are attracted to the neutral bottle, thus providing an even coating to the bottle. Examples of electrostatic spray devices that may be useful for use in the present invention include devices disclosed in and devices referred to in U.S. Patent Nos. 5,759,271 and 5,704,554, or any other electrostatic spray device known to those of skill in the art.

As in dipping methods previously described, the flame polished, sprayed bottles may then be subjected to heat treatment 240 in a strengthening lehr or any other suitable environment such

as an oven. Preferably, the heat treatment is at a temperature less than the strain point of the glass. For example, if the strain point is 530°C, heat treatment in the strengthening lehr may be at a set point temperature of 510°C for 20 to 25 minutes. As another example, heat treatment in the strengthening lehr may be 520°C for 15 minutes. However, other embodiments include heat treatment at a temperature greater than 80°C below the strain point of the glass or heat treatment at a temperature greater than the strain point of the glass. In a preferred embodiment, the strengthening lehr may have a temperature between about 150°C below the strain point, more preferably between about 130°C below the strain point temperature and about the strain point temperature of the glass. In each of these embodiments, as discussed with reference to Figure 4, there is a balancing that must be achieved between speeding up the ion-exchange reaction, which happens at higher temperatures, and preventing relaxation of the glass surface, which is best achieved at lower temperatures. For example, at the annealing point, relaxation of the glass surface occurs in approximately 15 minutes.

In a preferred embodiment, the temperature of the heat treatment is less than the melting point of the salt that was sprayed onto the surface of the bottles in order to prevent the salt from dripping down the side of the bottle. This prevents an uneven distribution of the salt on the bottle surface, and thus prevents uneven strengthening, and it also prevents pooling of the salts inside the lehr. The aqueous spray application of the salt forms a tenacious coating on the glass bottle not easily removed by abrasive contact. After the bottles have been subjected to heat treatment 240, they are cooled 250 and washed with water 260 to remove the remaining salt residue. Other additional processing may be the application of decorative coatings and the application of second protective coatings, as described above.



Figure 6 is a bar chart comparing the benefits of various glass strengthening methods according to an embodiment of the invention. As is apparent from the chart in Figure 6, the use of an ion-exchanged method including flame polishing can produce glass having a greater strength than ion-exchanged methods and flame polishing methods alone. The experiments conducted to achieve this chart are described in further detail below in Example 12.

Figure 7 is a plan view of a glass strengthening system 700 according to one embodiment of the invention. The glass forming machine 712 receives raw materials for making a particular type of glass via input 711. The glass forming machine 712 may be configured to process drops or individual gobs of glass into formed glass articles as described in the background. Formed glass articles emerge from the forming machine in the shapes of, for example, bottles 701. Other glass articles, such as, for example, jugs, jars, and vases, to name a few examples, can be formed in the same manner.

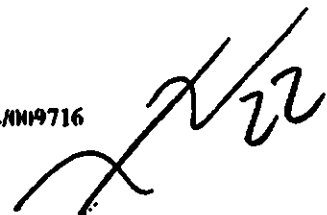
After the bottles 701 are output from the forming machine 712, they may be monitored, and defective bottles may be discarded via output 713. After an initial inspection, the bottles can be coated with a coating at 721. The application of the coating at 721, can include, for example, the application of a tin oxide coating. The tin oxide coating may be applied to a thickness of, for example, between about 20 and 45 ctu. In some embodiments, coating of the bottles 701 is optional. In yet another embodiment, the bottles 701 can be flame polished prior to applying the tin oxide coating at 721.

After the coating of the bottles 721 is complete, the bottles may be passed through center transfer wheel 722 onto the cross conveyor 730. On the cross conveyor 730, bottles 701 may be flame polished using flame polishing means 731. The flame polishing means 731 can be any type of flame polishing apparatus that can be configured to be used on an industrial

manufacturing line. Flame polishing of the bottles is optional, but in some embodiments it may be preferred because of the potentially beneficial effects that flame polishing has on the strength of the final glass product. It has been found that flame polishing is especially beneficial for bottles with large defects, which tend to weaken the glass article. Flame polishing can substantially diminish the breakage rate because flame polishing eliminates those large defects, thus strengthening the bottles that are most likely to break due to imperfections, as described above. In some embodiments, the bottles do not need to have the sides flame polished. For example, beer bottles may not need to have their sides flame polished in all embodiments of the invention. Therefore, a decision of whether to flame polish a bottle may depend on the type of bottle being polished.

After the bottles have been flame polished using flame polishing apparatus 731, the bottles may be arranged at the front of thelehr so that a glass article moving means 741, such as, for example, a robotic machine arm, illustrated by circles 741 may pick the glass bottles up from a staging area in front of thelehr, and dip them into salt bath 751. Alternatively, salt bath 751 may be replaced by a mechanism for spraying the bottles with a salt solution, or alternatively a means for flame-spraying the bottle. In an alternative embodiment, prior to being dipped in the salt solution, the glass bottles 701 can be moved over optional flame polishing means 732, so that the bottom of the bottles 701 can be flame polished. The bottles may be flame polished at any acceptable flame polishing rate.

After the bottles have been flame polished using optional flame polishing means 732, and dipped in the salt bath 751, the bottles may be placed into the strengthening lehr 760. In one embodiment of the invention, strengthening lehr can have a strengthening section 761 and a cooling section 762. Alternatively, there may be more than one strengthening section 761, and



more than one cooling section 762. An exemplary annealing lehr configuration is illustrated in Figure 8A. In this embodiment, there are six annealing sections and three cooling sections. The annealing lehr in Figure 8A was used to perform comparison testing as described with respect to Example 11, discussed below. the traditional annealing lehr illustrated in Figure 8A may include a first zone having a set point temperature of 555°C. A glass article may remain in each zone for, for example, three minutes. A second zone can have a set point temperature of 550°C. A third zone can have a set point temperature of, for example, 540°C. A fourth zone can have a set point temperature of about 500°C. A fifth zone can have a set point temperature of 460°C. A sixth zone can have a set point temperature of 430°C. The seventh, eighth, and ninth zones can have set point temperatures of 320°C, 200°C, and 130°C, respectively. Any known annealing temperature profile may be used in comparing the effects of maintaining the set point temperatures of the lehr below the temperature of the glass articles, and preferably between about 150°C below the strain point temperature of the glass and about the strain point temperature of the glass. More preferably, the temperature may be between about 130°C less than the strain point temperature of the glass and about the strain point temperature of the glass.

An example of a strengthening lehr is illustrated in Figure 8B. In this embodiment, there are five strengthening sections and four cooling sections. A strengthening lehr may include a first, second, third, fourth and fifth zone each having a set point temperature of about 500°C. A sixth zone may have a set point temperature of, for example, 470°C. The seventh, eighth, and ninth zones can have set point temperatures of, for example, about 320°C, 200°C, and 130°C, respectively. Other strengthening temperature profiles may be used in connection with the methods of the present invention.

A number of trials were performed using a simulated factory environment. In order to simulate the production line, after being formed in the forming machine 712, the bottles were preheated. In one example, a 200 mL bottle was flame treated at 4" per second, preheated at 500°C for five minutes, dipped in a salt bath at 615°C, and strengthened in a Lehr 760 for 20 minutes at 500°C. The average temperature of this bottle prior to this treatment was 501°C and after this treatment was 451°C. In another example, a 200 mL bottle was flame polished at 4" per second, and was preheated for five minutes at 590°C. The surface temperature of the bottle prior to the treatments was 501°C, and following the treatment was 525°C. In another example, a 200mL bottle was flame polished at 4" per second, preheated at a temperature of 500°C for five minutes and was dipped in a salt bath, the salt bath being at a temperature of 615°C. The temperature of the bottle prior to this treatment was 496°C, and the temperature following this treatment was 489°C. In yet another example, a 200 mL bottle was flame polished at 4" per second, and was preheated at a temperature of 500°C. The bottle temperature before the treatment was 494°C and following the treatment, the bottle temperature was 463°C. In yet another example, a 200 mL bottle was only flame polished at 4" per second. The bottle temperature prior to flame polishing was 500°C and the temperature following the flame polishing was 471°C. In another example, a 200 mL bottle was flame polished at a rate of 4" per second, was preheated at a temperature of 500°C and was strengthened in a Lehr 760 for 20 minutes at 500°C. The bottle temperature prior to this treatment was 492°C and following the treatment was 452°C. All of the temperatures referred to above are average bottle temperatures based on measurements taken from at least three locations on the bottle.

An optional three-step salt removal process (where each of the steps may be used alone or in combination with any of the other steps) may begin with a first spray rinse step after the bottles leave the Lehr 760. After bottles 701 have been sprayed, they can be moved by machine arms 761 and immersed in a warm water bath to loosen any remaining salt on the bottles 701. In one embodiment, after being immersed, bottles 701 may be spray rinsed again to remove any remaining salt. After any optional rinsing steps have been performed, the bottles may be dried with, for example, a jet of air. After being dried, the bottles 701 can be output via conveyor 790 to a post-coating machine (not illustrated).

Figure 9 is a perspective view of a mechanism for dipping bottles in a system for strengthening bottles according to one aspect of the invention. Mechanical arm 741 may be configured to move, for example, two rows of bottles 701 using grasping elements 742. Mechanical arm can then dip the two rows of bottles 701 into the salt bath 751. Bottles 701 may be dipped in a salt bath for a duration between, for example, one minute or less. Alternatively, the bottles may be dipped for a time between about 0.5 seconds and about 30 seconds. Preferably, the bottles may be dipped for a time between about 3 seconds and 5 seconds. In yet another preferred embodiment, the bottles may be dipped for a time less than about 10 seconds. After a predetermined time has passed, mechanical arm 741 may remove the bottles 701 from the salt bath 751. In one embodiment of the invention, the bottoms of bottles 701 may be flame polished. In an alternative embodiment, the bottoms of bottles 701 are not flame polished.

Figure 10 is a perspective view of a mechanism for rinsing bottles 770 in a system for strengthening bottles according to one aspect of the invention. The system for rinsing bottles 770 can include a mechanical arm 771, having a grasping member 772. In one embodiment of the invention, the grasping member 772 can be configured to grasp two rows of bottles 701 and

rinse them in a bath of warm water. In one embodiment, water in the rinse tank 780 can be at a temperature of, for example, 90 °C. Water in the rinse tank 780 may be any temperature close to the temperature of the bottles when they leave thelehr 760, as described above. After rinsing the bottles in the rinse tank 780 for a predetermined time period, the mechanical arm 771 may place the rinsed bottles 701 on a conveyor 751 for further handling.

In one experiment using all of the aforementioned strengthening processes, except for the chemical ion exchange process, the average temperature of five bottles was taken at various points in the system. Temperatures of the glass bottles were taken at the following stages of the process: the glass gob ("A"), glass blank ("B"), take outs ("C"), machine end ("D"), prior to the hot-end coater ("E"), after the hot-end coater ("F"), at the center transfer wheel ("G"), at the lehr entrance ("H"), and at the end of the lehr ("I"). As mentioned above, these temperature measurements were taken without the flame polishing on the conveyor between the forming machine 712 and the transfer wheel 722, or the transfer wheel 722 and the lehr entrance ("H") or a chemical ion exchange process or the flame polishing being used at the lehr entrance ("I").

The results represent an average of five bottles having the capacities of 200 mL bottle, a 300 mL bottle, a 330 mL bottle, a 350 mL bottle, and a 1 L bottle. The results for these different bottle capacities at each of the different locations are illustrated in Table 1.

| Location | 200 mL (°C) | 300 mL (°C) | 330 mL (°C) | 350 mL (°C) | 1 L (°C) |
|----------|-------------|-------------|-------------|-------------|----------|
| A        | 1030.5      | 1007.3      | 1038.8      | 1016.8      | 1016.4   |
| B        | 796.5       | 740.3       | 804.7       | 749.1       | 776.4    |
| C        | 687.4       | 634.1       | 665.6       | 657.4       | 622.1    |
| D        | 683.4       | 618.8       | 614.8       | 636.2       | 605.0    |
| E        | 679.2       | 618.7       | 638.5       | 620.6       | 604.5    |

|   |       |       |       |       |       |
|---|-------|-------|-------|-------|-------|
| F | 673.9 | 615.3 | 621.2 | 630.8 | 594.4 |
| G | 637.4 | 592.8 | 581.8 | 570.8 | 578.0 |
| H | 605.3 | 579.3 | 561.9 | 570.9 | 571.4 |
| I | 172.5 | 147.4 | 179.3 | 145.6 | 176.4 |

TABLE 1

The 200 mL bottle had a cooling rate at cold-end per inch °C of 0.38. The conveyor speed of the conveyor between the forming machine 712 and the transfer wheel 722 was 34" per second. The conveyor speed between the transfer wheel 722 and thelehr entrance was 26" per second. The 300 mL bottle had a cooling rate at cold-end per inch °C of 0.29. The conveyor speed of the conveyor between the forming machine 712 and the transfer wheel 722 was 21" per second. The conveyor speed between the transfer wheel 722 and thelehr entrance was 16" per second. The 330 mL bottle had a cooling rate at cold-end per inch °C of 0.40. The conveyor speed of the conveyor between the forming machine 712 and the transfer wheel 722 was 34" per second. The conveyor speed between the transfer wheel 722 and thelehr entrance was 25" per second. The 350 mL bottle had a cooling rate at cold-end per inch °C of 0.35. The conveyor speed of the conveyor between the forming machine 712 and the transfer wheel 722 was 22" per second. The conveyor speed between the transfer wheel 722 and thelehr entrance was 16" per second. The 1 L bottle had a cooling rate at cold-end per inch °C of 0.37. The conveyor speed of the conveyor between the forming machine 712 and the transfer wheel 722 was 15" per second. The conveyor speed between the transfer wheel 722 and thelehr entrance was 11" per second.

One advantage of using the aforementioned system is that there is no need for substantial modification to production lines to set a manufacturing facility up to manufacture glass articles

using the methods of the present invention. For example, with the addition of bottle moving means, as well as, for example, a salt bath or spraying means, many of the features of the present invention may be utilized. Additionally, an annealing lehr may be used as a strengthening lehr merely by modifying the temperatures within the lehr. Finally, using the invention, glass may be selectively made using either annealing methods or the methods of the present invention depending on the requirements of the glass to be manufactured.

### EXAMPLES

A number of examples are presented herein using various methods according to the present invention. In order to simulate conditions on an actual production line, the bottles were preheated after being formed in a forming machine and prior to being dipped and placed into a furnace. In actual implementations of the invention, it is assumed that preheating would be unnecessary, and that the bottles may have an average temperature approximating the temperature to which the bottles were preheated to. Additionally, rather than using a furnace, a lehr may be used, as described above. The temperatures referred to herein are set-point temperatures unless otherwise stated. Table 2 presents the results of 10 trials run using various furnace temperature settings in association with the present invention.

| Run | SnO <sub>2</sub><br>Coat<br>(ctu) | Flame<br>Polish | Preheat       |              | Salt<br>Bath<br>Temp<br>(°C) | Dip<br>Time<br>(s) | Strength<br>ening<br>Temp.<br>(°C) | Wt.<br>(g) | Burst<br>Press.<br>(psi) | Control<br>Burst<br>Press.<br>(psi) | Delta<br>(psi) |
|-----|-----------------------------------|-----------------|---------------|--------------|------------------------------|--------------------|------------------------------------|------------|--------------------------|-------------------------------------|----------------|
|     |                                   |                 | Time<br>(min) | Temp<br>(°C) |                              |                    |                                    |            |                          |                                     |                |
| 1   | 40                                | Yes             | 1             | 510          | 600                          | 1                  | 520                                | 3.0        | 739                      | 427                                 | 312            |
| 2   | 40.4                              | Yes             | 5             | 510          | 630                          | 1                  | 520                                | 2.6        | 738                      | 433                                 | 305            |
| 3   | 41.6                              | No              | 5             | 550          | 615                          | 1                  | 500                                | 1.5        | 724                      | 443                                 | 281            |
| 4   | 40.2                              | Yes             | 5             | 510          | 600                          | 1                  | 480                                | 7.2        | 763                      | 484                                 | 279            |
| 5   | 40.4                              | No              | 5             | 510          | 600                          | 1                  | 520                                | 5.6        | 760                      | 486                                 | 274            |
| 6   | 40                                | No              | 1             | 550          | 615                          | 1                  | 500                                | 1.5        | 701                      | 427                                 | 274            |
| 7   | 40                                | Yes             | 1             | 510          | 600                          | 1                  | 480                                | 3.86       | 735                      | 472                                 | 263            |
| 8   | 41.2                              | Yes             | 5             | 510          | 600                          | 1                  | 520                                | 5.2        | 745                      | 495                                 | 249            |

25

|    |      |    |   |     |     |   |     |     |     |     |     |
|----|------|----|---|-----|-----|---|-----|-----|-----|-----|-----|
| 9  | 41   | No | 5 | 550 | 615 | 1 | 500 | 1.3 | 736 | 506 | 230 |
| 10 | 40.6 | No | 5 | 550 | 615 | 1 | 500 | 1.3 | 662 | 434 | 228 |

TABLE 2

The type of glass used in making the bottles used in these examples was flint glass. As one of ordinary skill in the art will appreciate, varying the type of glass used to make glass articles using any of the methods according to the various embodiments of the invention, may require some optimization because of potentially different characteristics of the glass, such as, for example different annealing temperatures, different strain point temperatures, and different resulting strengths. The composition of the flint glass used in the following examples is summarized in Table 3, below.

| FLINT GLASS COMPOSITION        |                 |
|--------------------------------|-----------------|
| OXIDES                         | COMPOSITION (%) |
| SiO <sub>2</sub>               | 72              |
| Al <sub>2</sub> O <sub>3</sub> | 1.6             |
| Fe <sub>2</sub> O <sub>3</sub> | 0.7             |
| Na <sub>2</sub> O              | 13              |
| K <sub>2</sub> O               | 0.86            |
| MgO                            | 0.20            |
| CaO                            | 10              |
| SO <sub>3</sub>                | 0.21            |
| BAO                            | 0               |
| Cr <sub>2</sub> O <sub>3</sub> | 0.0010          |
| TiO <sub>2</sub>               | 0.019           |
| SrO                            | 0               |
| Annealing Point                | 540°C           |

TABLE 3

## EXAMPLE 1

In a first example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40  $\mu$ m. To simulate conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 510 °C for one minute. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 600 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottles was 3.0 grams. The amount of salt that adheres to the bottle is a function of both the temperature of the salt bath and the temperature of the bottle before it is placed in the salt bath. After being dipped, the bottles underwent a heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of

520 °C. This process was repeated three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace but were not subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure of the strengthened bottles created using the temperatures mentioned above was 739 psi, as opposed to the average burst pressure applied to the control bottles of 427 psi, accounting for a burst pressure difference of 312 psi. These results are illustrated generally in the Weibull plot in Figure 11. The abscissa of the plot of Figure 11 is a measure of applied pressure and the ordinate reflects the probability of failure. Figure 11 shows that bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 2

In a second example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40.4  $\mu\text{m}$ . To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 510 °C for five minutes. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 630 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 2.6 grams. Using Example 1 as a basis for comparison, one can see that less salt adhered to the surface of the bottle in this Example because the temperature of the salt bath was higher than that used in Example 1. This relationship verifies that the amount of

salt that adheres to the bottle is a function of at least the temperature of the salt bath. After being dipped, the bottles underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 520 °C. This process was repeated three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure of the strengthened bottles created using the temperatures mentioned above was 738 psi, as opposed to the average burst pressure applied to the control bottles of 433 psi, accounting for a pressure difference of 305 psi. Thus, this Example further illustrates the advantages of using a short salt bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 12. Figure 12 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods

### EXAMPLE 3

In a third example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 41.6  $\mu\text{m}$ . To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 550 °C for five minutes. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 615 °C. The bottles were then

dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 1.5 grams. Using Example 1 as a basis for comparison, one can see that less salt adhered to the surface of the bottle in this Example because the temperature of the salt bath was higher than that used in Example 1, and the temperature of the bottle was also greater than the temperature of the bottle used in Example 1. This relationship verifies that the amount of salt that adheres to the bottle is a function of both the temperature of the salt bath and the temperature of the bottle before it is placed in the salt bath. After being dipped, the bottles underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 500 °C. This process was repeated three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that bottles created using the temperatures mentioned above was 724 psi, as opposed to the average burst pressure applied to the control bottles of 443 psi, accounting for a burst pressure difference of 281 psi. Thus, this Example further illustrates the advantages of using a short salt bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 13. Figure 13 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 4

In a fourth example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40.2  $\mu\text{m}$ . To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 510 °C for five minutes. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50:50 KCl/KNO<sub>3</sub> and was kept at a temperature of 600 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 7.2 grams. Using Example 1 as a basis for comparison, one can see that more salt adhered to the surface of the bottle in this Example. After being dipped, the bottles underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 480 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that the strengthened bottles created using the temperatures mentioned above was 763 psi, as opposed to the average burst pressure applied to the control bottles of 484 psi, accounting for a burst pressure difference of 279 psi. Thus, this Example further illustrates the advantages of using a short salt bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in

the Weibull plot in Figure 14. Figure 14 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods

#### EXAMPLE 5

In a fifth example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40.4  $\mu\text{m}$ . To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 510 °C for five minutes. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 600 °C. The bottles were then dipped in the salt bath for 1 second. The weight of the salts that adhered to the bottle was 5.6 grams. After being dipped in the salt bath, the bottles underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 520 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they broke. The average pressure that the strengthened bottles created using the temperatures mentioned above was 760 psi, as opposed to the average pressure applied to the control bottles of 486 psi, accounting for a pressure difference of 274 psi. Thus, this Example further illustrates the advantages of using a short salt bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in

Figure 15. Figure 15 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 6

In a sixth example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40  $\mu\text{m}$ . In this example, the bottles were not flame polished. To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 550 °C for one minute. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 615 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 1.5 grams. After being dipped, the bottle underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 500 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that the strengthened bottles created using the temperatures mentioned above was 701 psi, as opposed to the average burst pressure applied to the control bottles of 427 psi, accounting for a burst pressure difference of 274 psi. Thus, this Example further illustrates the advantages of using a short salt bath

followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 16. Figure 16 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 7

In a seventh example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40 nm. To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 510 °C for one minute. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 600 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 3.86 grams. After being dipped, the bottles underwent a heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 480 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that the strengthened bottles created using the temperatures mentioned above was 735 psi, as opposed to the average burst pressure applied to the control bottles of 472 psi, accounting for a burst pressure difference of 263 psi. Thus, this Example further illustrates the advantages of using a short salt bath

followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 17. Figure 17 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 3

In a eighth example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 41.2  $\mu$ m. To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 510 °C for one minute. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 600 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 5.2 grams. After being dipped, the bottles underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 520 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that the strengthened bottles created using the temperatures mentioned above was 745 psi, as opposed to the average maximum burst pressure applied to the control bottles of 496 psi, accounting for a burst pressure difference of 249 psi. Thus, this Example further illustrates the advantages of using a short salt

bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 18. Figure 18 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 9

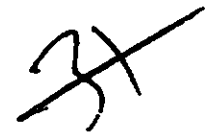
In a ninth example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 41.0  $\mu\text{m}$ . A tin oxide coating was then applied to the glass. The tin oxide coating had a thickness of 40  $\mu\text{m}$ . To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 550 °C for five minutes. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 615 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 1.3 grams. After being dipped, the bottle underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 500 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.

These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that the strengthened

bottles created using the temperatures mentioned above was 736 psi, as opposed to the average maximum burst pressure applied to the control bottles of 506 psi, accounting for a burst pressure difference of 230 psi. Thus, this Example further illustrates the advantages of using a short salt bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 19. Figure 19 shows that the bottles strengthened according to a method of the invention were stronger than those strengthened by prior art annealing methods.

#### EXAMPLE 10

In a tenth example according to an embodiment of the invention, five bottles were formed in the forming machine and were coated with a tin oxide hot-end coating. Then the bottles were flame polished. The tin oxide coating had a thickness of 40.6  $\mu\text{m}$ . To simulate the conditions as they might occur in an actual production line, the bottles were preheated at a temperature of 550 °C for five minutes. After being preheated, the bottles were dipped in a salt bath. The salt bath consisted of 50/50 KCl/KNO<sub>3</sub> and was kept at a temperature of 615 °C. The bottles were then dipped in the salt bath for 1 second. The average weight of the salt that adhered to the bottle was 1.3 grams. After being dipped, the bottles underwent heat treatment, which allows the reaction (i.e., the ion exchange between the sodium ions and the potassium ions) to take place more efficiently and more readily. The heat treatment was performed in a furnace for a time of 20 minutes and at a temperature of 500 °C. This process was repeated a total of three more times to construct a total of 20 strengthened glass bottles. Additionally, 20 control bottles were made. The 20 control bottles had been annealed using a prior art annealing process in an annealing furnace, but had not been subjected to chemical strengthening.



These forty bottles were then tested to determine how much internal pressure could be applied within the bottles before they burst. The average burst pressure that the strengthened bottles created using the temperatures mentioned above was 662 psi, as opposed to the average burst pressure applied to the control bottles of 434 psi, accounting for a burst pressure difference of 228 psi. Thus, this Example further illustrates the advantages of using a short salt bath followed by a period of heat strengthening in a furnace. These results are illustrated generally in the Weibull plot in Figure 20. Figure 20 shows the advantages of dipping the bottles in the salt solution prior to performing heat strengthening according to an embodiment of the invention. The abscissa of the plot in Figure 20 is a measure of applied stress and the ordinate is a measure of the probability of failure.

As described in some detail with respect to Examples 1-10, the weight of the salt adhering to the surface of each of the bottles depends on at least the following factors: (1) the temperature of the bottles and (2) the temperature of the salt bath. Based on another set of tests, it was determined that if too little salt adhered to the glass, there was a negative impact on the glass strength. Additionally, as the amount of salt adhering to the glass was increased, there was a clear indication of diminishing returns. The plot illustrated in Figure 21 illustrates this point. Therefore, in some embodiments of the invention, particularly where cost is a concern, temperatures of the salt bath and the bottles prior to dipping (or in alternative embodiments, spraying) may be tailored so that approximately, for example, between 1 and 3 grams of salt solution adheres to the bottles.

#### EXAMPLE 11

An additional set of tests was performed using both a 200 mL bottle and a 330 mL bottle. The test data appears in Table 4, below. This data demonstrates that as the temperature of the

glass during ion-exchange approaches, and reaches the annealing temperature of the glass, most of the benefits of using a chemical ion exchange process to strengthen glass are lost. In one case, the treated bottles had only 17 psi greater burst pressure than the control, and in another case, the treated bottle actually had 1 psi smaller burst pressure than the control. Therefore, this data demonstrates the relative importance of keeping the temperature of the glass below the annealing point after applying the salt coating to the glass, using for example a spraying or a dipping process. The strengthening lehr profiles and the annealing lehr profile used to produce the treated and control bottles are illustrated in Figures 8A and 8B, described above.

| Run | Pre-Heat |              | Time<br>(s) | Dip<br>Temp<br>(°C) | Strengthening |                      | SnO <sub>2</sub><br>Coat<br>(ctu) | Coat<br>Wt.<br>(g) | Wt./cm <sup>2</sup><br>(g/cm <sup>2</sup> ) | IE<br>(psi) | Ann.<br>(psi) | Delta<br>(psi) |
|-----|----------|--------------|-------------|---------------------|---------------|----------------------|-----------------------------------|--------------------|---------------------------------------------|-------------|---------------|----------------|
|     | min.     | Temp<br>(°C) |             |                     | min.          | Lehr<br>temp<br>(°C) |                                   |                    |                                             |             |               |                |
| 1   | 10       | 540          | 1           | 606                 | Ann. Profile  |                      | 42                                | 1.45               | 0.00474                                     | 680         | 681           | -1             |
| 2   | 1        | 540          | 1           | 630                 | Ann. Profile  |                      | 42.5                              | 1.9                | 0.00621                                     | 606         | 589           | 17             |

TABLE 4

EXAMPLE 12

Glass rods were subjected to 15 minutes of abrasion by tumbling them with sand for 15 minutes. A first set of rods were immersed for approximately 5 seconds in a molten bath of 48 mol% KNO<sub>3</sub> and 52 mol% KCl, then subjected to heat treatment at 520°C for 20 minutes. A second set of rods were immersed for approximately 5 seconds in a molten bath of 45 mol% KNO<sub>3</sub> and 55 mol% KCl, then subjected to heat treatment at 520°C for 20 minutes. Both sets of rods were cooled and the salt washed away with a cold water spray. The results of these two trials are shown in Figure 22. Control rods subjected to abrasion with no ion-exchange treatment were less strong than control rods not subjected to abrasion with no ion-exchange treatment, as expected. However, both sets of rods subjected to abrasion followed by ion-exchange treatment were much stronger than both sets of control rods.

72

### EXAMPLE 13

Glass rods were subjected to 15 minutes of abrasion by tumbling them with sand for 15 minutes. A first set of rods were immersed for approximately 5 seconds in a molten bath of 26.3 mol%  $K_2SO_4$  and 73.7 mol% KCl having a bath temperature of 730°C, then subjected to heat treatment at 520°C for 20 minutes. A second set of rods were immersed for approximately 5 seconds in a molten bath of 20.2 mol%  $K_2SO_4$ , 56.7 mol% KCl, and 23.1 mol%  $KNO_3$  having a bath temperature of 645°C, then subjected to heat treatment at 520°C for 20 minutes. Both sets of rods were cooled and the salt washed away with a warm water spray. The results of these two trials are shown in Figure 23. Control rods subjected to abrasion with no ion-exchange treatment were less strong than control rods not subjected to abrasion with no ion-exchange treatment, as expected. However, both sets of rods subjected to abrasion followed by ion-exchange treatment were much stronger than both sets of control rods. The rods dipped in the  $K_2SO_4$ /KCl/ $KNO_3$  bath were stronger than those dipped in the  $K_2SO_4$ /KCl bath.

### EXAMPLE 14

Glass bottles exited the forming machine at a temperature of approximately 600°C. The annealing point of the glass was 550°C, and the strain point was 530°C. The bottles were annealed and cooled to room temperature. The bottles were pre-heated to approximately 665°C, then sprayed with a 50/50 weight percent aqueous solution of potassium phosphate ( $K_3PO_4$ ). The bottles were then maintained at a temperature of about 500°C for approximately 45 minutes during the ion-exchange reaction. As the bottles exited the strengthening furnace, the salt solution was rinsed from the bottles with a cold-water spray.

Table 5, which follows, demonstrates the superior strength characteristics of bottles manufactured using the method described in this example, compared to control bottles prepared

by prior art methods. The impact resistance of the glass was measured with an AGR Pendulum Impact Tester using the straight bar-backstop. The tests were conducted in a progressive style, starting at a 20 in/sec level, and increasing in increments of 5 in/sec. One sample of bottles was used to measure the impact resistance at the shoulder contact. A second sample of bottles was used to measure the impact resistance at the heel contact. For the shoulder and heel impact data, each bottle was impacted at 10 locations equally spaced around the circumference at the shoulder contact.

|                                                             | Shoulder<br>Impact (ips) | Heel Impact<br>(ips) | Pressure<br>(psi) | Empty Drop<br>Height (in) | Filled Drop<br>Height (in) |
|-------------------------------------------------------------|--------------------------|----------------------|-------------------|---------------------------|----------------------------|
| Control<br>Bottles                                          | 74                       | 85                   | 389               | 35 (164<br>inches/sec)    | 26 (142<br>inches/sec)     |
| Bottles<br>manufactured<br>by the<br>method of<br>Example 1 | 113+                     | 112+                 | 730-              | 59 (214<br>inches/sec)    | 38 (171<br>inches/sec)     |

TABLE 5

While the preceding sections describe several embodiments, they are not meant to limit the scope of the invention in any way. For example, while particular embodiments were described using a dipping method, glass may be coated with a hot salt solution using, for example, a spray method, chemical vapor deposition, or flame spraying, as described above. Additionally, while the hot-end coating applied to the bottles was described as being tin oxide, any number of coatings may be applied to the glass. Alternatively, as described above, no coating need be applied to the glass.

Additionally, the invention was described in terms of strengthening glass bottles. The methods of the invention are equally applicable to strengthen all types of glass articles. It will be apparent to those skilled in the art that various modifications and variations can be made in the

23  
apparatus and methods of the invention without departing from their spirit and scope. It should also be noted that true definitions of the terms "strain point temperature" and "annealing point temperature" are not to be literally construed as one of ordinary skill in the art is aware that the rate of stress release in a glass will depend on the shear modulus, and therefore the definitions are merely an approximation. Each patent and other citation herein is incorporated by reference in its entirety.

We claim:

1. A method, comprising the steps of:  
forming a glass article from molten glass, the glass having an annealing point temperature;  
dipping the formed glass article in a molten salt bath, the salt bath comprising potassium ions wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the dipping step; and  
maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.
2. The method of claim 1, wherein the surface temperature of the glass article is at least about 25°C above the annealing point temperature of the glass.
3. The method of claim 1, wherein the glass article is dipped in the salt bath for less than about one minute.
4. The method of claim 1, wherein the glass article is dipped in the salt bath for about 10 seconds or less.
5. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 0.5 second and about 30 seconds.

- 3-1
6. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.
  7. The method of claim 1, wherein the salt bath comprises potassium nitrate and potassium chloride.
  8. The method of claim 7, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
  9. The method of claim 1, wherein the salt bath comprises potassium sulfate and potassium chloride.
  10. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
  11. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.
  12. The method of claim 1, wherein the salt bath has a temperature of between about 550°C and about 750°C.

13. The method of claim 1, wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
14. The method of claim 1, wherein the strain point temperature is about 530°C.
15. The method of claim 1, further comprising:  
flame polishing the glass article prior to dipping the glass article in the salt bath.
16. The method of claim 1, further comprising:  
after the step of maintaining, cooling the glass article, removing residual salt from the glass article and applying a protective scuff resistant coating to the surface of the glass article.
17. An apparatus, comprising:  
a staging area;  
a glass article moving means;  
a salt bath, the salt bath comprising molten salt, the glass article moving means being configured to move the glass article from the staging area and dip the glass article into the salt bath, the glass article moving means being configured to dip glass articles having a surface temperatures of at least the annealing point temperature of the glass, the glass article being configured to remain in the salt bath for less than about one minute; and  
a strengtheninglehr, the strengtheninglehr being configured to keep the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

18. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for about 10 seconds or less.
19. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 0.5second and about 30 seconds.
20. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 3 and about 5 seconds.
21. The apparatus of claim 17, wherein the salt bath comprises potassium nitrate and potassium chloride.
22. The apparatus of claim 21, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
23. The apparatus of claim 17, wherein the salt bath comprises potassium sulfate and potassium chloride.
24. The method of apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

25. The apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.
26. The apparatus of claim 17, wherein the strengthening Lehr is configured to keep the glass article at a temperature between the strain point temperature of the glass and about 130°C below the strain point temperature
27. The apparatus of claim 17, wherein the strain point temperature is about 530°C.
28. The apparatus of claim 17, further comprising:  
flame polishing means, the flame polishing means being configured to flame polish the glass articles.
29. The apparatus of claim 28, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:  
a second flame polishing means configured to flame polish the bottoms of the glass articles.
30. The apparatus of claim 17, further comprising:  
a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengthening Lehr.

26

31. A glass manufacturing facility comprising a glass forming machine configured to form glass articles, and a strengthening lehr, the improvement comprising:

a salt bath comprising molten salt, the glass articles being dipped into the salt bath for less than about one minute, the glass articles having a surface temperature at least above the annealing point temperature of the glass while being dipped in the salt bath; and

a strengthening lehr, the strengthening lehr being configured to maintain the temperature of the glass articles at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

32. The glass manufacturing facility of claim 31, further comprising:

a glass article handling means, the glass article handling means being configured to dip the glass articles in the salt bath.

33. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for about 10 seconds or less.

34. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for between about 0.5second and about 30 seconds.

35. The apparatus of claim 31, wherein the glass articles are dipped in the salt bath for between about 3 and about 5 seconds.

36. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium nitrate and potassium chloride.
37. The glass manufacturing facility of claim 31, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
38. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium sulfate and potassium chloride.
39. The glass manufacturing facility of claim 31, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
40. The glass manufacturing facility of claim 31, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.
41. The glass manufacturing facility of claim 31 wherein the strengtheninglehr is configured to maintain the glass articles at a temperature between the strain point temperature and about 130°C below the strain point temperature.
42. The glass manufacturing facility of claim 31 wherein the strain point temperature is about 530°C.

43. The glass manufacturing facility of claim 31, further comprising:

flame polishing means, the flame polishing means being configured to flame polish the glass articles.

44. The glass manufacturing facility of claim 43, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:

a second flame polishing means configured to flame polish the bottoms of the glass articles.

45. The glass manufacturing facility of claim 31, further comprising:

a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengtheninglehr.

46. A method for strengthening a glass article, comprising:

forming the glass article from molten glass, the glass having an annealing point temperature;

applying potassium ions to the surface of the glass article, wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the applying step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

47. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for less than about 10 seconds.

48. The method of claim 46, wherein the glass article is dipped in the salt bath for about 0.5 second and about 30 seconds.

49. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for between about 3 and about 5 seconds.

50. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by spraying potassium ions on the surface of the glass article.

51. The method of claim 50, wherein spraying comprises flame spraying.

52. The method of claim 50, wherein the spraying comprises electrostatic spraying.

53. The method of claim 50, wherein the spraying step comprises power spraying.

54. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by chemical vapor deposition (CVD).

38  
78

55. The method of claim 46, wherein the glass article is at a temperature of at least about 25°C above the annealing point of the glass during the applying step.

56. The method of claim 46, wherein the glass article is at a temperature of at least about 50°C above the annealing point of the glass during the applying step.

57. The method of claim 46, wherein the surface of the glass article is at a temperature of at least about 80°C above the annealing point of the glass during the applying step.

58. The method of claim 46 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.

59. The method of claim 46 wherein the strain point temperature is about 530°C.

60. The method of claim 46, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.

61. A method, comprising:  
forming a glass article from molten glass;  
dipping the formed glass article in a salt bath, the salt bath comprising potassium ions,  
the glass articles being dipped for less than about 30 seconds; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

62. The method of claim 61, wherein the glass article is dipped in the salt bath for about 20 seconds or less.

63. The method of claim 61, wherein the glass article is dipped in the salt bath for about 10 seconds or less.

64. The method of claim 61, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.

65. The method of claim 61, wherein the salt bath comprises potassium nitrate and potassium chloride.

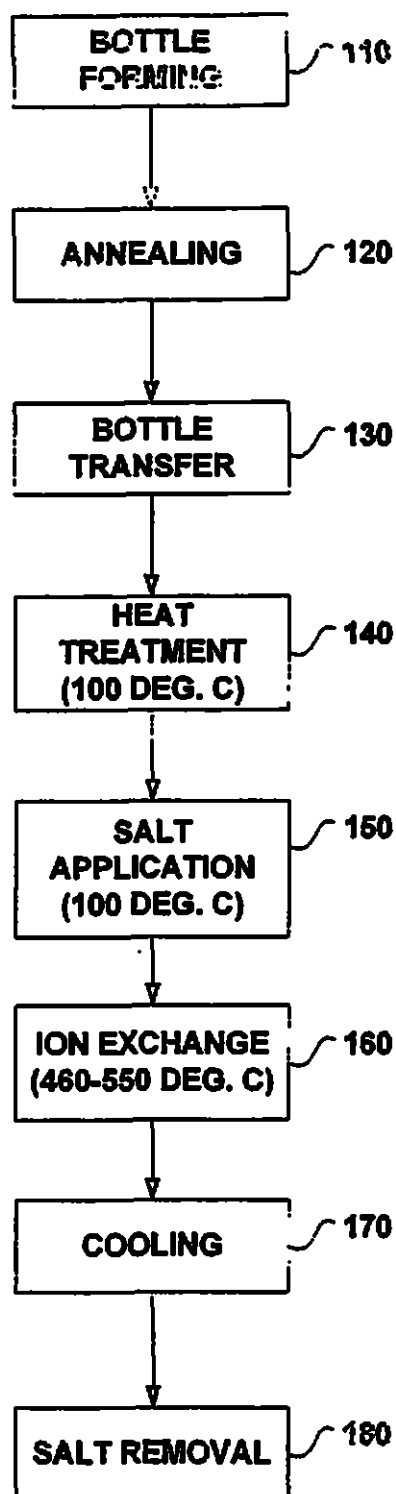
66. The method of claim 65, wherein the potassium nitrate is in the range of 40–60 mol% and the potassium chloride is in the range of 40–60 mol%.

67. The method of claim 61, wherein the salt bath comprises potassium sulfate and potassium chloride.

68. The method of claim 61, further comprising:  
flame polishing the glass article prior to dipping the article in the salt bath.

~~34~~

69. The method of claim 61, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.
70. The method of claim 61, wherein the salt bath has a temperature of between about 550°C and about 750°C.
71. The method of claim 61 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
72. The method of claim 61 wherein the strain point temperature is about 530°C.



**FIGURE 1**  
**(PRIOR ART)**

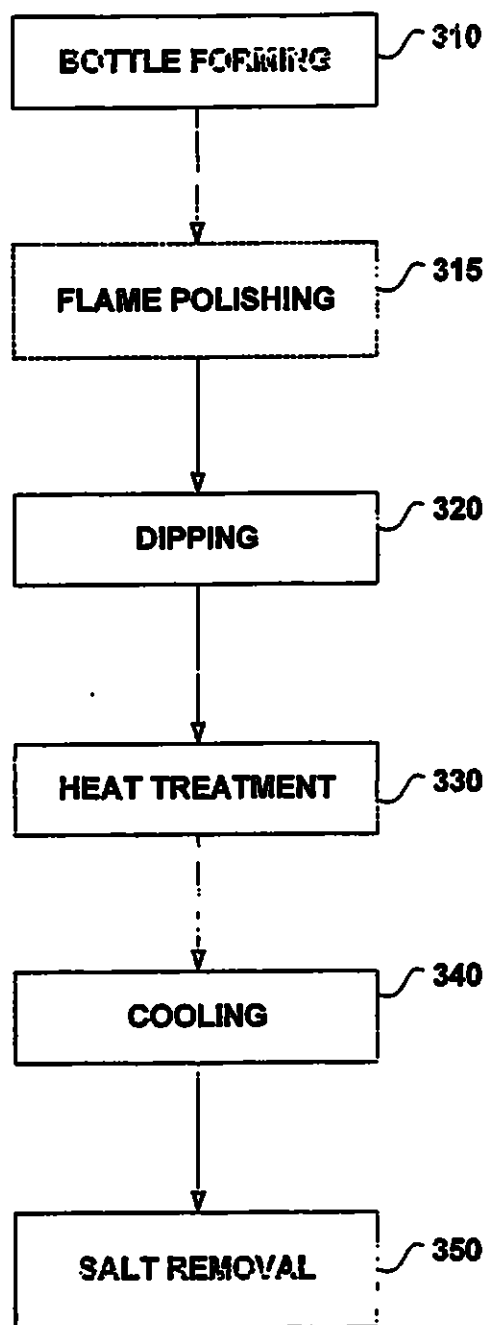


FIGURE 2

# FLAME POLISHING

Induced Defects (50 micron) on flat plates

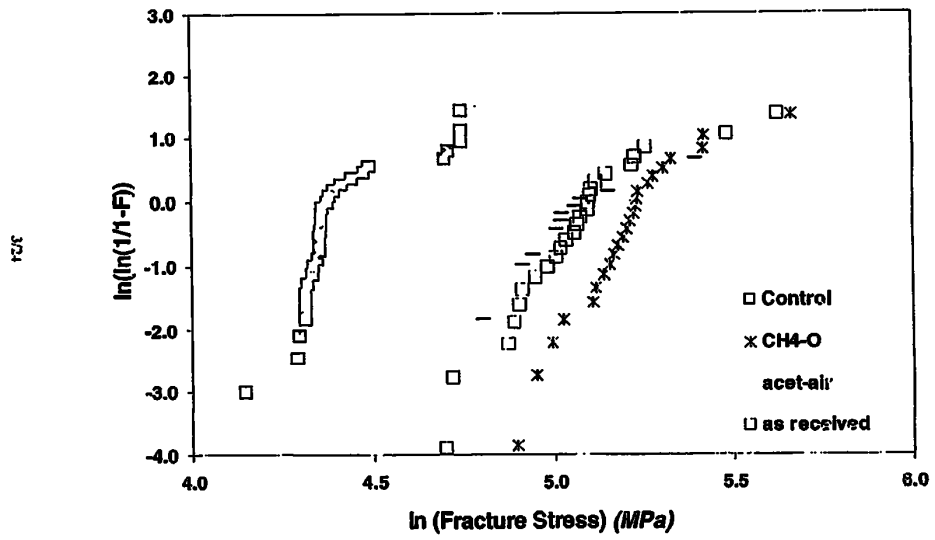


FIGURE 3

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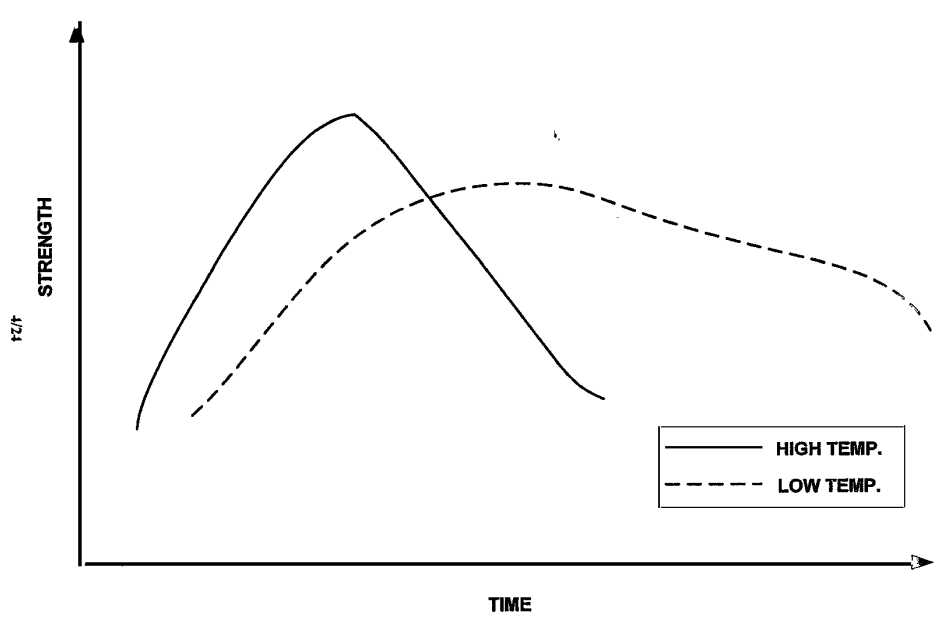
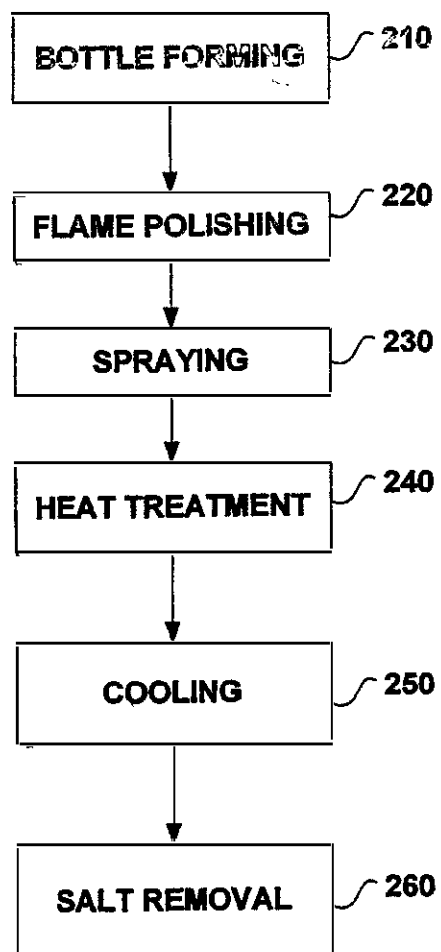
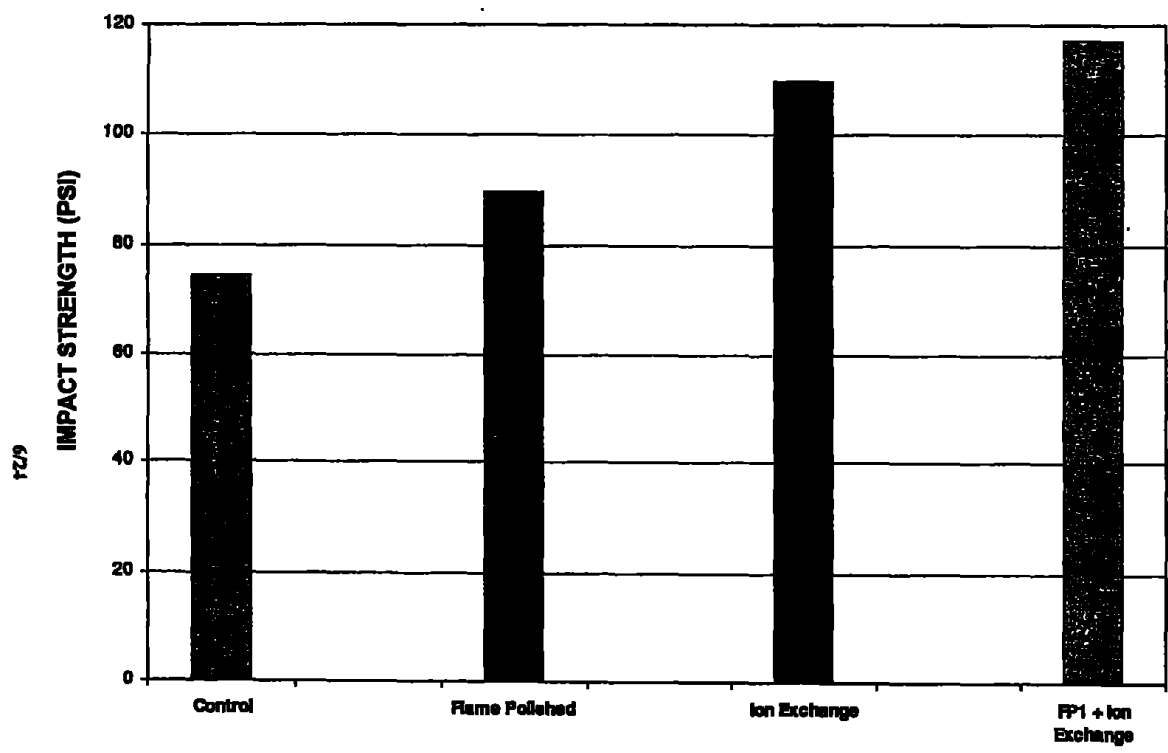


FIGURE 4

~~44~~**FIGURE 5**

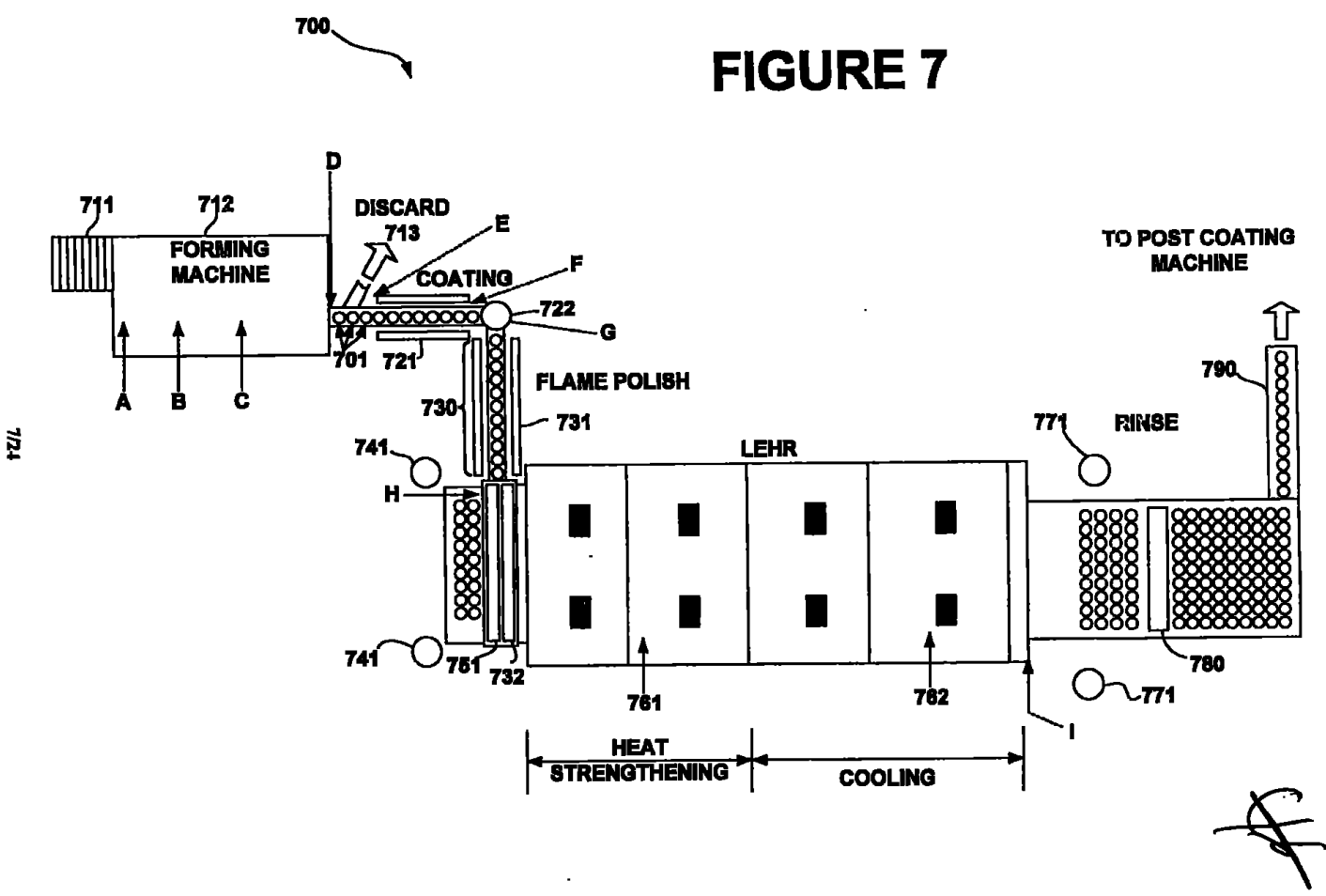
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**FIGURE 6**

6/24

FIGURE 7



7/24

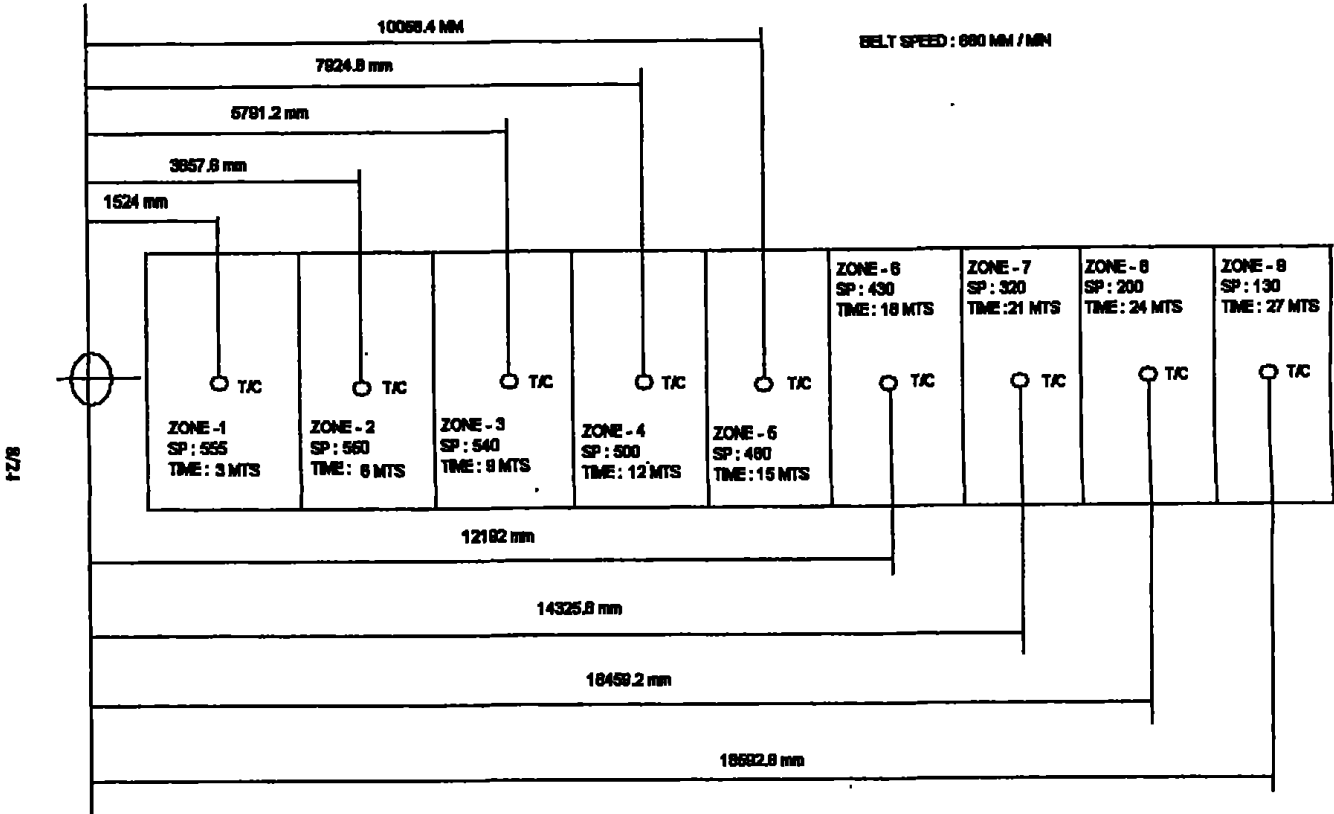


FIGURE 8A

~~FIGURE 8A~~

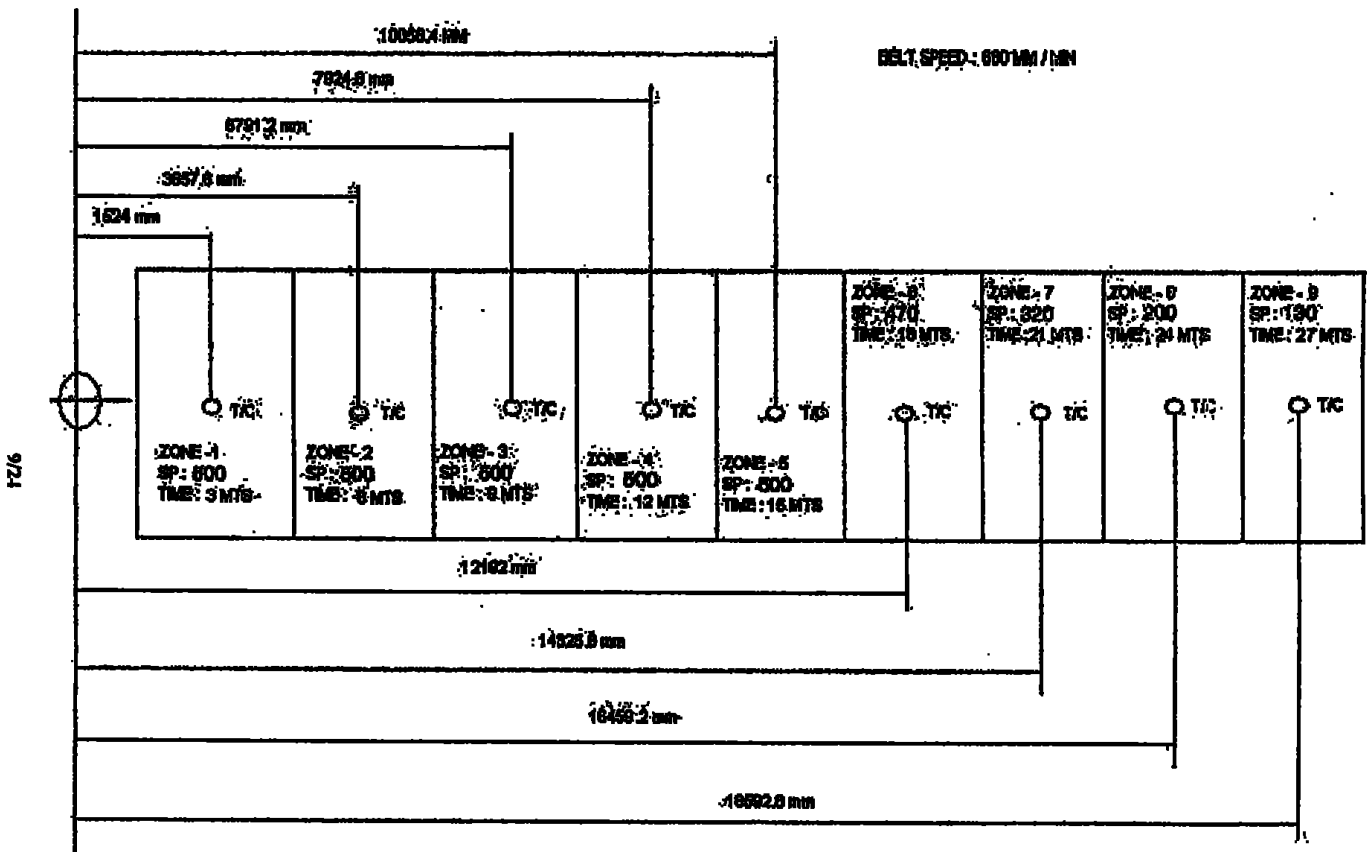
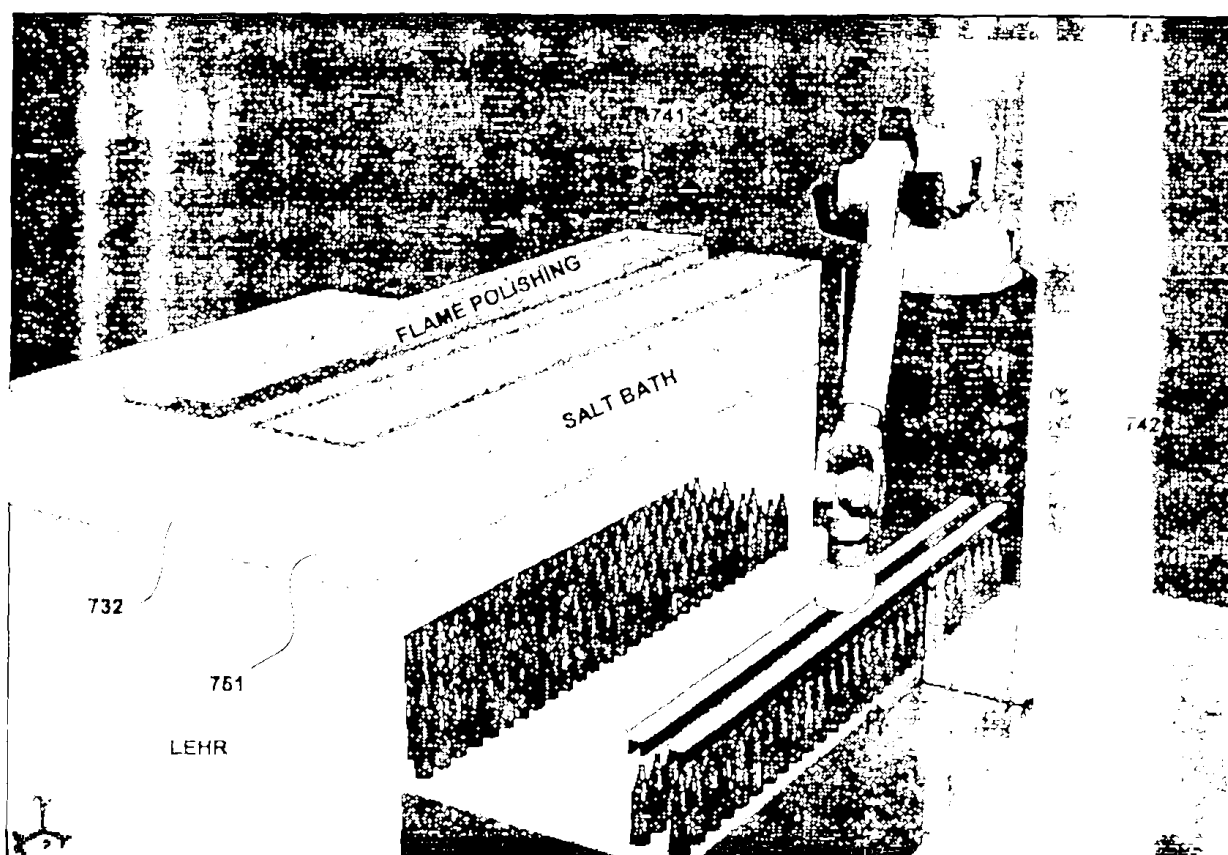


FIGURE 8B

**FIGURE 9**

17

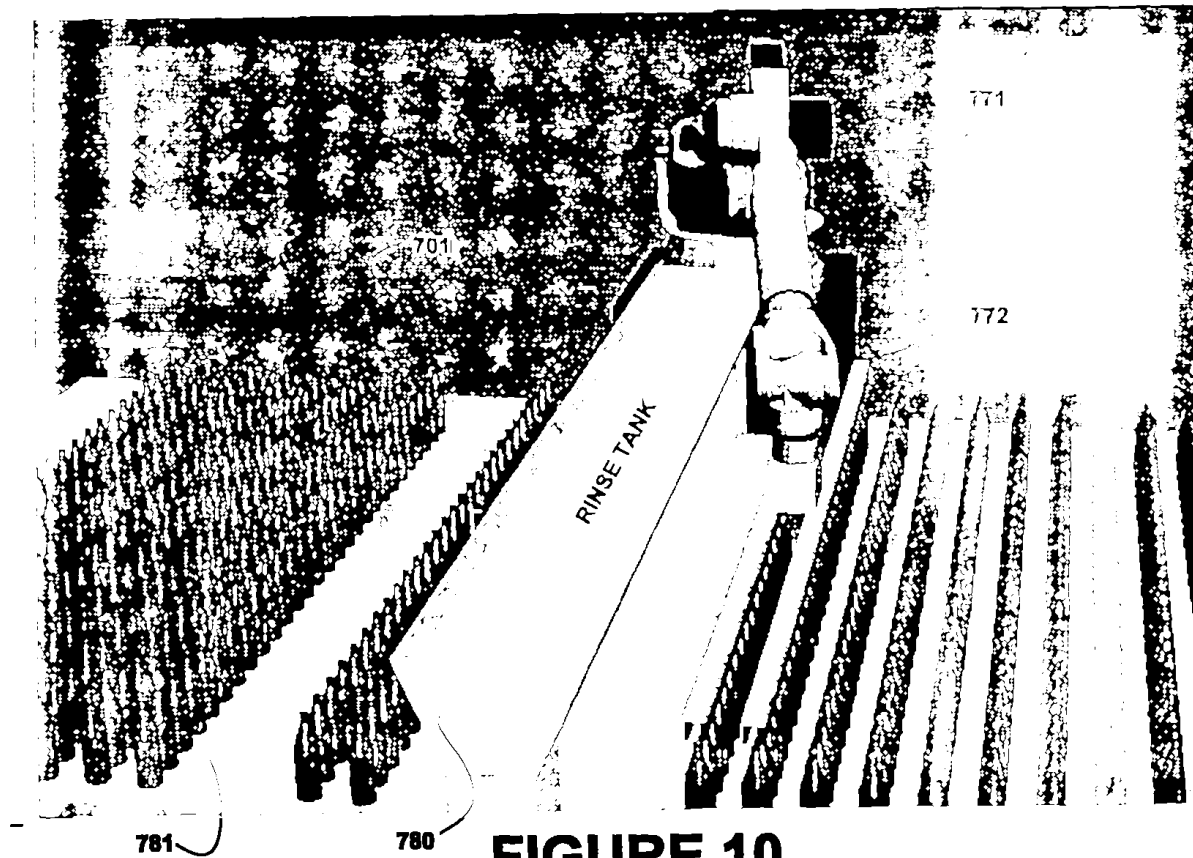


FIGURE 10

RUN NO. 1

Pre-heat 1 m @ 510°C; dip 600°C, Flame Polish - Side and Bottom, 4 in/sec, Strengthen 20 m 520°C

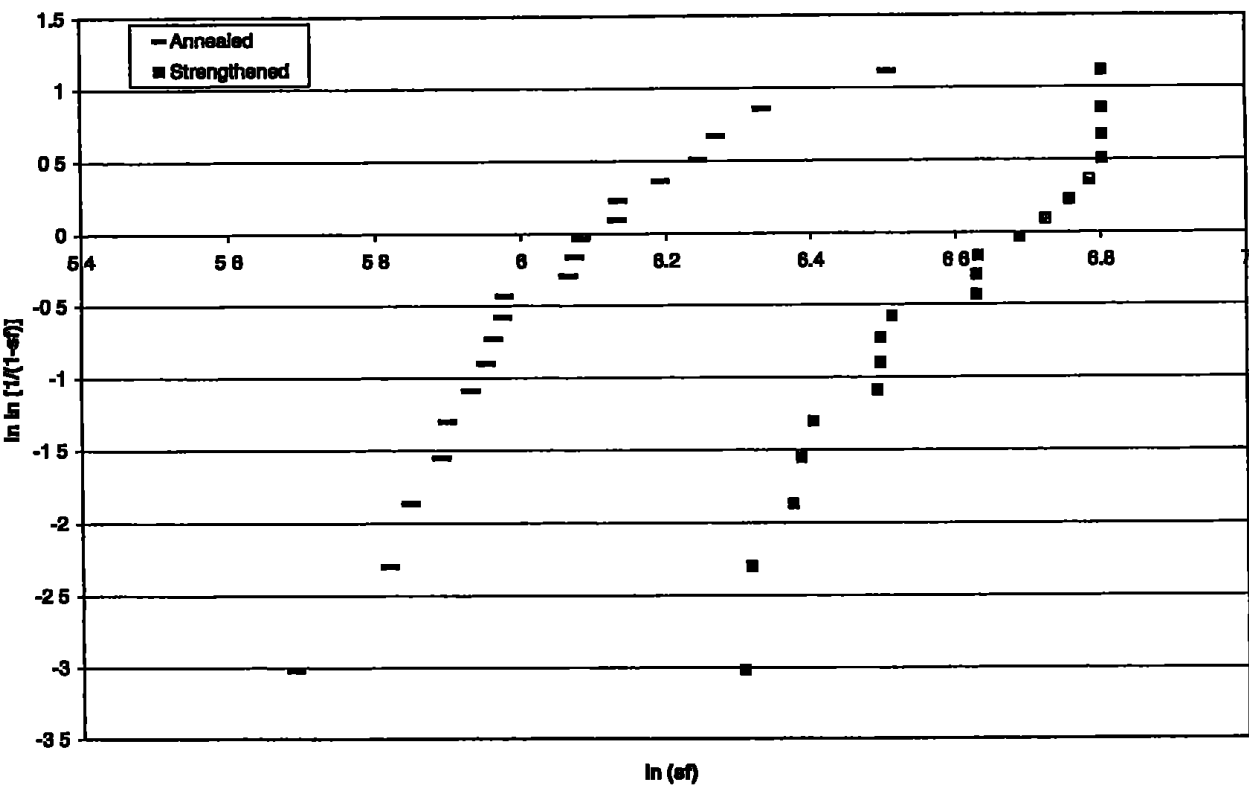


FIGURE 11

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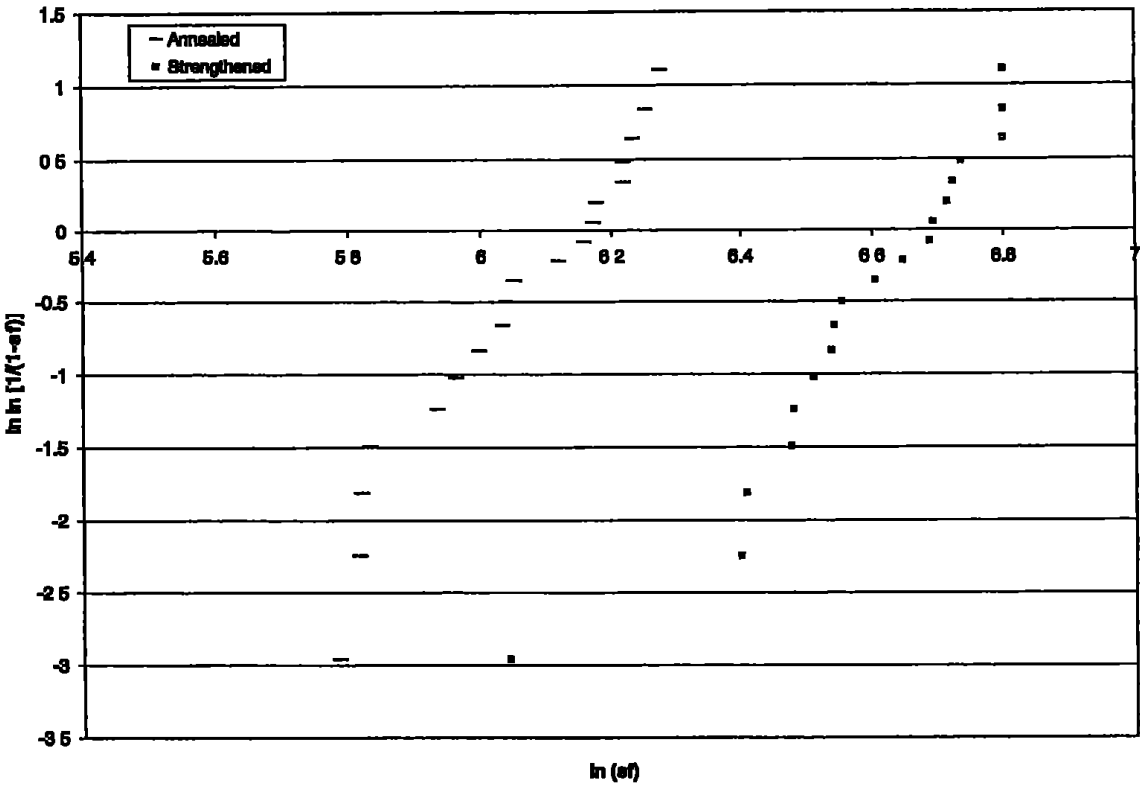
PCT/US2004/009716

7

12/24

RUN NO. 2

Pre-heat 5 m 510°C, dip 630°C, Flame Polish - Side and Bottom, 4 in/sec, Strengthen 20 m @ 520°C



13/24

FIGURE 12

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PCT/US2004/009716

RUN NO. 3

Pre-heat 5 m @ 550°C, dip 615°C, Strengthen 20 m @ 500°C

W/O 2004/094329

PCT/US2004/009716

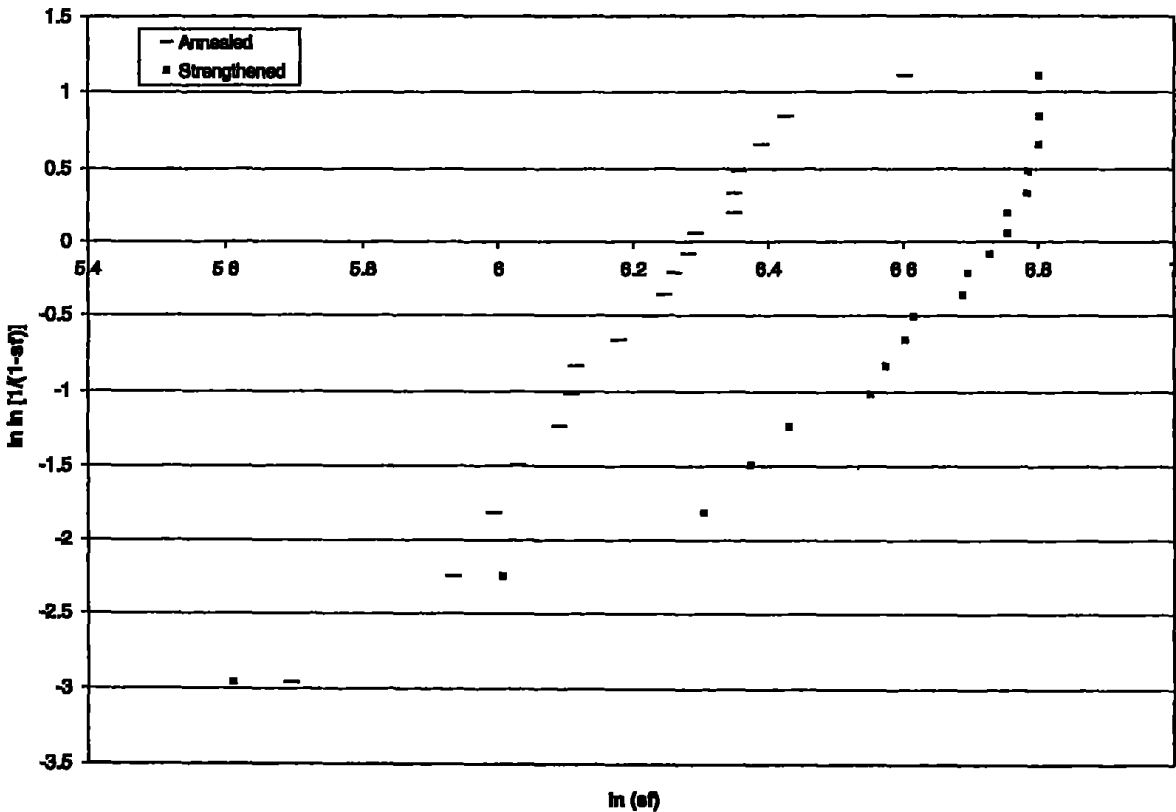


FIGURE 13

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RUN NO. 4

Pre-heat 5 m @ 510°C, dip 600°C, Flame Polish - Side and Bottom, 4 in/sec, Strengthen 20 m @ 480°C

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PCT/US2004/009716

*[Handwritten signature]*

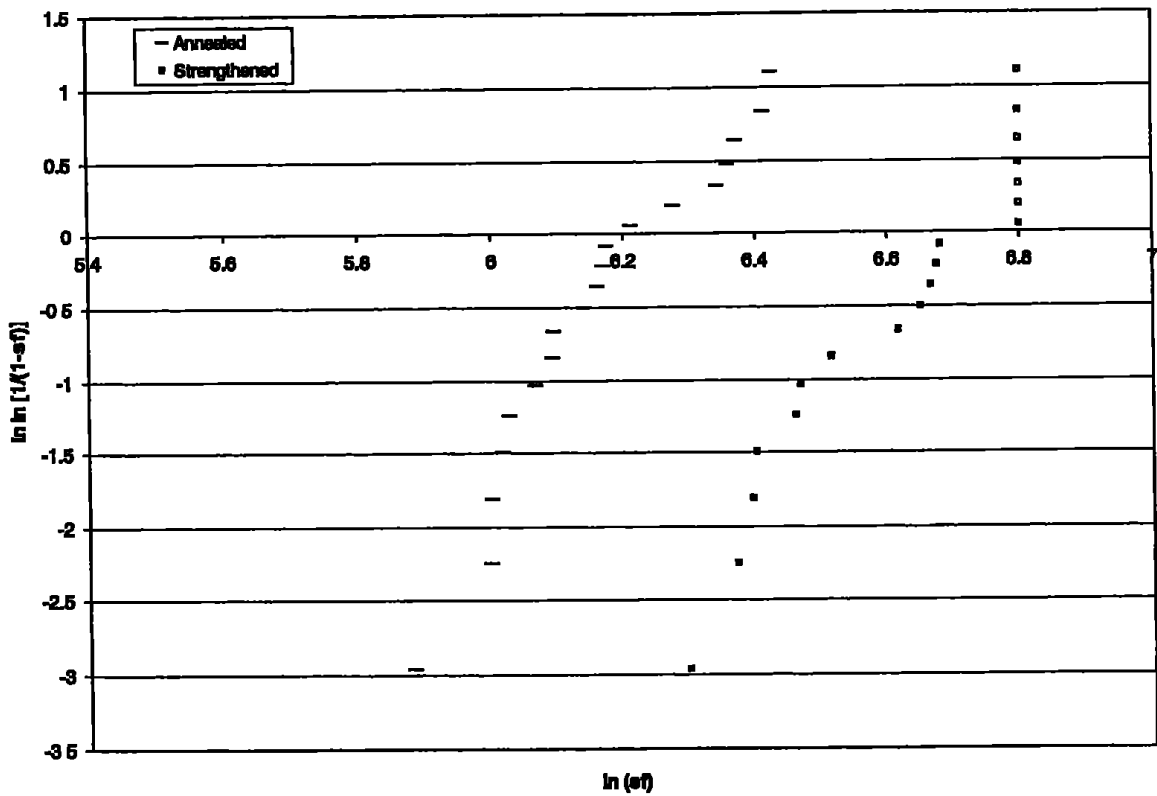


FIGURE 14

15/24

5

RUN NO. 5

Pre-heat 5 m @ 510°C, dip 600°C, Flame Polish - Side and Bottom, 4 in/sec, Strengthen 20 m @ 520°C

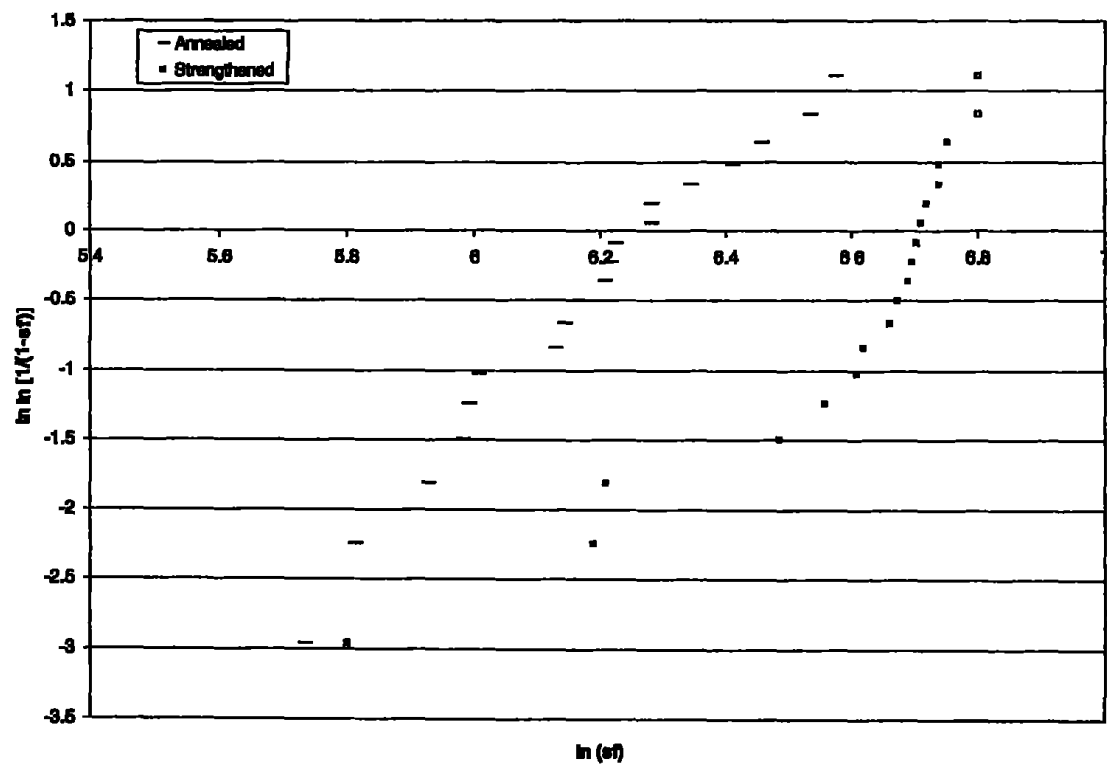


FIGURE 15

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RUN NO 6

Pre-heat 1 m @ 550°C, dip 615°C, Strengthen 20 m @ 500°C

W/O 2004/09A329

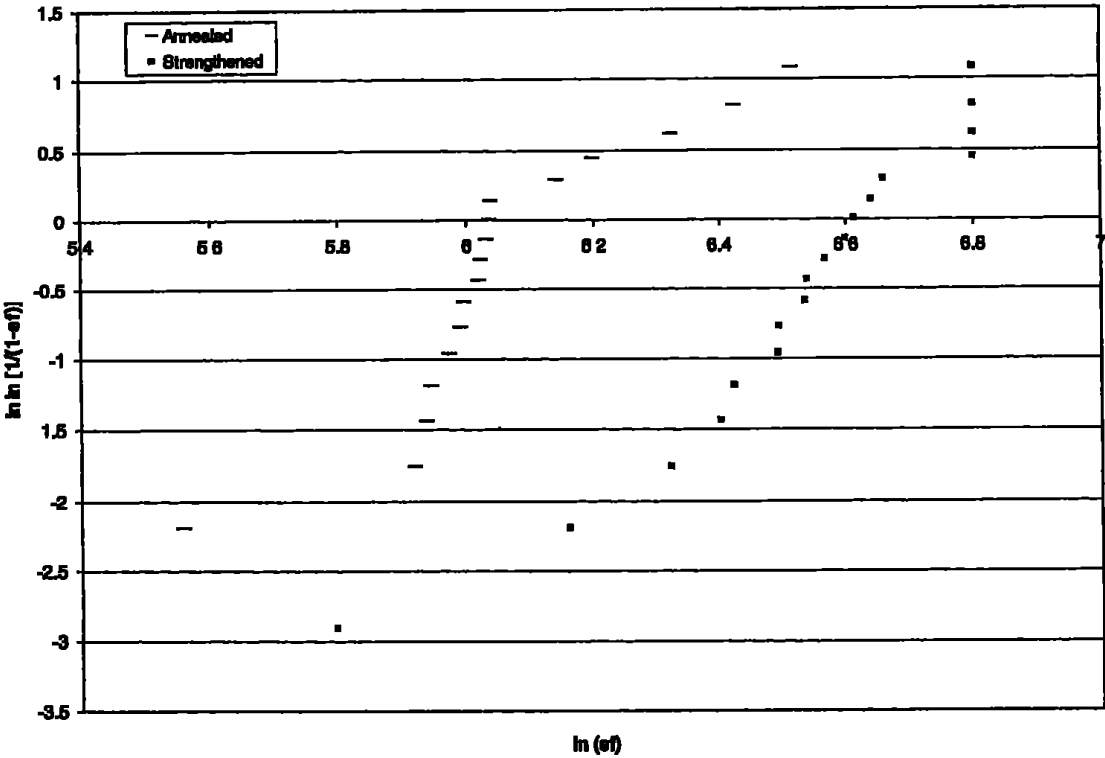


FIGURE 16

PCT/US2004/009716

76

57

RUN NO. 7

Pre-heat 1 m @ 510°C, dip 600°C, Flame Polish - Side and Bottom, 4 in/sec, Strengthen 20 m @ 480°C

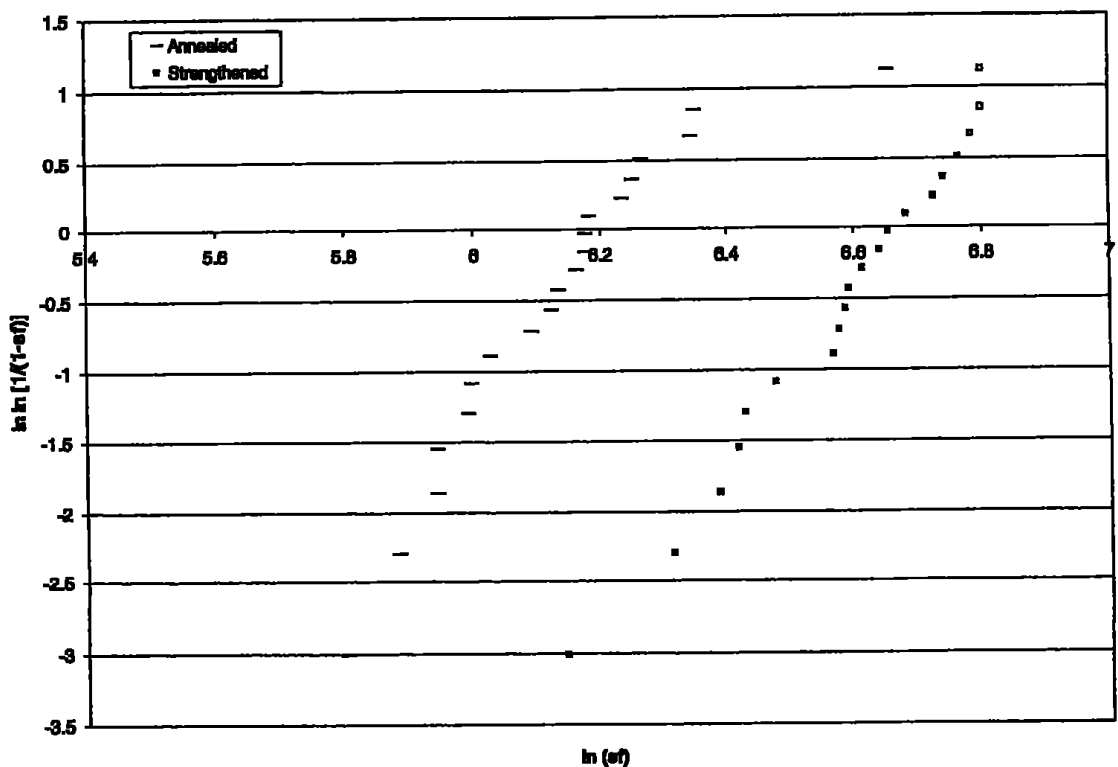


FIGURE 17

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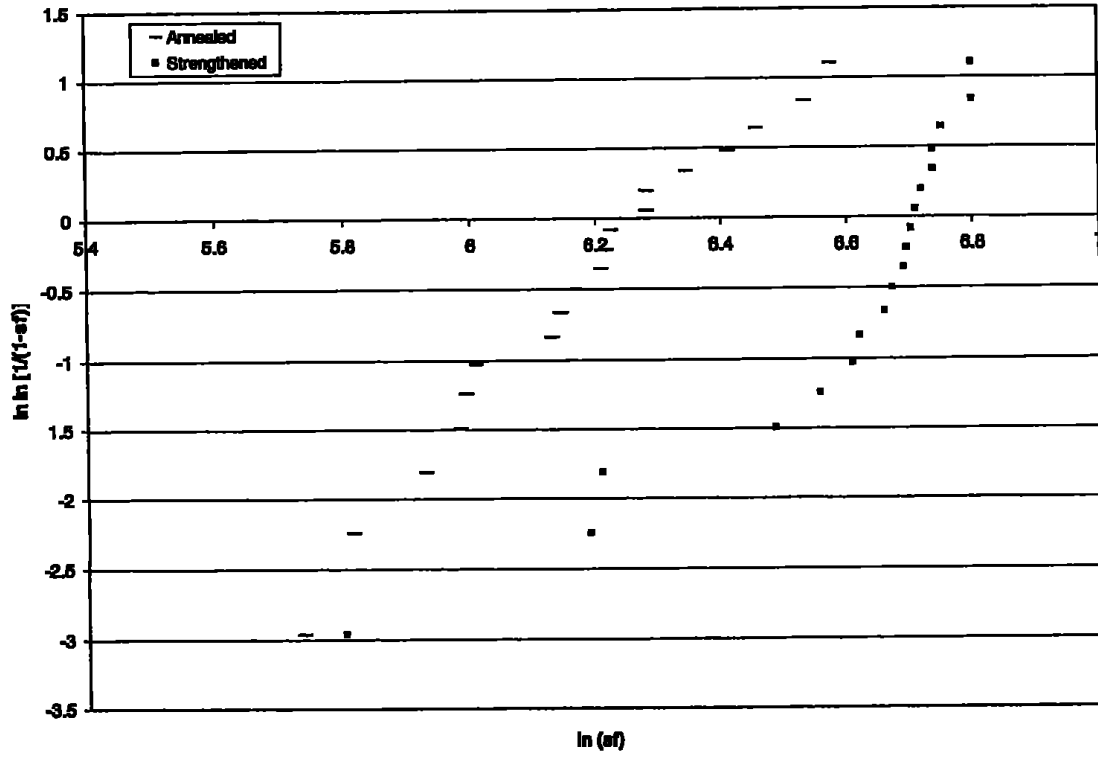
18/24

58

# RUN NO. 8

Pre-heat 5 m @ 510°C, dip 600°C, Flame Polish - Side and Bottom, 4 in/sec, Strengthen 20 m @ 520°C

W/O 2004/091329



## FIGURE 18

PCT/US2004/009716

58

RUN NO. 9

Pre-heat 5 m @ 550°C, dip 615°C, Strengthen 20 m @ 500°C

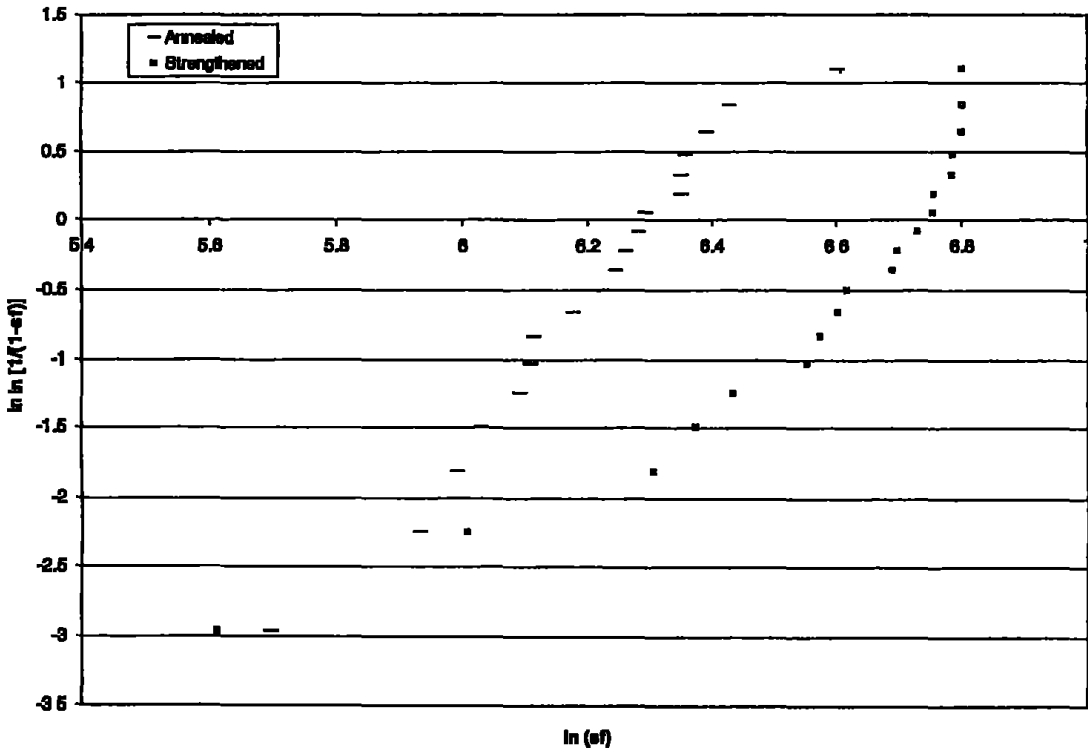


FIGURE 19

W/O 2004/091329

PCT/US2004/009716

2/5

RUN NO. 10

Pre-heat 5 m @ 550°C, dip 615°C, Strengthen 20 m @ 500°C

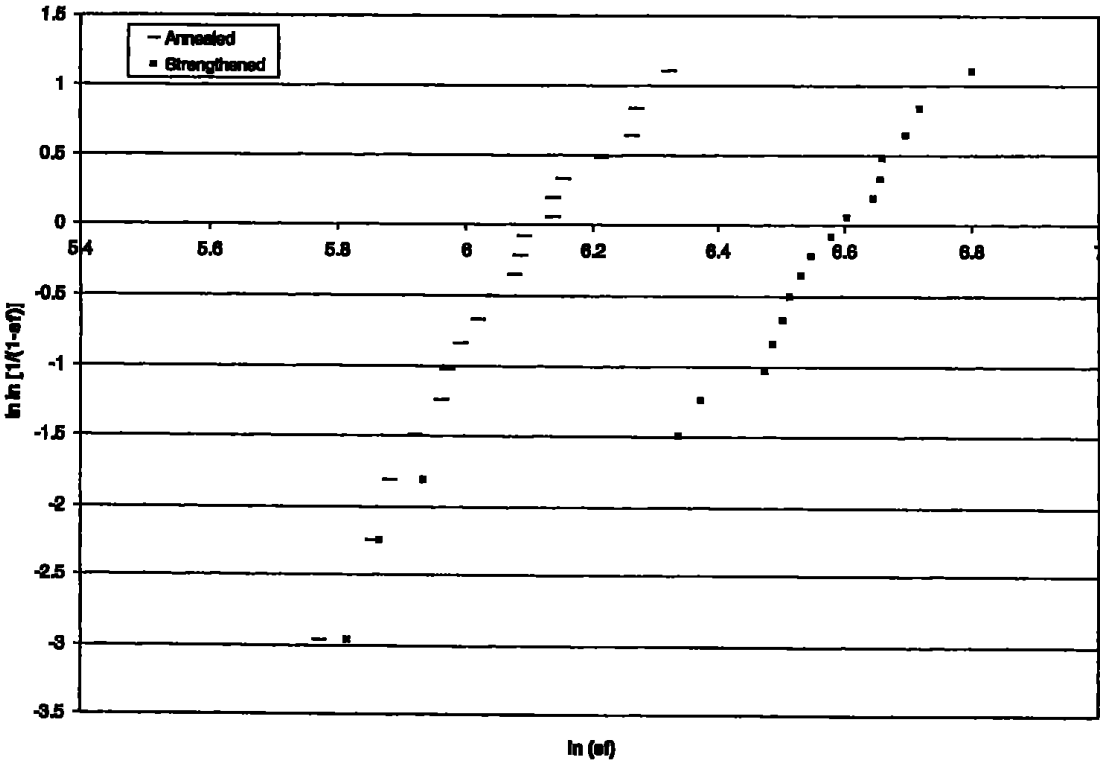
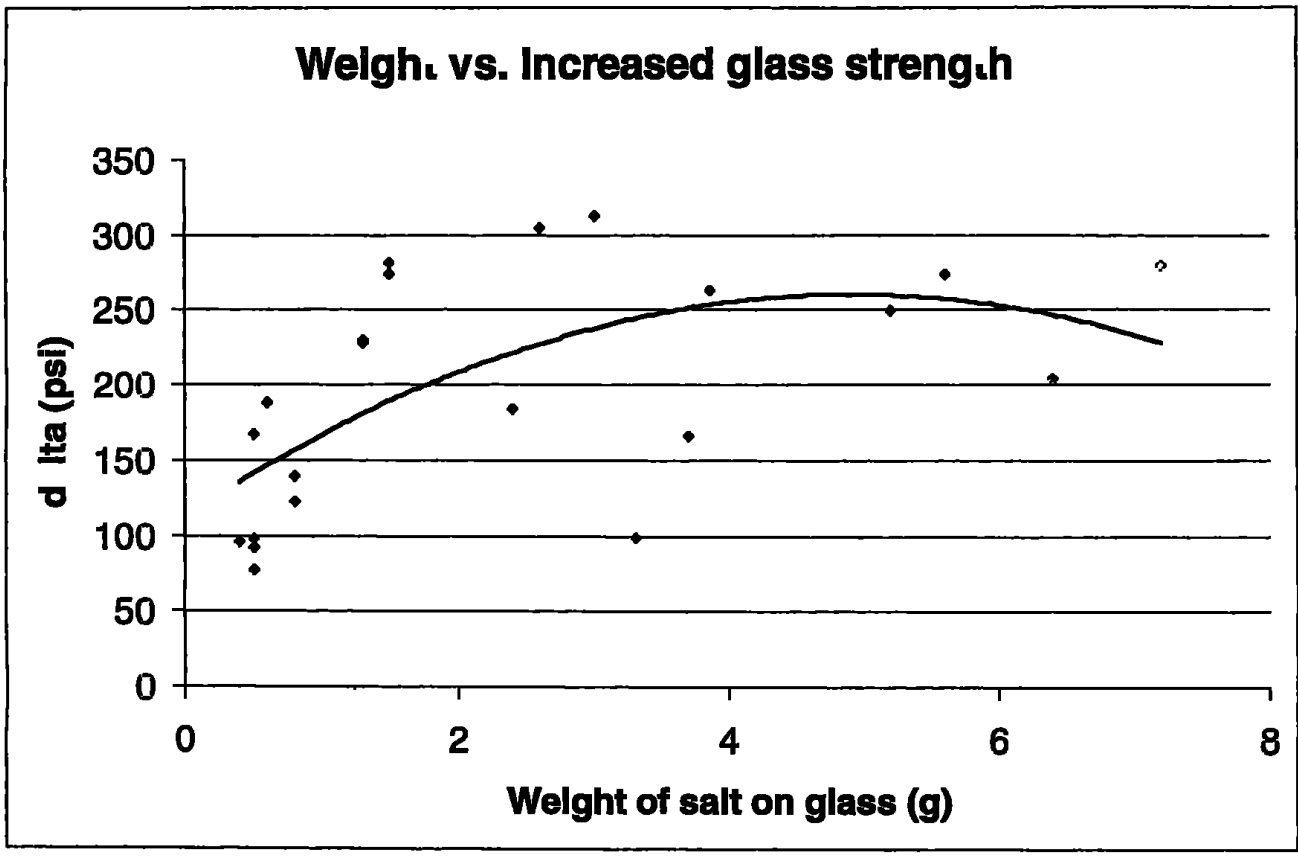


FIGURE 20

22/21



**FIGURE 21**

~~61~~

Exchanges performed at 520C for 20 minutes after dips in either 48 mol % KNO<sub>3</sub> - 52 mol % KCl or 45 mol % KNO<sub>3</sub> - 55 mol % KCl

WO 2004/091329

PCT/US2004/009716

23/24

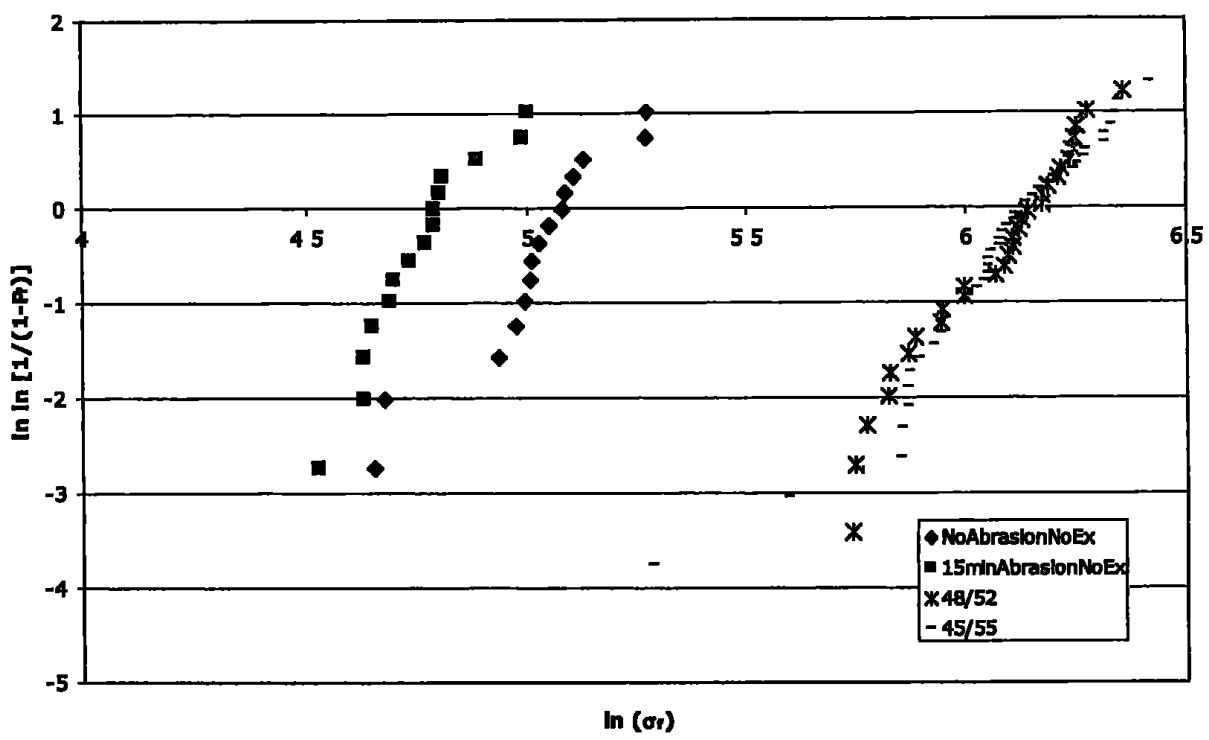


FIGURE 22

Rods exchanged at 520C for 20 minutes in 26.3 mol % K<sub>2</sub>SO<sub>4</sub>, 73.7 mol % KCl and 20.2 mol % K<sub>2</sub>SO<sub>4</sub>, 56.7 mol % KCl and 23.1 mol % KNO<sub>3</sub>.

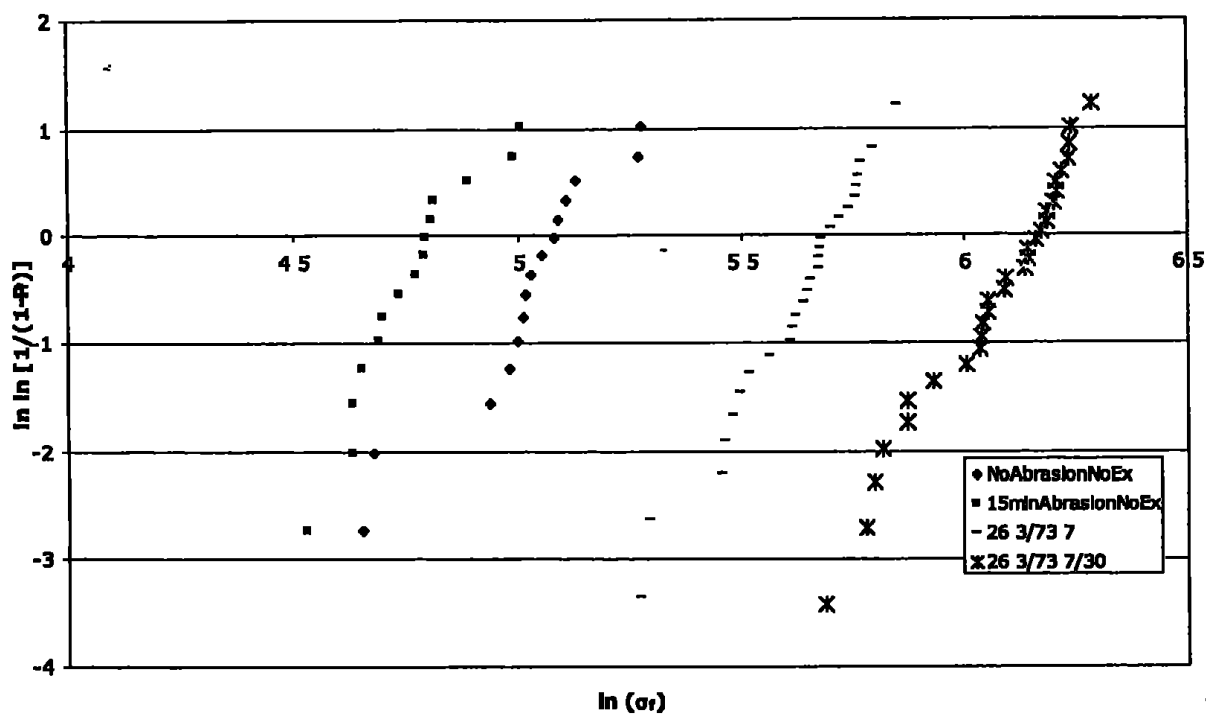


FIGURE 23

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US2004/009716

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 C03C21/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                              | Relevant to claim No.              |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| X          | GB 1 010 164 A (PITTSBURGH PLATE GLASS CO)<br>17 November 1965 (1965-11-17)<br>page 4, line 35 - line 68<br>page 4, line 89 - line 116<br>page 5, line 58 - line 81<br>examples I, IV<br>page 16, line 4<br>claim 2<br>figure 1 | 1-72                               |
| X          | GB 1 346 747 A (SAINT GOBAIN)<br>13 February 1974 (1974-02-13)<br>page 2, line 49 - line 78<br>page 2, line 89 - line 92                                                                                                        | 1-72                               |
| A          | US 3 938 977 A (GLIEMEROTH GEORG)<br>17 February 1976 (1976-02-17)<br><br>column 4, line 57 - column 5, line 1                                                                                                                  | 7, 8, 21,<br>22, 36,<br>37, 65, 66 |



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

**\* Special categories of cited documents:**

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\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*Z\* document member of the same patent family

Date of the actual completion of the international search

17 September 2004

Date of mailing of the international search report

30/09/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Somann, K

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(19) Organización Mundial de Propiedad Intelectual  
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WO 2004/094329 A1

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POSTUPACK, Dennis [US/US]; 560 Waterview Trail, Alpharetta, GA 30022 (US). LACOURSE, William [US/US]; 15 Reynolds Street, Alfred, NY 14802 (US)

(21) No. Solicitud Internacional: PCT/US2004/009716

(74) Agente: BELL, Michael, J. et al.; Howrey Simon Arnold & White, LLP, 2941 Fairview Park Drive, Box 7, Falls Church, VA 22042 (US).

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31 de marzo de 2004 (31.03.2004)

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(71) Solicitante (para todos los países destinatarios con excepción de US): THE COCA-COLA COMPANY [US/US]; One Coca-Cola Plaza, N.W., Atlanta, GA 30313 (US).

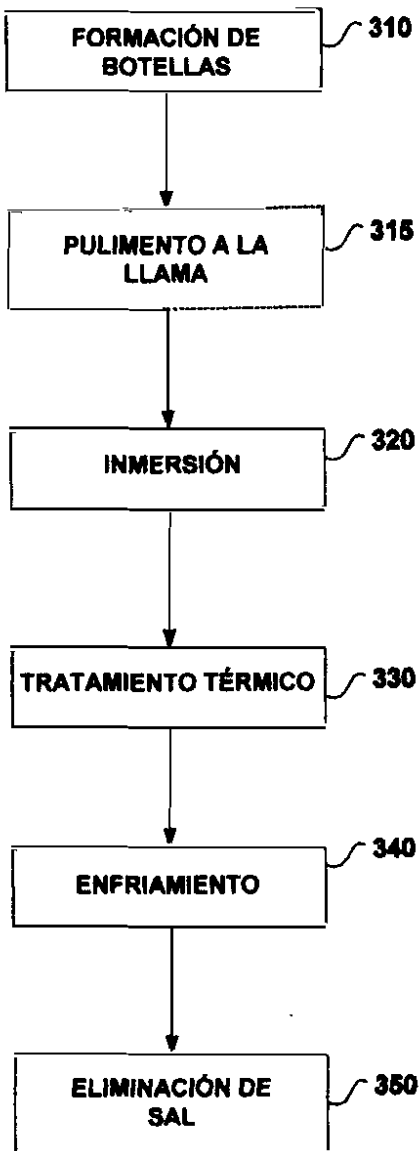
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(72) Inventores, e

(75) Inventores/Solicitantes (para US únicamente):

[Continúa en la página siguiente]

(54) Título: MÉTODO Y APARATO PARA ENDURECER VIDRIO



(57) Extracto: La invención se refiere a un método y aparato para endurecer vidrio. Un método de acuerdo con un aspecto de la invención endurece vidrio aplicando iones de potasio a la superficie de un artículo de vidrio, estando la superficie a por lo menos la temperatura de punto de recocido del vidrio y, luego, mantener la temperatura del vidrio entre la temperatura de punto de deformación del vidrio y alrededor de 150°C por debajo de la temperatura de punto de deformación durante al menos cinco minutos, para facilitar una reacción de intercambio iónico más eficiente. En una incorporación, el artículo de vidrio puede sumergirse en un baño de sal para aplicar los iones. En una incorporación alternativa, los artículos de vidrio pueden rociarse con sal de potasio fundida para aplicar los iones. Como resultado de los métodos de la invención, los artículos de vidrio tratados pueden endurecerse teniendo un esfuerzo superficial incrementado, o pueden contener menos vidrio sin variación en la dureza, comparados con el mismo artículo de vidrio no tratado.

WO 2004/094329 A1



ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasiática (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), Europea (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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Fecha de publicación del informe de búsqueda internacional:

27 de enero de 2005

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Para códigos de dos letras y otras abreviaturas, remítase a las "Notas Guía sobre Códigos y Abreviaturas" que aparece al comienzo de cada edición regular del Boletín Oficial PCT.

## **MÉTODO Y APARATO PARA ENDURECER VIDRIO**

### **REFERENCIA CRUZADA A SOLICITUDES RELACIONADAS**

La presente solicitud reclama prioridad a la Solicitud Provisional de los Estados Unidos No. 60/464,356, presentada el 22 de abril de 2003 (nuestra referencia: 01638.0010.PZUS00), titulada "Métodos y Aparato para Endurecer Vidrio," y su correspondiente solicitud no provisional (número de serie por asignarse), presentada el 31 de marzo de 2004 (nuestra referencia: 01638.0010.NPUS02), titulada "Método y Aparato para Endurecer Vidrio," cuyos contenidos se incorporan aquí por referencia en su integridad.

### **CAMPO DE LA INVENCION**

Esta invención se refiere a métodos y a un aparato para endurecer vidrio. Más específicamente, la invención concierne a métodos de endurecimiento químico, en los cuales se aplican iones a artículos de vidrio, y a un aparato para usar estos métodos en la manufactura de botellas.

### **ANTECEDENTES DE LA INVENCION**

Durante muchos años la manufactura de botellas de vidrio se ha automatizado y existen muchas instalaciones para la producción de botellas de vidrio, especialmente para las industrias de bebidas no-alcohólicas y bebidas alcohólicas. La manufactura tradicional automatizada de botellas de vidrio se inicia en un horno de fusión de vidrio. Las materias primas, incluidos carbonato de calcio, arena (sílice), carbonato de sodio y vidrio roto, por ejemplo, se alimentan al horno de fusión de vidrio, donde se funden a una temperatura de aproximadamente 1500°C. La temperatura de fusión depende de los ingredientes usados en el vidrio. Una corriente de vidrio fundido sale continuamente del horno, y un alimentador corta la corriente en bulbos de una cantidad predeterminada de vidrio.

Los métodos de formación de botellas de vidrio implican a menudo un paso inicial de formación y un paso de acabado. El proceso inicial de

formación deja caer bulbos individuales de vidrio en un molde de blancos, donde toman una forma inicial, convirtiéndose en parisones. El paso inicial del proceso de prensado-y-soplado usa un pistón de metal para prensar un bulbo en un molde de blancos, y el paso inicial del proceso de soplado-y-soplado utiliza aire comprimido para presionar un bulbo en un molde de blancos. Los parisones de los pasos iniciales se transfieren luego a un molde de acabado. Los parisones pueden recalentarse, si es necesario, antes de aplicar aire comprimido para expandir los parisones y llenar el molde de acabado, de manera que el vidrio tome la forma del molde de acabado, moldeando así la forma final de la botella.

Típicamente, las botellas recién formadas se transportan a través de un túnel de recocido, en el cual éstas se recalientan y enfrían gradualmente por el punto de recocido del vidrio. El punto de recocido del vidrio depende de la composición del vidrio. Por ejemplo, el punto de recocido puede definirse como la temperatura a la cual un vidrio liberará 95% de sus esfuerzos en un término de 15 minutos. Esta definición puede variar, sin embargo, dependiendo de la composición del vidrio y el módulo de corte asociado con la composición del vidrio. Para cualquier composición particular, el punto de recocido es la temperatura a la cual la viscosidad del vidrio es  $10^{13}$  poise. En el punto de recocido, se elimina la deformación en el vidrio en 15 minutos. Para efectos de ilustración, el punto de recocido del vidrio de pedernal es alrededor de 550°C. Manteniendo las botellas a la temperatura de recocido o por encima de ella durante un tiempo, la temperatura cerca de la superficie del vidrio se hace prácticamente la misma que la temperatura en el interior. Esto minimiza el diferencial de temperatura entre el interior y las superficies, e impide así que las superficies exteriores se enfríen a una velocidad más rápida que el interior. Por consiguiente el recocido reduce en gran medida la deformación del vidrio que, de lo contrario, resultaría eventualmente. En ausencia del proceso de recocido, los artículos de vidrio acabados pueden hacerse añicos espontáneamente bajo sus propias deformaciones internas. El vidrio recocido es por lo tanto mucho más fuerte que el vidrio que se ha enfriado rápidamente por su temperatura de recocido en una manera no

controlada.

La rotura del vidrio ocurre como resultado de la tensión, especialmente en las superficies, y las fracturas del vidrio se originan típicamente en las superficies. Con el propósito de endurecer artículos de vidrio y, por consiguiente, reducir la probabilidad de rotura, un enfoque alternativo al recocido es aumentar uniformemente el esfuerzo compresivo en las superficies de los artículos de vidrio. El endurecimiento químico de vidrio es un proceso mediante el cual iones más pequeños, en la superficie del vidrio, se reemplazan por iones más grandes, con el fin de aumentar el esfuerzo compresivo en la superficie del vidrio e incrementar así su dureza. Muy típicamente con vidrios de sílice-cal-sosa, los iones de sodio en la superficie del vidrio se reemplazan con iones de potasio, aunque el sodio puede reemplazar al litio, y el potasio puede reemplazar tanto al sodio como al litio.

En un método de endurecimiento químico, un producto de vidrio se trata con iones intercambiantes por inmersión en un baño de sal fundida durante un período de tiempo. Por ejemplo, Tabla 1 de la Patente de los Estados Unidos No. 3,773,489 muestra varios baños de sal de potasio para uso en endurecimiento químico de vidrio, incluidos baños de  $\text{KNO}_3$ ,  $\text{K}_2\text{Cr}_2\text{O}_7/\text{KCl}$ , donde las temperaturas de los baños de sal varían desde  $525^\circ\text{C}$  a  $625^\circ\text{C}$ , y los tiempos de inmersión del vidrio varían desde 8 horas a 7 días. No obstante, tales procesos son poco prácticos en un escenario de manufactura de producción masiva, porque requieren sumergir lotes de productos en el baño de sal fundida durante períodos prolongados, interrumpiendo en esa forma el flujo suave de una línea de fabricación tipo cinta transportadora. La Patente de los Estados Unidos No. 3,751,238 discute un método de endurecimiento químico, con inmersión en baño de sal de potasio, de dos pasos. En el primer paso, un artículo de vidrio se sumerge en un baño de sal de  $\text{KCl}/\text{K}_2\text{SO}_4$  durante 20 minutos a  $750^\circ\text{C}$  (bien por encima del punto de deformación de  $581^\circ\text{C}$  y el punto de recocido de  $631^\circ\text{C}$ ). En el segundo paso, el artículo de vidrio se sumerge en un baño de  $\text{KNO}_3$  durante 4 horas a  $525^\circ\text{C}$  ( $56^\circ\text{C}$  por debajo del punto de deformación).

Otros métodos de endurecimiento químico involucran enfriar artículos

de vidrio bien por debajo del punto de deformación, antes de aplicar el material de intercambio iónico, típicamente en la forma de soluciones de sales saturadas. El punto de deformación del vidrio es la temperatura del vidrio por debajo de la cual no puede introducirse una deformación permanente, que puede ser la temperatura a la cual la viscosidad es  $10^{14.5}$  poise ( $10^{13.5}$  Pa-sec). Por ejemplo, en los procesos descritos en la Patente de los Estados Unidos No. 4,206,253, una vez se han producido y enfriado los productos de vidrio por debajo de alrededor de  $60^{\circ}\text{C}$ , se aplican soluciones acuosas de KCl,  $\text{KNO}_3$  y  $\text{K}_2\text{SO}_4$  a alrededor de  $75^{\circ}\text{C}$  a las superficies de los productos. Los productos se someten entonces a tratamiento térmico a una temperatura justo por debajo del punto de deformación (alrededor de  $510^{\circ}\text{C}$ ).

Figura 1 muestra un ejemplo de un proceso de endurecimiento químico del arte previo, que utiliza una solución de sal de potasio para endurecer artículos de vidrio. Los pasos de moldeo de las botellas 110 y recocido 120 se realizan como se describe anteriormente. El vidrio se transfiere luego 130 a un proceso secundario, en el cual las botellas se recalientan 140 a una temperatura de aproximadamente  $100^{\circ}\text{C}$ . Se aplica una solución de sales 150 a las botellas, las cuales se calientan entonces a la temperatura de intercambio iónico, es decir,  $460\text{-}550^{\circ}\text{C}$  en un túnel de endurecimiento. La temperatura de intercambio iónico depende de cuánto tiempo se dispone para la reacción de intercambio iónico, lo que a su vez depende de consideraciones prácticas de producción. Entre más corto el tiempo disponible para el intercambio iónico, más alta debe ser la temperatura de intercambio iónico. Luego del remojo en caliente a la temperatura de intercambio iónico 160, las botellas se dejan enfriar 170 a la temperatura de la sal, tiempo en el cual el recubrimiento residual, es decir, aquella porción de la sal, que no ha contribuido al intercambio iónico en la superficie del vidrio, se retira por ejemplo con un atomizador de agua a temperatura de la sala. En esta etapa, los artículos de vidrio se habrán enfriado preferiblemente a alrededor de  $90^{\circ}\text{C}$ .

Un propósito del proceso de intercambio iónico es aumentar el esfuerzo compresivo en la superficie del vidrio sustituyendo iones más

pequeños en la superficie del vidrio (por ejemplo, sodio) con iones más grandes (por ejemplo, potasio). Si el vidrio se mantuviera luego a la temperatura de recocido durante un tiempo, el resultado sería que se mitigaría el esfuerzo compresivo, introducido en la superficie por el intercambio iónico. Por lo tanto, el túnel de endurecimiento puede estar en un margen de temperatura de 460-550 °C, dependiendo del tiempo de intercambio iónico disponible, basándose en consideraciones prácticas de producción. Esta temperatura, por ejemplo, puede estar ligeramente por debajo de la temperatura de recocido, por ejemplo, 525°C. Se requiere un equilibrio en este paso de intercambio iónico: Temperaturas más calientes aceleran el proceso de intercambio iónico, pero si la temperatura es demasiado caliente y se acerca a la temperatura de recocido, el esfuerzo compresivo, introducido por el intercambio iónico, podría mitigarse por el relajamiento de la estructura del vidrio.

Refiriéndonos de nuevo a Figura 1, puede aplicarse una solución de sales 150 a las botellas a una temperatura relativamente fría, bien por debajo de los puntos de recocido y deformación. Si la temperatura de las botellas es demasiado elevada durante la aplicación de una solución de sales, entonces la aplicación de la solución de sales acuosas se traduce en un enfriamiento rápido de las botellas, lo cual resulta a menudo en rotura. Luego de la aplicación de la solución, se eleva la temperatura de las botellas con el fin de acelerar el proceso de intercambio iónico. El método del arte previo adolece de falta de adaptabilidad a los equipos de manufactura de botellas en línea, porque requiere que las botellas se enfríen durante un tiempo, con el fin de evitar fracturas durante la aplicación de la solución de sales, y exige el recalentamiento posterior para la reacción de intercambio iónico. Estos pasos adicionales toman tiempo y reducen la eficiencia de la fabricación de botellas. Estos procesos, sin embargo, tienen la desventaja de no adaptarse fácilmente a líneas pre-existentes de manufactura de botellas en línea, debido a los ciclos adicionales de enfriamiento y calentamiento, que las operaciones de manufactura de botellas estándar no están equipadas para manejar. Por consiguiente, cambiar el proceso industrial para incluir, por ejemplo, los

72

métodos ya mencionados de endurecimiento de vidrio, puede resultar muy costoso.

La Patente de los Estados Unidos No. 4,218,230 se propone divulgar un método para adaptar el método de intercambio iónico a líneas de producción comerciales de alta velocidad. En este método, una solución acuosa de fosfato de potasio y fosfato de sodio se rocía sobre artículos de vidrio a una temperatura entre 200°C y el punto de recocido del vidrio. El vidrio se mantiene a una temperatura en el margen de 300°C a justamente por debajo del punto de recocido durante 5 a 30 minutos.

Un método en el cual se aplican sales en polvo a artículos de vidrio en caliente se describe en la Patente de los Estados Unidos No. 3,791,809. En este método, una mezcla de una sal con bajo punto de fusión,  $\text{KNO}_3$ , y una sal con alto punto de fusión,  $\text{K}_3\text{PO}_4$ , se muelen hasta obtener un polvo y se aplican a la superficie de un artículo de vidrio a una temperatura por encima del punto de recocido. Las sales con bajo punto de fusión se funden y fusionan, adhiriendo la mezcla a la superficie del vidrio. El intercambio iónico ocurre a una temperatura de por lo menos 200°C, pero preferiblemente por encima del punto de deformación del vidrio.

Otro enfoque para impedir la rotura del vidrio es el pulimento a la llama, que elimina los defectos superficiales tales como pequeñas astillas o rayaduras, fundiendo los defectos y permitiendo que el vidrio en la zona del defecto se endurezca alisadamente. Por ejemplo, la Patente de los Estados Unidos No. 4,231,778 describe un método en el cual productos de vidrio recién formado se dejan enfriar un poco, luego la superficie se somete a pulimento a la llama, seguido por un período de recocido. Existen muchas patentes que describen aparatos para pulir vidrio a la llama, por ejemplo, las Patentes de los Estados Unidos No. 4,265,651; 2,422,482; 2,338,841; y 2,331,014.

Subsiste una necesidad en el arte de métodos de manufactura de vidrio que produzcan artículos de vidrio de alta dureza. Existe una necesidad relacionada de métodos mejorados de endurecimiento por intercambio iónico. Hay igualmente una necesidad de métodos de endurecimiento de

vidrio que puedan adaptarse a los equipos existentes de manufactura de botellas, sin requerir re-equipamiento sustancial de esas instalaciones.

### SUMARIO DE LA INVENCION

Esta invención proporciona métodos de endurecimiento químico de artículos de vidrio, que comprenden aplicar una sal a artículos de vidrio a temperaturas de por lo menos la temperatura de punto de recocido del vidrio y, luego, mantener el artículo de vidrio a temperaturas elevadas en un túnel. Las temperaturas elevadas pueden estar, por ejemplo, entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación. El vidrio puede mantenerse a tal temperatura elevada durante por lo menos alrededor de cinco minutos. Incorporaciones de la invención pueden incluir métodos y un aparato para pulimento a la llama en combinación con endurecimiento químico. Algunas incorporaciones del aparato de la invención son adaptaciones de plantas de fabricación de botellas existentes para realizar incorporaciones de los métodos de la invención.

En un aspecto, la invención provee un método para endurecer un artículo de vidrio. El artículo de vidrio puede moldearse de vidrio fundido usando cualquier proceso de moldeo de vidrio. El artículo de vidrio moldeado acabado puede pulirse a la llama para fundir y, así, corregir cualesquiera imperfecciones superficiales, aumentando al mismo tiempo la temperatura de la superficie del artículo de vidrio a por lo menos la temperatura de punto de recocido del vidrio, usada para moldear el artículo. En una incorporación, el artículo de vidrio es una botella de vidrio. En otra incorporación, el artículo de vidrio se moldea de un vidrio con una temperatura de punto de deformación de alrededor de 530°C y una temperatura de punto de recocido de alrededor de 550°C.

En una incorporación del método, la sal se aplica en un paso de sumergir un artículo de vidrio en un baño de sal fundida, durante menos de alrededor de un minuto, por ejemplo, alrededor de 0.5 a alrededor de 30 segundos, o preferiblemente alrededor de 3 a alrededor de 5 segundos. En

74

una incorporación preferida, el baño de sal fundida comprende nitrato de potasio y cloruro de potasio en una mezcla equimolar. Algunas incorporaciones del baño de sal incluyen nitrato de potasio y cloruro de potasio en mezclas de porcentaje molar en el margen de 40 a 60 por ciento, y otras incorporaciones incluyen mezclas de 40-60% de nitrato de potasio y 40-60% de cloruro de potasio. Otras incorporaciones incluyen baños de sal fundidas que comprenden sulfato de potasio y cloruro de potasio. En todavía otras incorporaciones, el baño de sal fundida comprende combinaciones de cualesquiera dos o más de: nitrato de potasio, sulfato de potasio, cloruro de potasio, fosfato de potasio y dicromato de potasio. En una incorporación, la temperatura del baño de sal es mayor que la temperatura de la botella inmediatamente precedente a la inmersión. En otra incorporación, las temperaturas de los baños de sal fundidas pueden ser superiores a 25°C por encima del punto de recocido del vidrio. En todavía otra incorporación, el baño de sal puede tener un margen de temperatura de entre 550°C y 750°C.

En una incorporación alternativa, se aplica sal a la superficie de un artículo de vidrio rociando el vidrio con una solución que contiene iones de potasio o una sal de potasio en polvo o fundida, mientras la temperatura superficial del vidrio está por lo menos alrededor de 25°C por encima del punto de recocido del vidrio. Alternativamente, el paso de rociado puede tener lugar a una temperatura de por lo menos 50°C por encima del punto de recocido del vidrio o por lo menos 100°C por encima del punto de recocido del vidrio. En una incorporación, la solución de potasio o sal es fosfato de potasio ( $K_3PO_4$ ). En otra incorporación, la solución de potasio comprende alrededor de 50% fosfato de potasio en peso y 50% en peso de agua.

El paso de rociado puede ser cualquier pulverización convencional forzando una solución a través de una tobera, o puede ser pulverización a la llama, pulverización electrostática, o pulverización de polvo. Si se utiliza pulverización convencional, pequeñas gotas de una solución de potasio o sal de potasio contactan el artículo de vidrio caliente, y pueden enfriar ligeramente la superficie del artículo de vidrio caliente. Si se emplea pulverización a la llama, una sal de potasio en polvo puede alimentarse a

través de una pistola aspersora de polvo a la llama, donde el polvo se licua en el aspersor, y pequeñas gotas líquidas de sal de potasio fundida contactan el artículo de vidrio caliente. Alternativamente, puede aplicarse una solución de potasio entre las toberas de pulimento a la llama. Si se usa pulverización electrostática, pequeñas gotas de la solución de potasio se cargan eléctricamente y se hacen electrostáticamente atractivas al artículo de vidrio. Alternativamente, pueden emplearse sales de potasio en polvo en un atomizador convencional o electrostático. En todavía otras incorporaciones, pueden aplicarse sales de potasio por deposición de vapor químico.

Luego del paso de aplicar sal a un artículo de vidrio, por inmersión, pulverización, u otro método de aplicación, los procesos de la invención incluyen el paso de tratar térmicamente el artículo de vidrio en un túnel u otro aparato de tratamiento térmico. Este paso permite una alta tasa de difusión de iones de potasio en una superficie del artículo de vidrio, manteniendo la superficie a una temperatura entre, o incluyendo, el punto de deformación del vidrio y 150°C por debajo del punto de deformación. El vidrio puede mantenerse a una temperatura elevada durante por lo menos alrededor de cinco minutos, preferiblemente menos de una hora, más preferiblemente entre diez minutos y una hora, o entre quince y veinte minutos.

En otra incorporación, la invención provee un aparato para producir un artículo de vidrio endurecido. Este aparato puede incluir un medio para producir un artículo de vidrio moldeado. El artículo de vidrio moldeado puede producirse por cualesquiera medios conocidos por las personas expertas en el arte, incluidos pero no limitados a procesos de prensado-y-soplado y soplado-y-soplado. El aparato puede incluir un túnel de aislamiento térmico luego de la estación de formación para minimizar la pérdida de calor. El aparato puede incluir además toberas de pulimento a la llama para pulir a la llama la superficie del artículo de vidrio para eliminar desperfectos superficiales y calentar la superficie a una temperatura de por lo menos alrededor de 25°C por encima del punto de recocido del vidrio. En una incorporación, el artículo de vidrio es una botella de vidrio. En una incorporación, el artículo de vidrio se forma de vidrio con una temperatura de

deformación entre 520°C y 540°C y una temperatura de recocido entre 540°C y 560°C. En otra incorporación, el artículo de vidrio se forma de un vidrio con una temperatura de deformación de alrededor de 530°C y una temperatura de recocido de alrededor de 550°C.

En una incorporación, el aparato puede incluir además un baño de sal para sumergir el artículo de vidrio antes del endurecimiento por calor. En una incorporación, el baño de sal fundida es un baño de sal de potasio, por ejemplo, un baño de sal  $\text{KNO}_3/\text{KCl}$ , un baño de sal  $\text{K}_2\text{SO}_4/\text{KCl}$ , o un baño de sal  $\text{K}_2\text{SO}_4/\text{KCl}/\text{KNO}_3$ . En una incorporación, el baño de sal se mantiene a una temperatura de por lo menos alrededor de 25°C por encima del punto de recocido del vidrio.

En otra incorporación, el aparato puede incluir asimismo toberas de aspersión para rociar el artículo de vidrio con una solución que contenga iones de potasio u otra fuente de potasio. En una incorporación, las toberas de aspersión pulverizan la fuente de potasio sobre la superficie del artículo de vidrio, mientras que la superficie se mantiene a una temperatura de por lo menos alrededor de 25 °C por encima del punto de recocido del vidrio. En otra incorporación, las toberas de aspersión pulverizan el potasio sobre la superficie del artículo de vidrio, mientras la superficie se mantiene a una temperatura de por lo menos alrededor de 50°C por encima del punto de recocido del vidrio. En todavía otra incorporación, la superficie se rocía mientras se mantiene a una temperatura de por lo menos alrededor de 100°C por encima del punto de recocido del vidrio. Las toberas de aspersión pueden sustituirse por toberas de aspersión a la llama que pulverizan una sal de potasio en polvo. Alternativamente, las toberas de aspersión pueden sustituirse por una tobera de aspersión electrostática que pulveriza una solución de potasio. Alternativamente, las toberas de aspersión pueden sustituirse por una tobera de aspersión de polvo, convencional o electrostática. En una incorporación, la solución de potasio comprende 50% de fosfato de potasio en peso y 50% de agua en peso.

Si el aparato tiene medios de inmersión en baño de sal, medios de pulverización de sal, u otros medios para aplicar sal, el aparato puede incluir

además un túnel de endurecimiento, en donde el túnel de endurecimiento puede configurarse para mantener el artículo de vidrio a una temperatura mayor de alrededor de 80°C por debajo del punto de deformación, y el artículo de vidrio se mantiene en el túnel de endurecimiento durante por lo menos alrededor de 45 minutos. Alternativamente, el túnel de endurecimiento puede mantenerse a una temperatura hasta el punto de deformación del vidrio. El artículo de vidrio puede mantenerse en el túnel de endurecimiento durante un tiempo máximo de 30 minutos. Alternativamente, el artículo de vidrio puede mantenerse en el túnel de endurecimiento durante por lo menos alrededor de 15 minutos para un endurecimiento con temperatura más alta. En todavía otra alternativa, el artículo de vidrio puede mantenerse en el túnel de endurecimiento durante alrededor de 45 minutos para un endurecimiento con temperatura más baja. En otra incorporación, el artículo de vidrio se mantiene a una temperatura en, o por debajo del punto de recocido del vidrio durante por lo menos alrededor de 5 minutos.

Un método preferido de poner en práctica la invención variará de acuerdo con el tipo de vidrio, debido a diferentes puntos de recocido y puntos de deformación, el peso del vidrio, la forma del envase, etc. Para efectos de ilustración, cuando se tiempla una botella de vidrio de pedernal, con diseño de contorno, de la Compañía Coca-Cola de 200 ml con un peso de 165 gramos, el envase se somete a alrededor de veinte minutos de intercambio iónico a alrededor de 520 grados Celsius. El vidrio de pedernal típicamente usado en tales botellas tiene una temperatura de recocido de 550 grados Celsius y una temperatura de deformación de 530 grados Celsius.

### **BREVE DESCRIPCIÓN DE LOS DIBUJOS**

Figura 1 ilustra un método del arte previo de endurecimiento de vidrio;

Figura 2 es un flujograma de un método de acuerdo con una incorporación de la invención;

Figura 3 es un gráfico de Weibull, que ilustra los beneficios del pulimento a la llama;

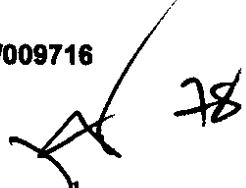


Figura 4 es un gráfico dureza vs. tiempo, tanto para un proceso de endurecimiento de vidrio con intercambio iónico a alta temperatura como para un proceso de endurecimiento de vidrio con intercambio iónico a baja temperatura;

Figura 5 es un flujograma de un método de acuerdo con una incorporación alternativa de la invención;

Figura 6 un gráfico de columnas que compara los beneficios de varios métodos de endurecimiento de vidrio de acuerdo con una incorporación de la invención;

Figura 7 es una vista en planta de un sistema de endurecimiento de vidrio de acuerdo con una incorporación de la invención;

Figura 8A es un diagrama que ilustra un ejemplo de un túnel de recocido, usado para comparar los métodos de la presente invención con los del arte previo;

Figura 8B es un diagrama que ilustra un túnel ejemplar de endurecimiento de acuerdo con una incorporación de la invención;

Figura 9 es una vista en perspectiva de un mecanismo para sumergir botellas en un sistema para endurecer botellas de acuerdo con un aspecto de la invención;

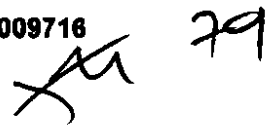
Figura 10 es una vista en perspectiva de un mecanismo para enjuagar botellas en un sistema para endurecer botellas de acuerdo con un aspecto de la invención;

Figuras 11-20 son gráficos de Weibull que ilustran los beneficios de los métodos ejemplares de endurecimiento químico de vidrio de acuerdo con incorporaciones de la invención, comparados con métodos de endurecimiento de vidrio del arte previo;

Figura 21 es un gráfico del cambio en la dureza del vidrio vs. el peso de la sal que se adhiere a la botella;

Figura 22 es un gráfico de Weibull que demuestra características superiores de dureza de varillas de vidrio manufacturadas por el método de inmersión de la invención en baños de  $\text{KNO}_3/\text{KCl}$ ; y

Figura 23 es un gráfico de Weibull que demuestra características



superiores de dureza de varillas de vidrio, manufacturadas por el método de inmersión de la invención en baños de  $K_2SO_4/KCl$  y  $K_2SO_4/KCl/KNO_3$ .

### DESCRIPCIÓN DETALLADA DE LA INVENCION

Los métodos y aparato de la invención se refieren a procesos y dispositivos de manufactura de vidrio. Específicamente, los métodos y aparato son mejoras a procesos y dispositivos existentes de manufactura de botellas de vidrio, que permiten la producción de botellas de vidrio con las características superiores de dureza aportadas por el endurecimiento químico. Algunas incorporaciones no requieren cambios sustanciales a equipos existentes de fabricación de botellas. Los beneficios de usar los métodos y aparato de la invención incluyen botellas de dureza más alta por peso unitario de vidrio que los métodos del arte previo. Alternativamente, puede usarse menos vidrio para fabricar botellas de la misma dureza usando los métodos de la invención en lugar de utilizar los métodos del arte previo. Aunque los ejemplos y la descripción ofrecidos aquí se dirigen a la manufactura de botellas de vidrio, debería entenderse que la invención puede ser aplicable a cualquier clase de artículos de vidrio, incluidos pero no limitados a: jarras de vidrio, vasos o copas de vino o cualquier artículo de vidrio, potes de vidrio y vajillas de vidrio, lentes con fórmula médica, lentes reflectivos, fibras ópticas y parabrisas para automóviles y ventanas para edificios, por ejemplo.

Figura 2 es un flujograma de un método de endurecer vidrio de acuerdo con una incorporación de la invención. Los pasos de moldeado de la botella 310 pueden realizarse como se describe anteriormente en la sección de antecedentes. No obstante, se ha descubierto que el proceso de formación de botellas soplado-y-soplado puede moldear botellas superiores que el proceso prensado-y-soplado, porque pueden ocurrir defectos en el interior de las botellas, causados por el contacto entre el pistón y la superficie interior de las botellas, cuando se usa el método prensado-y-soplado. Estos defectos se pueden convertir en los puntos débiles en botellas endurecidas por los métodos de la invención y, por consiguiente, el proceso soplado-y-soplado

puede ser preferible para la formación de botellas. No obstante, los métodos de endurecimiento de la invención pueden usarse beneficiosamente en botellas formadas con los procesos prensado-y-soplado y soplado-y-soplado.

Inmediatamente después que se ha formado una botella, su temperatura está típicamente por encima del punto de recocido. En algunas incorporaciones, las botellas pueden sumergirse entonces en un baño de sal fundida 320, una vez se han moldeado. En algunas incorporaciones, las botellas se pueden pulir a la llama antes de sumergirse en el baño de sal. Como se describe con mayor detalle a continuación, a medida que una botella se pasa a través de la sección de pulimento a la llama de un sistema de endurecimiento de vidrio de acuerdo con una incorporación de la invención, las llamas pueden moverse por medios mecánicos perpendiculares a la dirección de desplazamiento de la botella. En algunas incorporaciones, puede usarse un método de pulimento a la llama, de dos pasos. El primer paso se realiza, por ejemplo, mientras los artículos de vidrio se encuentran sobre la cinta transportadora. Este paso puede incluir pulimento a la llama de los lados y las acanaladuras en la parte superior de, por ejemplo, una botella de vidrio. El segundo paso puede incluir pulir a la llama los fondos de los artículos de vidrio. Esto puede hacerse levantando los artículos de vidrio de la cinta transportadora y pasándolos sobre una llama. El pulimento a la llama que incluye este segundo paso puede eliminar defectos en, por ejemplo, protuberancias (es decir, los pliegues en el fondo de una botella de vidrio).

Figura 3 ilustra los beneficios que pueden lograrse usando un paso de pulimento a la llama de acuerdo con una incorporación de la invención. Este gráfico se creó usando láminas de vidrio plano, dañadas con una aguja de diamante para inducir defectos de 50 micrones. Un juego de láminas se sometió a pulimento a la llama usando una llama de metano/oxígeno. Un segundo juego de láminas se sometió a pulimento a la llama usando una llama de acetileno/aire. Un tercer juego de láminas, las láminas de control, no se pulieron a la llama. Un cuarto juego de láminas no se rayó para inducir defectos ni se pulieron a la llama. Las láminas de vidrio se sometieron entonces a esfuerzo hasta romperse, y se registró el esfuerzo de fractura para

cada una de las láminas de vidrio.

Figura 3 es un gráfico de Weibull que muestra los resultados de estos ensayos. La abscisa del gráfico es una medida del esfuerzo aplicado y la ordenada es una medida de la probabilidad de fractura. Las láminas pulidas a la llama resistieron aproximadamente tanto esfuerzo como las láminas sin defectos inducidos, y fueron superiores en dureza a las láminas de control. Las láminas pulidas con la llama de metano/oxígeno fueron ligeramente superiores en dureza a las pulidas con acetileno/aire y las láminas sin defectos inducidos. Las láminas pulidas con acetileno/aire fueron ligeramente inferiores en dureza a las láminas sin defectos inducidos.

En algunas incorporaciones de la invención, la temperatura de las botellas inmediatamente antes de ser sumergidas en un baño de sal puede ser entre, por ejemplo, 500 °C y 600 °C. En una incorporación alternativa de la invención, la temperatura de las botellas puede estar por encima del punto de recocido del vidrio. En todavía otra incorporación de la invención, las botellas pueden estar por lo menos alrededor de 25°C por encima del punto de recocido del vidrio. En otra incorporación, la temperatura de las botellas puede estar entre 510 °C y 590 °C. En todavía otra incorporación, la temperatura de las botellas puede estar entre, por ejemplo, 510 °C y 550 °C. En una incorporación ejemplar, la temperatura de las botellas inmediatamente antes de la inmersión en el baño de sal puede ser de alrededor de 540°C. El tiempo de inmersión puede ser más corto que los tiempos de inmersión del arte previo. La temperatura del baño de sal puede ser más alta que la temperatura de la botella. En una incorporación, la temperatura del baño de sal puede estar entre, por ejemplo, 550°C y 750°C. En una incorporación ejemplar, el baño de sal puede estar a una temperatura de aproximadamente 610 °C. En otra incorporación, la temperatura del baño de sal puede estar a alrededor de 600°C. Como ya se discutió, el arte previo requiere típicamente una inmersión durante entre ½ hora a 4 horas. En el paso 320, sin embargo, las botellas pueden estar inmersas durante menos de un minuto. Preferiblemente, las botellas pueden sumergirse en el baño de sal durante entre 0.5 segundos y 30 segundos. En otra incorporación, las botellas

82

pueden sumergirse en el baño de sal durante entre alrededor de 3 segundos y 5 segundos. En otra incorporación preferida, las botellas pueden sumergirse durante menos de 10 segundos.

En una incorporación, el baño de sal fundida puede ser un baño de sal de potasio con un punto de fusión por encima de la temperatura del túnel de endurecimiento, usada durante el paso de tratamiento térmico 330. Una composición preferida para el baño de sal fundida es 45 mol% de nitrato de potasio ( $\text{KNO}_3$ ) y 55 mol% de cloruro de potasio ( $\text{KCl}$ ). Esta composición puede ser líquida a una temperatura de entre  $550^\circ\text{C}$  a  $750^\circ\text{C}$ , permitiendo así un recubrimiento uniforme de las botellas sumergidas en el baño mantenido en este margen de temperatura. Esta composición es semi-sólida a una temperatura de alrededor de  $520^\circ\text{C}$ , permitiéndole así a la sal permanecer en su sitio como un recubrimiento uniforme en términos generales en la botella durante el paso de tratamiento térmico 330, el cual permite un endurecimiento uniforme en términos generales e impide la acumulación de sal en el túnel de endurecimiento. Otras composiciones apropiadas de baño de sal pueden determinarse por las personas de habilidades ordinarias en arte usando diagramas de fases y experimentación rutinaria. Por ejemplo, otras composiciones apropiadas de baño de sal pueden incluir  $\text{KCl/KNO}_3/\text{K}_2\text{SO}_4$ . En general, la composición de baño de sal es preferiblemente tal que el baño sea líquido a una temperatura de alrededor de  $50^\circ\text{C}$  por encima del punto de recocido del vidrio, y sólido o semi-sólido a la temperatura del túnel de endurecimiento.

Como se ilustra en Figura 4, la dureza del vidrio luego del proceso de endurecimiento depende de la temperatura y el tiempo en que se trata el vidrio. Por lo tanto, hay que transar, cuando se realizan cualesquiera métodos de endurecimiento de vidrio. Por ejemplo, cuando se endurece vidrio a una temperatura inferior, el vidrio puede no volverse tan fuerte como lo sería si el vidrio se tratara a una temperatura elevada tal como, por ejemplo, la temperatura de recocido del vidrio. No obstante, cuando se trata vidrio a una temperatura más elevada, la dureza máxima del vidrio varía más dramáticamente con el tiempo y, por consiguiente, puede requerirse ajustar



las tolerancias en la forma correspondiente.

Por lo tanto, se contempla que la reacción de intercambio iónico pueda ocurrir en o por debajo del punto de recocido, a condición de que la temperatura se mantenga durante un tiempo menor que, o igual a, alrededor de 15 a 20 minutos. No obstante, debido a que tanto la reacción de intercambio iónico como el relajamiento, que ocurre en o por encima del punto de recocido, son procesos dinámicos, puede conseguirse una desviación significativa de esta regla general. Por consiguiente, la invención no debería considerarse limitada por cualquier temperatura particular durante cualquier tiempo particular.

El tiempo y temperatura del paso de tratamiento térmico puede ajustarse dependiendo de los requerimientos del equipo de producción, usándose mayores temperaturas y menores tiempos, cuando sea necesario, para una producción más rápida, y empleándose tiempos más prolongados de tratamiento térmico para incrementar aún más la dureza del vidrio tratado. En otra incorporación, el artículo de vidrio se mantiene a la temperatura del punto de deformación durante tiempos en el margen de 5 a 30 minutos. Aumentar el tiempo de exposición a estas temperaturas puede resultar en durezas decrecientes del artículo de vidrio. A medida que aumenta el tiempo de exposición a cualquier temperatura, la dureza del artículo de vidrio puede incrementarse gradualmente a un valor máximo y, luego, puede decrecer. Este tiempo de dureza máxima disminuye con incrementos de temperatura.

Las botellas pueden someterse entonces a tratamiento térmico 330 en un túnel de endurecimiento. Este tratamiento térmico puede acelerar el proceso de intercambio iónico. La temperatura del túnel de endurecimiento es preferiblemente menos de o aproximadamente igual a 150°C menos del punto de deformación del vidrio. Más preferiblemente, la temperatura del túnel de endurecimiento puede fijarse entre alrededor de 130°C por debajo del punto de deformación del vidrio. En una incorporación, la temperatura del túnel de endurecimiento es aproximadamente más de 30 °C por debajo de la temperatura del punto de deformación del vidrio. Alternativamente, la temperatura del túnel de endurecimiento es aproximadamente más de 10°C

menos de la temperatura del punto de deformación del vidrio. En una incorporación, el vidrio puede permanecer en el túnel durante un tiempo entre 15 minutos y 55 minutos. Más preferiblemente, el vidrio puede permanecer en el túnel durante un tiempo entre 20 y 50 minutos. En algunas incorporaciones, dependiendo del tipo de vidrio usado, el vidrio puede permanecer en el túnel de endurecimiento por una duración de alrededor de 30 minutos. Puede necesitarse procesar botellas más grandes a velocidades más bajas y, por lo tanto, pueden estar en el túnel durante periodos de tiempo más prolongados. Puesto que pueden estar expuestas durante un período de tiempo más prolongado, puede necesitarse reducir la temperatura para optimizar el proceso de endurecimiento. No obstante, la duración de la reacción de intercambio iónico puede ser más o menos de esa, dependiendo de la temperatura seleccionada, como se describe anteriormente con referencia a Figura 3. Luego del tratamiento térmico 330, las botellas pueden enfriarse 340, y retirarse la sal 350 en la misma forma que ya se describió. Como se expondrá con detalles adicionales más adelante con referencia a Figura 10, el vidrio puede enfriarse lentamente en el túnel.

En un método ejemplar de acuerdo con y en una incorporación de la invención, artículos de vidrio formados emergen del proceso de formación de vidrio a una temperatura de aproximadamente 650°C. La temperatura puede ser mayor o menor, dependiendo de los procesos y materiales particulares usados, el diseño de la botella y el espesor de la pared. En una incorporación, una cantidad mínima de un recubrimiento de óxido de estaño en la zona caliente puede aplicarse al artículo de vidrio con un espesor de recubrimiento de cualquiera de entre, por ejemplo, 20 y 45 ctu (unidades de espesor de recubrimiento). La aplicación del recubrimiento de óxido de estaño puede formar una textura en la superficie del vidrio para permitir que el recubrimiento de la zona enfriamiento, aplicada más tarde, se adhiera a la superficie de la botella de vidrio. La unidad de espesor del recubrimiento asociada con una ctu de óxido de estaño es alrededor de 4 angstroms. Este recubrimiento puede aplicarse usando cualquier método conocido en las artes de manufactura de vidrio, típicamente en un sitio entre la formación de la

botella y la entrada del túnel. Alternativamente, el recubrimiento de óxido de estaño puede aplicarse antes del pulimento a la llama de las botellas, si se usa pulimento a la llama.

Luego de depositar el recubrimiento de óxido de estaño, el artículo de vidrio cubierto con óxido de estaño, en algunas incorporaciones, puede pulirse a la llama para fundir y corregir cualesquiera imperfecciones superficiales en el vidrio. Alternativamente, puede emplearse cualquier velocidad aceptable de pulimento a la llama. El pulimento a la llama puede aumentar asimismo la temperatura del artículo de vidrio a alrededor de 25°C, por encima del punto de recocido del vidrio, o incluso más en algunas situaciones. En otra incorporación de la invención, las botellas no se recubren con el óxido de estaño. En algunas incorporaciones, después del pulimento a la llama y la deposición del recubrimiento de óxido de estaño, la temperatura de la botella puede ser superior a 550°C.

El endurecimiento químico puede ocurrir directamente luego de aplicar el recubrimiento de óxido de estaño o, alternativamente, después del pulimento a la llama. Para efectuar el endurecimiento químico, el artículo puede sumergirse en un baño de sal. En una incorporación, las botellas se sumergen en, por ejemplo, un baño de sal 50% KNO<sub>3</sub>/50% KCl que está a una temperatura de 610°C durante alrededor de 1 segundo. Luego de la breve inmersión en el baño de sal, las botellas pueden transferirse a un túnel de endurecimiento que está a una temperatura de, por ejemplo, entre 480°C y 530°C. En otra incorporación, las botellas pueden ponerse en un túnel de endurecimiento, siendo la temperatura del túnel entre, por ejemplo, 490 °C y 520 °C. En incorporaciones alternativas, el túnel de endurecimiento puede tener una temperatura de punto de ajuste entre alrededor de 150°C menos del punto de deformación del vidrio y entre alrededor del punto de deformación del vidrio. La temperatura del artículo endurecido puede reducirse en una sección de enfriamiento del túnel durante aproximadamente 25 minutos a 90°C. Después del enfriamiento, el artículo de vidrio se sumerge a continuación en un baño de agua a 90°C durante una duración pre-determinada para eliminar el exceso de sal. En una incorporación, el

86

tiempo pre-determinado puede ser, por ejemplo, 6 segundos para eliminar el exceso de sal. A continuación puede eliminarse el exceso de agua utilizando, por ejemplo, una cortina de aire.

Un recubrimiento de zona de enfriamiento tal como, por ejemplo, un recubrimiento de estearato o polietileno puede aplicarse al artículo caliente. Otros recubrimientos de zona de enfriamiento pueden incluir agregar un recubrimiento de zona de enfriamiento a baja temperatura tal como una cera de silicona, polietileno, alcohol polivinílico, ácido esteárico, o ácido oleico, o cualquier recubrimiento de zona de enfriamiento conocido por aquellos en el arte de la fabricación de botellas para proporcionar lubricidad y evitar el rayado de la botella al pasar las líneas de inspección y llenado. El artículo recubierto puede transferirse entonces a una línea de decoración para aplicar un recubrimiento decorativo orgánico de baja temperatura. En una incorporación usando un recubrimiento de polietileno, es posible que no se requiera que el recubrimiento cure. En una incorporación, puede aplicarse a la superficie del artículo de vidrio un recubrimiento protector, resistente al rayado. En una incorporación alternativa, puede aplicarse un recubrimiento pos-terminado luego de un proceso de lavado cáustico antes del proceso de envasado de la botella. Este recubrimiento pos-terminado puede ser, por ejemplo, un recubrimiento de polietileno. En el caso de botellas recargables, estos recubrimientos pueden aplicarse después de cada ciclo de lavado cáustico. Un ejemplo de un recubrimiento de botella aceptable que puede utilizarse como un recubrimiento pos-acabado es el Recubrimiento Anti-Rayaduras Tegoglas 3000+ ofrecido para venta por Atofina.

Debe anotarse que la mayor dureza del vidrio en botellas manufacturadas usando las técnicas descritas aquí puede permitir que se emplee menos vidrio, conservando al mismo tiempo una dureza equivalente de la botella. Por ejemplo, usando un modelo por computador, botellas que pesan 170 gramos, manufacturadas empleando métodos del arte previo, pueden reducirse a 110 gramos, conservando simultáneamente la dureza de las botellas. Debe anotarse además que pueden mejorarse los métodos superiores de endurecimiento de la presente invención, y reducirse aún más

87

el peso de la botella diseñando botellas que aprovechen las características de alta dureza de las superficies exteriores de las botellas elaboradas por estos métodos. Pueden diseñarse botellas para sacar provecho de estas características usando modelamiento por computador, por ejemplo, métodos de análisis de elementos finitos conocidos por los expertos en el arte.

Figura 5 es un flujograma de un método de acuerdo con una incorporación alternativa de la invención. Los pasos de formación de la botella 210 pueden realizarse como ya se describió en la sección de antecedentes. Inmediatamente después de que se ha formado una botella, su temperatura está típicamente por encima del puede tener una temperatura de aproximadamente 600°C. El proceso de formación de la botella acarrea frecuentemente defectos del vidrio, en general por choque térmico por el contacto con un material más frío tal como un molde o una placa pasiva. Estos defectos pueden ser concentradores de esfuerzos y constituyen a menudo la causa de la baja dureza en las botellas de vidrio.

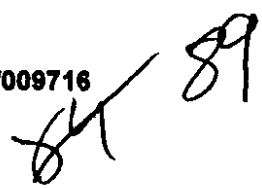
La botella puede pulirse entonces a la llama 220 en una manera similar a la ya descrita con respecto a los métodos de inmersión en baño de sal. El pulimento a la llama puede realizarse por cualquier método conocido en el arte. Por ejemplo, el pulimento a la llama puede llevarse a cabo pasando la botella a lo largo de una serie de toberas que despiden un gas combustible, por ejemplo, aire-metano, oxi-metano, aire-acetileno, u oxi-acetileno. Pueden agregarse otros componentes tales como humedad a la corriente de la llama para acelerar el proceso de suavizado de los defectos. El pulimento a la llama es útil para realizar cualquiera de los dos o ambos de los dos objetivos: (1) corregir los defectos superficiales en la superficie del vidrio, y (2) aumentar la temperatura superficial del vidrio a una temperatura que puede aumentarse más allá del punto de recocido, minimizando así cualquier rotura durante el subsiguiente proceso de pulverización descrito a continuación.

El pulimento a la llama 220 puede efectuarse aplicando la llama a la botella durante 0.1-10 segundos, preferiblemente desde 0.1-5 segundos. Muy preferiblemente, la llama se pone en contacto con la superficie de la botella durante un tiempo suficiente para hacer que cualesquiera grietas

filosas se fundan y se redondeen. El paso de pulimento a la llama 220 puede aumentar la temperatura superficial de la botella bien por encima del punto de recocido del vidrio. En una incorporación, las botellas pueden calentarse, por ejemplo, a una temperatura por encima de 650°C. Alternativamente, el pulimento a la llama 220 puede aumentar la temperatura superficial de las botellas a entre 550°C y 650°C. Los beneficios del pulimento a la llama ya se han descrito con referencia Figura 3.

En incorporaciones alternativas de métodos inmersión, pulverización, u otros métodos de aplicación de sales, en lugar de, o adicional al, pulimento a la llama, un método de la invención puede utilizar calentamiento superficial con microondas para corregir defectos en el vidrio, para introducir esfuerzo residual superficial controlado, para acelerar el endurecimiento con intercambio iónico luego de que se ha rociado una sal, para endurecer por desalcalinización mediante un compuesto de sulfato de amonio aplicado por pulverización, y/o aumentar la temperatura superficial para acelerar un proceso de endurecimiento subsiguiente de intercambio iónico. El calentamiento de la superficie del vidrio por irradiación de microondas puede facilitarse por la aplicación de un recubrimiento sensible a microondas a la superficie del artículo de vidrio. Particularmente útil en reacciones de intercambio iónico es un recubrimiento sensible a microondas, que contiene también iones de potasio intercambiables.

En una incorporación de la invención, las botellas pueden rociarse entonces 230 con una solución de sal, mientras la temperatura superficial de la botella es mayor que la temperatura de recocido. En un ejemplo, las botellas pueden tener una temperatura superficial de entre alrededor de 550°C y 650°C cuando la temperatura de recocido está alrededor de 550°C. Preferiblemente, la temperatura superficial del vidrio es lo suficientemente caliente para que la pulverización de la solución de sal no enfríe el vidrio por debajo del punto de deformación (el punto de deformación puede ser, por ejemplo, 530°C). Preferiblemente, el disolvente se evapora antes de, o inmediatamente, en contacto con la superficie de la botella. Un margen preferido de temperatura es mayor que alrededor de 50°C por encima del



punto de recocido del vidrio. Un margen alternativo de temperatura es mayor que alrededor de 50°C por encima del punto de deformación del vidrio. En todavía otra incorporación alternativa, la temperatura de la superficie del vidrio es cualquier temperatura a la cual el paso de pulverización no resulta en inducir defectos en el artículo de vidrio.

La solución de sales puede ser cualquier solución conocida por aquellas personas expertas en el arte por ser útiles en el endurecimiento de vidrio con intercambio iónico. Una solución de sales preferida es una solución acuosa con 50% en peso de fosfato de potasio ( $K_3PO_4$ , anhidro). Esta solución es preferida porque una solución de 50% en peso de fosfato de potasio es obtenible a la temperatura de la sal; por consiguiente, sería innecesario calentar la solución. No obstante, una solución de 62% en peso de fosfato de potasio puede lograrse a alrededor de 50°C, y tal solución puede usarse igualmente en la invención. Alternativamente, la solución de sales puede ser 45% en peso de fosfato de potasio, 10% en peso de fosfato de sodio ( $Na_3PO_4$ ), y el resto puede ser agua. En otra incorporación, la solución de sales comprende una mezcla de sulfato de potasio ( $K_2SO_4$ ), cloruro de potasio (KCl), y nitrato de potasio ( $KNO_3$ ).

En una incorporación alternativa, las botellas pueden rociarse a la llama en lugar de rociarse de una manera convencional. En la incorporación del rociado a la llama, una sal en polvo, por ejemplo, sal de fosfato de potasio, puede pulverizarse sobre la superficie de las botellas. Usando una incorporación de pulverización a la llama de acuerdo con una incorporación de la invención, se contempla que la cinética de rociado puede aumentarse y reducirse la rotura con el método de rociado a la llama, porque este método no requiere que el calor de la botella evapore el agua en la gotícula atomizada. La sal en polvo puede fundirse en una llama para formar un rociado atomizado fundido, fino. En una incorporación alternativa, en lugar de la sal en polvo, el rociado a la llama puede usar una solución. La llama puede ser cualquier llama conocida por aquellas personas expertas en el arte, por ejemplo, metano, oxi-metano, acetileno, oxi-acetileno o hidrógeno. Ejemplos de dispositivos de rociado a la llama que pueden ser útiles para uso

en la presente invención incluyen dispositivos divulgados y mencionados en las Patentes de los Estados Unidos No. 4,674,683 y 5,297,733, o cualquier otro dispositivo de rociado a la llama conocido por las personas expertas en el arte.

En todavía otra incorporación alternativa, las botellas pueden rociarse electrostáticamente. En esta incorporación, se aplica un potencial eléctrico al pulverizador, por ejemplo, un potencial negativo, y la botella se conecta a tierra. Pequeñísimas gotas de solución de sales o sales fundidas se cargan negativamente y se atraen a la botella neutra, proporcionando así un recubrimiento uniforme a la botella. Ejemplos de dispositivos de rociado electrostático que pueden ser útiles para uso en la presente invención incluyen dispositivos divulgados y mencionados en las Patentes de los Estados Unidos No. 5,759,271 y 5,704,554, o cualquier otro dispositivo de rociado electrostático conocido por las personas expertas en el arte.

Como en los métodos de inmersión descritos previamente, las botellas rociadas, pulidas a la llama, pueden someterse entonces a tratamiento térmico 240 en un túnel de endurecimiento o cualquier otro entorno apropiado, tal como un horno. Preferiblemente, el tratamiento térmico se hace a una temperatura menor que el punto de deformación del vidrio. Por ejemplo, si el punto de deformación es 530°C, el tratamiento térmico en el túnel de endurecimiento puede estar a una temperatura de punto de ajuste de 510°C durante 20 a 25 minutos. Como otro ejemplo, el tratamiento térmico en el túnel de endurecimiento puede ser 520°C durante 15 minutos. No obstante, otras incorporaciones incluyen tratamiento térmico a una temperatura mayor de 80°C por debajo del punto de deformación del vidrio o tratamiento térmico a una temperatura mayor que el punto de deformación del vidrio. En una incorporación preferida, el túnel de endurecimiento puede tener una temperatura entre alrededor de 150°C por debajo del punto de deformación; más preferiblemente, entre alrededor de 130°C por debajo de la temperatura del punto de deformación y entre alrededor de la temperatura del punto de deformación del vidrio. En cada una de estas incorporaciones, como se discute con referencia a Figura 4, hay un equilibrio que tiene que lograrse

entre acelerar la reacción de intercambio iónico, que ocurre a temperaturas más elevadas, y evitar el relajamiento de la superficie del vidrio, lo cual se obtiene mejor con temperaturas más bajas. Por ejemplo, en el punto de recocido, el relajamiento de la superficie del vidrio ocurre en **aproximadamente 15 minutos**.

En una incorporación preferida, la temperatura del tratamiento térmico es menor que el punto de fusión de la sal que se roció sobre la superficie de las botellas, con el fin de evitar que la sal escurra por las caras de la botella. Esto impide una distribución desigual de la sal en la superficie de la botella y, por consiguiente, impide un endurecimiento desigual, y evita además la acumulación de las sales dentro del túnel. La aplicación de rociado acuoso de la sal forma un recubrimiento persistente sobre la botella de vidrio, que no se elimina fácilmente por contacto abrasivo. Una vez las botellas se han sometido a tratamiento térmico 240, se enfrían 250 y se lavan con agua 260 para eliminar el residuo de sal residual. Otro procesamiento adicional puede ser la aplicación de recubrimientos decorativos y la aplicación de segundos recubrimientos protectores, como ya se describió.

Figura 6 es un gráfico de columnas que compara los beneficios de varios métodos de endurecimiento de vidrio, de acuerdo con una incorporación de la invención. Como es evidente en el gráfico de Figura 6, el uso de un método de intercambio iónico, incluyendo el pulimento a la llama, puede producir vidrio con una dureza mayor que los métodos de intercambio iónico y pulimento a la llama, solos. Los experimentos llevados a cabo para obtener este gráfico se describe con más detalle a continuación en Ejemplo 12.

Figura 7 es una vista en planta de un sistema de endurecimiento de vidrio 700 de acuerdo con una incorporación de la invención. La máquina formadora de vidrio 712 recibe las materias primas para elaborar un tipo particular de vidrio por la entrada/carga 711. La máquina formadora de vidrio 712 puede configurarse para procesar gotas o bulbos individuales de vidrio en artículos de vidrio formados, como se describe en los antecedentes. Artículos de vidrio formados emergen de la máquina formadora en las

42 92

formas de, por ejemplo, botellas 701. En la misma manera pueden formarse otros artículos de vidrio, tales como, por ejemplo, potes, jarras y vasos, para mencionar unos cuantos ejemplos.

Luego que las botellas 701 se extraen de la máquina formadora 712, pueden monitorearse, y las botellas defectuosas pueden descartarse por la salida/descarga 713. Después de una inspección inicial, las botellas pueden recubrirse con un recubrimiento en 721. La aplicación del recubrimiento en 721 puede incluir, por ejemplo, la aplicación de un recubrimiento de óxido de estaño. El recubrimiento de óxido de estaño puede aplicarse en un espesor, de, por ejemplo, entre alrededor de 20 y 45 ctu. En algunas incorporaciones, el recubrimiento de las botellas 701 es opcional. En todavía otra incorporación, las botellas 701 pueden pulirse a la llama antes de aplicar el recubrimiento de óxido de estaño en 721.

Una vez concluido el recubrimiento de las botellas 721, las botellas pueden pasarse por una rueda de transferencia de centro 722 a la cinta transportadora transversal 730. En la cinta transportadora transversal 730, las botellas 701 pueden pulirse a la llama usando medios de pulimento a la llama 731. Los medios de pulimento a la llama 731 pueden ser cualquier tipo de aparato de pulimento a la llama, que puede configurarse para utilizarse en la línea de manufactura industrial. El pulimento a la llama de las botellas es opcional, pero en algunas incorporaciones puede preferirse debido a los efectos potencialmente benéficos que el pulimento a la llama tiene sobre la dureza del producto final de vidrio. Se ha descubierto que el pulimento a la llama es especialmente beneficioso para botellas con grandes defectos, que tienden a debilitar el artículo de vidrio. El pulimento a la llama puede disminuir sustancialmente el porcentaje de rotura porque el pulimento a la llama elimina estos defectos grandes, endureciendo así las botellas que tienen más tendencia a romperse debido a las imperfecciones, como ya se describió. En algunas incorporaciones, las botellas no necesitan que se pulan a la llama los lados. Por ejemplo, es posible que las botellas de cerveza no necesiten tener pulidos sus lados en todas las incorporaciones de la invención. Por lo tanto una decisión de si pulir o no una botella a la llama puede depender del

47

tipo de botella que se está puliendo.

Una vez que las botellas se han pulido a la llama usando un aparato de pulimento a la llama 731, las botellas pueden disponerse frente al túnel, de modo que un medio de traslado del artículo de vidrio 741, tal como, por ejemplo, un brazo de una máquina robótica, ilustrado por círculos 741 pueda recoger las botellas de vidrio de un área de operaciones frente al túnel, y sumergirlas en el baño de sal 751. Alternativamente, el baño de sal 751 puede reemplazarse por un mecanismo para rociar las botellas con una solución de sales o, alternativamente, un medio para rociar la botella a la llama. En una incorporación alternativa, antes de sumergirlas en la solución de sales, las botellas de vidrio 701 pueden desplazarse sobre medios opcionales de pulimento a la llama 732, de manera que puedan pulirse a la llama los fondos de las botellas 701. Las botellas pueden pulirse a la llama a cualquier velocidad aceptable de pulimento a la llama.

Después de que las botellas se han pulido a la llama usando medios opcionales de pulimento a la llama 732 y se han sumergido en el baño de sal 751, las botellas pueden ponerse en el túnel de endurecimiento 760. En una incorporación de la invención, el túnel de endurecimiento puede tener una sección de endurecimiento 761 y una sección de enfriamiento 762. Alternativamente, puede haber más de una sección de endurecimiento 761, y más de una sección de enfriamiento 762. Una configuración ejemplar de túnel de recocido se ilustra en Figura 8A. En esta incorporación, hay seis secciones de recocido y tres secciones de enfriamiento. El túnel de recocido en Figura 8A se usó para efectuar pruebas de comparación, como se describe con respecto a Ejemplo 11, discutido más adelante, el túnel tradicional de recocido ilustrado en Figura 8A puede incluir una primera zona con una temperatura de punto de ajuste de 555°C. Un artículo de vidrio puede permanecer en cada zona durante, por ejemplo, tres minutos. Una segunda zona puede tener una temperatura de punto de ajuste de 550°C. Una tercera zona puede tener una temperatura de punto de ajuste de, por ejemplo, 540°C. Una cuarta zona puede tener una temperatura de punto de ajuste de alrededor de 500°C. Una quinta zona puede tener una temperatura de punto de ajuste

de 460°C. Una sexta zona puede tener una temperatura de punto de ajuste de 430°C. La séptima, octava, y novena zonas pueden tener temperaturas de punto de ajuste de 320°C, 200°C y 130°C, respectivamente. Puede usarse cualquier perfil conocido de temperatura de recocido en comparar los efectos de mantener las temperaturas de punto de ajuste del túnel por debajo de la temperatura de los artículos de vidrio y, preferiblemente, entre alrededor de 150°C por debajo de la temperatura del punto de deformación del vidrio y entre alrededor de la temperatura del punto de deformación del vidrio. Más preferiblemente, la temperatura puede estar entre alrededor de 130°C menos de la temperatura del punto de deformación del vidrio y entre alrededor de la temperatura del punto de deformación del vidrio.

Un ejemplo de un túnel de endurecimiento se ilustra en Figura 8B. En esta incorporación, existen cinco secciones de endurecimiento y cuatro secciones de enfriamiento. Un túnel de endurecimiento puede incluir una primera, segunda, tercera, cuarta y quinta zona, cada una con una temperatura de punto de ajuste de alrededor de 500°C. Una sexta zona puede tener una temperatura de punto de ajuste de, por ejemplo, 470°C. Las zonas séptima, octava y novena pueden tener temperaturas de punto de ajuste de, por ejemplo, alrededor de 320°C, 200°C y 130°C, respectivamente. Pueden utilizarse otros perfiles de temperatura de endurecimiento en conexión con los métodos de la presente invención.

Se realizó un número de ensayos usando un entorno de fábrica simulado. Con el fin de simular la línea de producción, luego de haberse formado en la máquina formadora 712, las botellas se pre-calentaron. En un ejemplo, una botella de 200 mL se trató a la llama a 4" por segundo, se pre-calentó a 500°C durante cinco minutos, se sumergió en un baño de sal a 615°C, y se endureció en un túnel 760 durante 20 minutos a 500°C. La temperatura media de esta botella antes de este tratamiento era de 501 °C y, después de este tratamiento, era de 451°C. En otro ejemplo, una botella de 200 mL se pulió a la llama a 4" por segundo, y se precalentó durante cinco minutos a 590°C. La temperatura superficial de la botella antes de los tratamientos era de 501°C y, luego del tratamiento, era de 525°C. En otro

95

ejemplo, una botella de 200mL se pulió a la llama a 4" por segundo, se pre-calentó a una temperatura de 500°C durante cinco minutos y se sumergió en un baño de sal, estando el baño de sal a una temperatura de 615°C. La temperatura de la botella antes de este tratamiento era 496°C, y la temperatura luego de este tratamiento era 489°C. En todavía otro ejemplo, una botella de 200 mL se pulió a la llama a 4" por segundo, y se pre-calentó a una temperatura de 500°C. La temperatura de la botella antes del tratamiento era 494°C y, luego del tratamiento, la temperatura de la botella era 463°C. En todavía otro ejemplo, una botella de 200 mL se pulió únicamente a la llama a 4" por segundo. La temperatura de la botella antes del pulimento a la llama era 500°C y la temperatura luego del pulimento a la llama era 471°C. En otro ejemplo, una botella de 200 mL se pulió a la llama a una velocidad de 4" por segundo, se pre-calentó a una temperatura de 500°C y se endureció en un túnel 760 durante 20 minutos a 500°C. La temperatura de la botella antes de este tratamiento era 492°C y, luego del tratamiento, era 452°C. Todas las temperaturas ya mencionadas son temperaturas medias de la botella, basadas en mediciones tomadas de por lo menos tres sitios en la botella.

Un proceso opcional de eliminación de sal en tres pasos (donde cada uno de los pasos puede usarse solo o en combinación con cualquiera de los otros pasos) puede comenzar con un primer paso de enjuague por rociado después de que las botellas salen del túnel 760. Una vez rociadas las botellas 701, pueden moverse por los brazos de la máquina 761 y sumergirse en un baño de agua caliente para disolver cualquier sal que quede en las botellas 701. En una incorporación, luego de sumergirse, las botellas 701 pueden enjuagarse nuevamente por rociado para eliminar cualquier resto de sal. Una vez realizados los pasos opcionales de enjuague, las botellas pueden secarse con, por ejemplo, un chorro de aire. Una vez secadas, las botellas 701 pueden extraerse por la cinta transportadora 790 a una máquina de post-recubrimiento (no ilustrada).

Figura 9 es una vista en perspectiva de un mecanismo para sumergir botellas en un sistema para endurecer botellas de acuerdo con un aspecto de

la invención. Un brazo mecánico 741 puede configurarse para mover, por ejemplo, dos hileras de botellas 701 usando elementos de agarre 742. El brazo mecánico puede entonces sumergir las dos hileras de botellas 701 en el baño de sal 751. Las botellas 701 pueden sumergirse en un baño de sal durante un período de entre, por ejemplo, un minuto o menos. Alternativamente, las botellas pueden sumergirse durante un tiempo entre alrededor de 0.5 segundos y entre alrededor de 30 segundos. Preferiblemente, las botellas pueden sumergirse durante un tiempo entre alrededor de 3 segundos y 5 segundos. En todavía otra incorporación preferida, las botellas pueden sumergirse durante un tiempo menos de alrededor de 10 segundos. Una vez transcurrido un tiempo pre-determinado, el brazo mecánico 741 puede retirar las botellas 701 del baño de sal 751. En una incorporación de la invención, los fondos de las botellas 701 pueden pulirse a la llama. En una incorporación alternativa, los fondos de las botellas 701 no se pulen a la llama.

Figura 10 es una vista en perspectiva de un mecanismo para enjuagar botellas 770 en un sistema para endurecer botellas de acuerdo con un aspecto de la invención. El sistema para enjuagar botellas 770 puede incluir un brazo mecánico 771, con un miembro de agarre 772. En una incorporación de la invención, el miembro de agarre 772 puede configurarse para agarrar dos hileras de botellas 701 y enjuagarlas en un baño de agua caliente. En una incorporación, el agua en el tanque de enjuagado 780 puede estar a una temperatura de, por ejemplo, 90 °C. El agua en el tanque de enjuagado 780 puede estar a cualquier temperatura cerca de la temperatura de las botellas cuando salen del túnel 760, como ya se describió. Luego de enjuagar las botellas en el tanque de enjuagado 780 durante un período de tiempo pre-determinado, el brazo mecánico 771 puede depositar las botellas enjuagadas 701 sobre una cinta transportadora 781 para manejo posterior.

En un experimento utilizando todos los procesos de endurecimiento ya aludidos, excepto por el proceso químico de intercambio iónico, se tomó la temperatura media de cinco botellas en varios puntos en el sistema. Las temperaturas de las botellas de vidrio se tomaron en las siguientes etapas del

proceso: el bulbo de vidrio ("A"), blanco de vidrio ("B"), desmoldeados ("take outs") ("C"), extremo de la máquina ("D"), antes del recubridor de zona caliente ("E"), después del recubridor de zona caliente ("F"), en la rueda de transferencia de centro ("G"), en la entrada del túnel ("H"), y al final del túnel ("I"). Como ya se mencionó, estas mediciones de temperatura se tomaron sin el pulimento a la llama en la cinta transportadora entre la máquina formadora 712 y la rueda de transferencia 722, o la rueda de transferencia 722 y la entrada del túnel ("H") o un proceso químico de intercambio iónico o el pulimento a la llama que se usa a la entrada del túnel ("I").

Los resultados representan un promedio de cinco botellas con las capacidades de botella de 200 mL, una botella de 300 mL, una botella de 330 mL, una botella de 350 mL, y una botella de 1 L. Los resultados para estas diferentes capacidades de botella en cada uno de los diferentes sitios se ilustran en Tabla 1.

| Punto | 200 mL (°C) | 300 mL (°C) | 330 mL (°C) | 350 mL (°C) | 1 L (°C) |
|-------|-------------|-------------|-------------|-------------|----------|
| A     | 1030.5      | 1007.3      | 1038.8      | 1016.8      | 1016.4   |
| B     | 796.5       | 740.3       | 804.7       | 749.1       | 776.4    |
| C     | 687.4       | 634.1       | 665.6       | 657.4       | 622.1    |
| D     | 683.4       | 618.8       | 614.8       | 636.2       | 605.0    |
| E     | 679.2       | 618.7       | 638.5       | 620.6       | 604.5    |
| F     | 673.9       | 615.3       | 621.2       | 630.8       | 594.4    |
| G     | 637.4       | 592.8       | 581.8       | 570.8       | 578.0    |
| H     | 605.3       | 579.3       | 561.9       | 570.9       | 571.4    |
| I     | 172.5       | 147.4       | 179.3       | 145.6       | 176.4    |

**TABLA 1**

La botella de 200 mL tuvo una velocidad de enfriamiento en la zona de enfriamiento por pulgada °C de 0.38. La velocidad de la cinta transportadora entre la máquina formadora 712 y la rueda de transferencia 722 era de 34"

por segundo. La velocidad de la cinta transportadora entre la rueda de transferencia 722 y la entrada del túnel era de 26" por segundo. La botella de 300 mL tuvo una velocidad de enfriamiento en la zona de enfriamiento por pulgada °C de 0.29. La velocidad de la cinta transportadora entre la máquina formadora 712 y la rueda de transferencia 722 era 21" por segundo. La velocidad de la cinta transportadora entre la rueda de transferencia 722 y la entrada del túnel era de 16" por segundo. La botella de 330 mL tuvo una velocidad de enfriamiento en la zona de enfriamiento por pulgada °C de 0.40. La velocidad de la cinta transportadora entre la máquina formadora 712 y la rueda de transferencia 722 era 34" por segundo. La velocidad de la cinta transportadora entre la rueda de transferencia 722 y la entrada del túnel era 25" por segundo. La botella de 350 mL tuvo una velocidad de enfriamiento en la zona de enfriamiento por pulgada °C de 0.35. La velocidad de la cinta transportadora entre la máquina formadora 712 y la rueda de transferencia 722 era 22" por segundo. La velocidad de la cinta transportadora entre la rueda de transferencia 722 y la entrada del túnel era 16" por segundo. La botella de 1 L tuvo una velocidad de enfriamiento en la zona de enfriamiento por pulgada °C de 0.37. La velocidad de la cinta transportadora entre la máquina formadora 712 y la rueda de transferencia 722 era 15" por segundo. La velocidad de la cinta transportadora entre la rueda de transferencia 722 y la entrada del túnel era 11" por segundo.

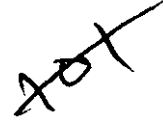
Una ventaja de emplear el sistema ya mencionado es que no hay necesidad de modificación sustancial a las líneas de producción para montar una instalación de manufactura para fabricar artículos de vidrio usando los métodos de la presente invención. Por ejemplo, con la adición de los medios de traslado de botellas, así como, por ejemplo, un baño de sal o medios de rociado, pueden utilizarse muchas de las características de la presente invención. Adicionalmente, puede usarse un túnel de recocido como un túnel de endurecimiento simplemente modificando las temperaturas dentro del túnel. Finalmente, usando la invención, se puede fabricar vidrio selectivamente usando cualquiera de los métodos de recocido o los métodos de la presente invención, dependiendo de los requerimientos del vidrio a

ordinaria en el arte, variar el tipo de vidrio utilizado para elaborar artículos de vidrio empleando cualquiera de los métodos de acuerdo con las varias incorporaciones de la invención, puede requerir alguna optimización debido a características potencialmente diferentes del vidrio, tales como, por ejemplo diferentes temperaturas de recocido, diferentes temperaturas de puntos de deformación, y diferentes durezas resultantes. La composición del vidrio de pedernal usada en los siguientes ejemplos se resume en la siguiente Tabla 3.

| <b>COMPOSICIÓN DEL VIDRIO DE PEDERNAL</b> |                        |
|-------------------------------------------|------------------------|
| <b>ÓXIDOS</b>                             | <b>COMPOSICIÓN (%)</b> |
| SiO <sub>2</sub>                          | 72                     |
| Al <sub>2</sub> O <sub>3</sub>            | 1.6                    |
| Fe <sub>2</sub> O <sub>3</sub>            | 0.7                    |
| Na <sub>2</sub> O                         | 13                     |
| K <sub>2</sub> O                          | 0.86                   |
| MgO                                       | 0.20                   |
| CaO                                       | 10                     |
| SO <sub>3</sub>                           | 0.21                   |
| BaO                                       | 0                      |
| Cr <sub>2</sub> O <sub>3</sub>            | 0.0010                 |
| TiO <sub>2</sub>                          | 0.019                  |
| SrO                                       | 0                      |
| Punto de Recocido                         | 540°C                  |

**TABLA 3**  
**EJEMPLO 1**

En un primer ejemplo de acuerdo con una incorporación de la invención, se formaron cinco botellas en la máquina formadora y se recubrieron con un recubrimiento de óxido de estaño en la zona caliente. A continuación, las botellas se pulieron a la llama. El recubrimiento de óxido de estaño tenía un espesor de 40 ctu. Para simular las condiciones, como podrían ocurrir en una línea real de producción, las botellas se pre-calentaron a una temperatura de 510 °C durante un minuto. Una vez pre-calentadas, las botellas se sumergieron en un baño de sal. El baño de sal consistía de 50/50 KCl/KNO<sub>3</sub> y se mantuvo a una temperatura de 600 °C. Las botellas se sumergieron entonces en el baño de sal durante 1 segundo. El peso promedio

**Reivindicamos:**

1. Un método, que comprende los pasos de:  
formar un artículo de vidrio de vidrio fundido, teniendo el vidrio una **temperatura de punto de recocido**;  
sumergir el artículo de vidrio formado en un baño de sal fundida, comprendiendo el baño de sal iones de potasio en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de inmersión; y  
mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.
2. El método de la reivindicación 1, en donde la temperatura superficial del artículo de vidrio es por lo menos alrededor de 25°C por encima de la temperatura de punto de recocido del vidrio.
3. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante menos de alrededor de un minuto.
4. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 10 segundos o menos.
5. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 0.5 segundo y entre alrededor de 30 segundos.
6. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.
7. El método de la reivindicación 1, en donde el baño de sal comprende

~~102~~

nitrato de potasio y cloruro de potasio.

8. El método de la reivindicación 7, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

9. El método de la reivindicación 1, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

10. El método de la reivindicación 1, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio.

11. El método de la reivindicación 1, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

12. El método de la reivindicación 1, en donde el baño de sal tiene una temperatura de entre alrededor de 550°C y entre alrededor de 750°C.

13. El método de la reivindicación 1, en donde mantener el artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

14. El método de la reivindicación 1, en donde la temperatura del punto de deformación es alrededor de 530°C.

15. El método de la reivindicación 1, que comprende además:  
pulir a la llama el artículo de vidrio antes de sumergir el artículo de vidrio en el baño de sal.



16. El método de la reivindicación 1, que comprende además:  
después del paso de mantenimiento, enfriar el artículo de vidrio, eliminar la sal residual del artículo de vidrio y aplicar a la superficie del artículo de vidrio un recubrimiento protector resistente al rayado

17. Un aparato, que comprende:

un área de operaciones;

medios de traslado del artículo de vidrio;

un baño de sal, comprendiendo el baño de sal fundida, configurándose los medios de traslado del artículo de vidrio para mover el artículo de vidrio desde el área de operaciones y sumergir el artículo de vidrio en el baño de sal, configurándose los medios de traslado del artículo de vidrio para sumergir artículos de vidrio con temperaturas superficiales de por lo menos la temperatura de punto de recocido del vidrio, configurándose el artículo de vidrio para permanecer en el baño de sal durante menos de alrededor de un minuto; y

un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

18. El aparato de la reivindicación 17, en donde los medios de traslado del artículo de vidrio se configura para sumergir el artículo de vidrio en el baño de sal durante alrededor de 10 segundos o menos.

19. El aparato de la reivindicación 17, en donde los medios de traslado del artículo de vidrio se configura para sumergir el artículo de vidrio en el baño de sal durante entre alrededor de 0.5 segundo y entre alrededor de 30 segundos.

104

20. El aparato de la reivindicación 17, en donde los medios de traslado del artículo de vidrio se configura para sumergir el artículo de vidrio en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

21. El aparato de la reivindicación 17, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

22. El aparato de la reivindicación 21, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

23. El aparato de la reivindicación 17, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

24. El método de aparato de la reivindicación 17, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio.

25. El aparato de la reivindicación 17, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

26. El aparato de la reivindicación 17, en donde el túnel de endurecimiento se configura para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 130°C por debajo de la temperatura del punto de deformación

27. El aparato de la reivindicación 17, en donde la temperatura del punto de deformación es alrededor de 530°C.

28. El aparato de la reivindicación 17, que comprende además:

medios de pulimento a la llama, configurándose los medios de pulimento a la llama para pulir a la llama los artículos de vidrio.

29. El aparato de la reivindicación 28, en donde los medios de pulimento a la llama es un primer medio de pulimento a la llama configurado para pulir a la llama los lados del artículo de vidrio, aparato que comprende además:

un segundo medio de pulimento a la llama configurado para pulir a la llama los fondos de los artículo de vidrio.

30. El aparato de la reivindicación 17, que comprende además:

un mecanismo de recubrimiento configurado para aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio después de que el artículo de vidrio se ha sacado del túnel de endurecimiento.

31. Una instalación de manufactura de vidrio que comprende una máquina formadora de vidrio configurada para formar artículos de vidrio, y un túnel de endurecimiento, mejora que comprende:

un baño de sal que comprende sal fundida, sumergiéndose los artículos de vidrio en el baño de sal durante menos de alrededor de un minuto, teniendo los artículos de vidrio una temperatura superficial por lo menos por encima de la temperatura de punto de recocido del vidrio, mientras están siendo sumergidos en el baño de sal; y

un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener la temperatura de los artículos de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

32. El equipo de manufactura de vidrio de la reivindicación 31, que comprende además:

medios de manipulación del artículo de vidrio, configurándose los

~~106~~  
medios de manipulación del artículo de vidrio para sumergir los artículo de vidrio en el baño de sal.

33. El equipo de manufactura de vidrio de la reivindicación 31, en donde los artículos de vidrio se sumergen en el baño de sal durante alrededor de 10 segundos o menos.

34. El equipo de manufactura de vidrio de la reivindicación 31, en donde los artículos de vidrio se sumergen en el baño de sal durante entre alrededor de 0.5 segundos y entre alrededor de 30 segundos.

35. El aparato de la reivindicación 31, en donde los artículos de vidrio se sumergen en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

36. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

37. El equipo de manufactura de vidrio de la reivindicación 31, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

38. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

39. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio.

40. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un

~~107~~

punto de fusión de por lo menos 550°C.

41. El equipo de manufactura de vidrio de la reivindicación 31 en donde el túnel de endurecimiento se configura para mantener los artículos de vidrio a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

42. El equipo de manufactura de vidrio de la reivindicación 31 en donde la temperatura del punto de deformación es alrededor de 530°C.

43. El equipo de manufactura de vidrio de la reivindicación 31, que comprende además:

medios de pulimento a la llama, configurándose los medios de pulimento a la llama para pulir a la llama los artículos de vidrio.

44. El equipo de manufactura de vidrio de la reivindicación 43, en donde los medios de pulimento a la llama es un primer medio de pulimento a la llama configurado para pulir a la llama los lados del artículo de vidrio, aparato que comprende además:

un segundo medio de pulimento a la llama configurado para pulir a la llama los fondos de los artículos de vidrio.

45. El equipo de manufactura de vidrio de la reivindicación 31, que comprende además:

un mecanismo de recubrimiento configurado para aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio después de que el artículo de vidrio se ha retirado del túnel de endurecimiento.

46. Un método para endurecer un artículo de vidrio, que comprende:

formar el artículo de vidrio a partir de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;

108

aplicar iones de potasio a la superficie del artículo de vidrio, en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de aplicación; y mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

47. El método de la reivindicación 46, en donde el paso de aplicar los iones de potasio a la superficie del artículo de vidrio se lleva a cabo sumergiendo el artículo de vidrio en un baño de sal durante menos de alrededor de 10 segundos.

48. El método de la reivindicación 46, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 0.5 segundo y entre alrededor de 30 segundos.

49. El método de la reivindicación 46, en donde el paso de aplicar los iones de potasio a la superficie del artículo de vidrio se lleva a cabo sumergiendo el artículo de vidrio en un baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

50. El método de la reivindicación 46, en donde el paso de aplicar iones de potasio a la superficie del artículo de vidrio se lleva a cabo rociando iones de potasio sobre la superficie del artículo de vidrio.

51. El método de la reivindicación 50, en donde el rociado comprende pulverización a la llama.

52. El método de la reivindicación 50, en donde el rociado comprende pulverización electrostática.

53. El método de la reivindicación 50, en donde el paso de pulverización comprende pulverización de polvo.

54. El método de la reivindicación 46, en donde el paso de aplicar iones de potasio a la superficie del artículo de vidrio se lleva a cabo por deposición de vapor químico (CVD).

55. El método de la reivindicación 46, en donde el artículo de vidrio está a una temperatura de por lo menos alrededor de 25°C por encima del punto de recocido del vidrio durante el paso de aplicación.

56. El método de la reivindicación 46, en donde el artículo de vidrio está a una temperatura de por lo menos alrededor de 50°C por encima del punto de recocido del vidrio durante el paso de aplicación.

57. El método de la reivindicación 46, en donde la superficie del artículo de vidrio está a una temperatura de por lo menos alrededor de 80°C por encima del punto de recocido del vidrio durante el paso de aplicación.

58. El método de la reivindicación 46 en donde el mantenimiento del artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

59. El método de la reivindicación 46 en donde la temperatura del punto de deformación es alrededor de 530°C.

60. El método de la reivindicación 46, que comprende además:  
luego del paso de mantenimiento, aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio.

61. Un método, que comprende:

formar un artículo de vidrio a partir de vidrio fundido;

sumergir el artículo de vidrio formado en un baño de sal, comprendiendo el baño de sal iones de potasio, sumergiéndose los artículo de vidrio durante menos de alrededor de 30 segundos; y

mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

62. El método de la reivindicación 61, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 20 segundos o menos.

63. El método de la reivindicación 61, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 10 segundos o menos.

64. El método de la reivindicación 61, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

65. El método de la reivindicación 61, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

66. El método de la reivindicación 65, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

67. El método de la reivindicación 61, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

68. El método de la reivindicación 61, que comprende además:

pulir a la llama el artículo de vidrio antes de sumergir el artículo en el

111

~~111~~

baño de sal.

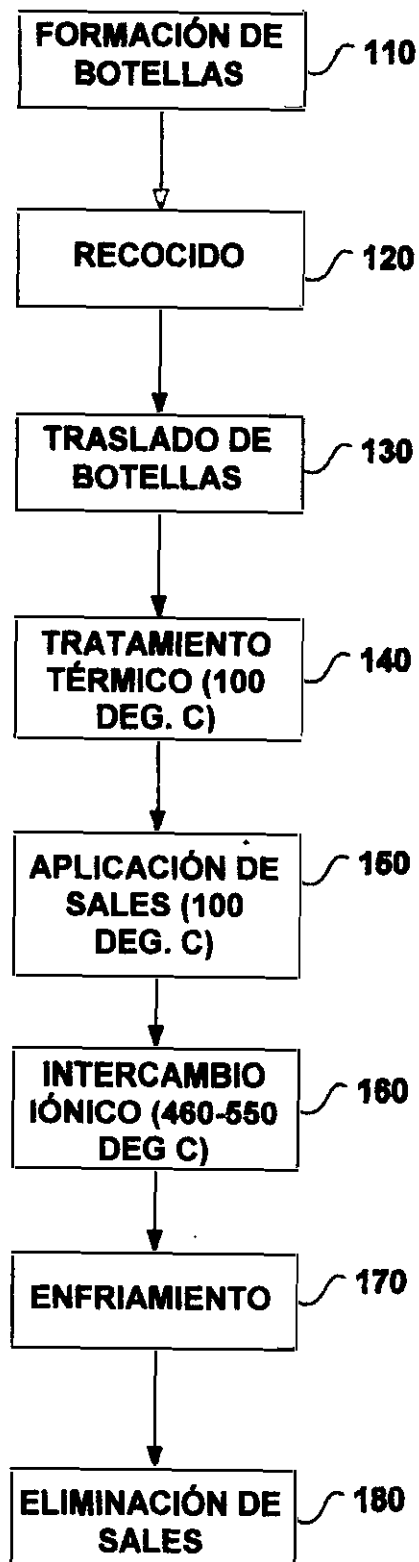
69. El método de la reivindicación 61, que comprende además:

luego del paso de mantenimiento, aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio.

70. El método de la reivindicación 61, en donde el baño de sal tiene una temperatura de entre alrededor de 550°C y entre alrededor de 750°C.

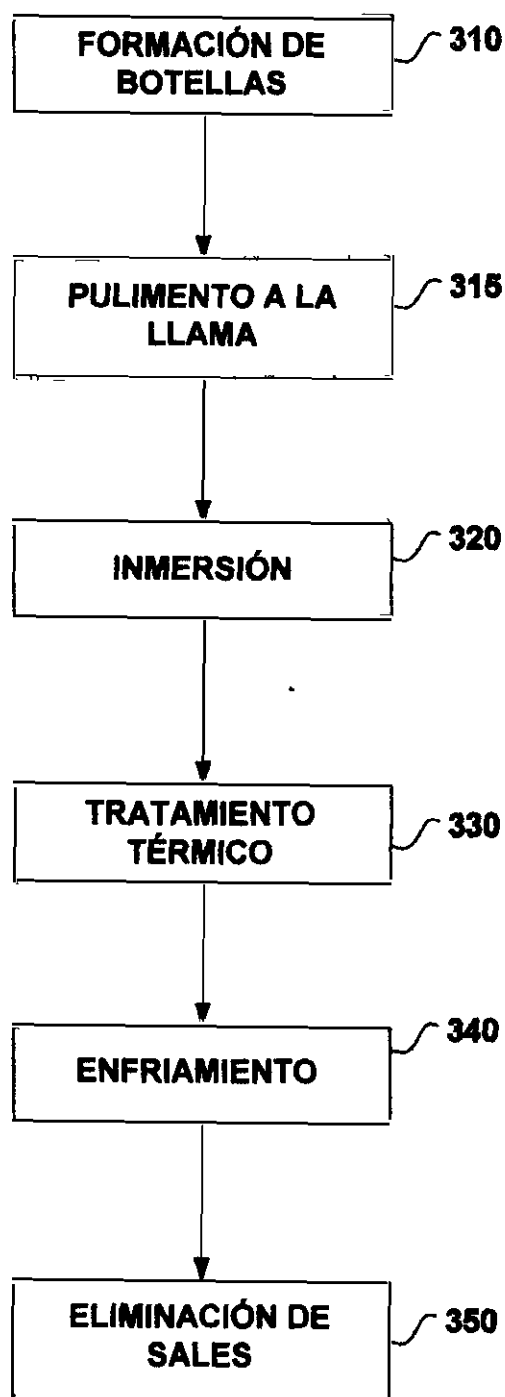
71. El método de la reivindicación 61 en donde el mantenimiento del artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

72. El método de la reivindicación 61 en donde la temperatura del punto de deformación es alrededor de 530°C.



**FIGURA 1**  
(ARTE PREVIO)

475

**FIGURA 2**

# PULIMENTO A LA LLAMA

Defectos Inducidos (50 micrones) en placas planas

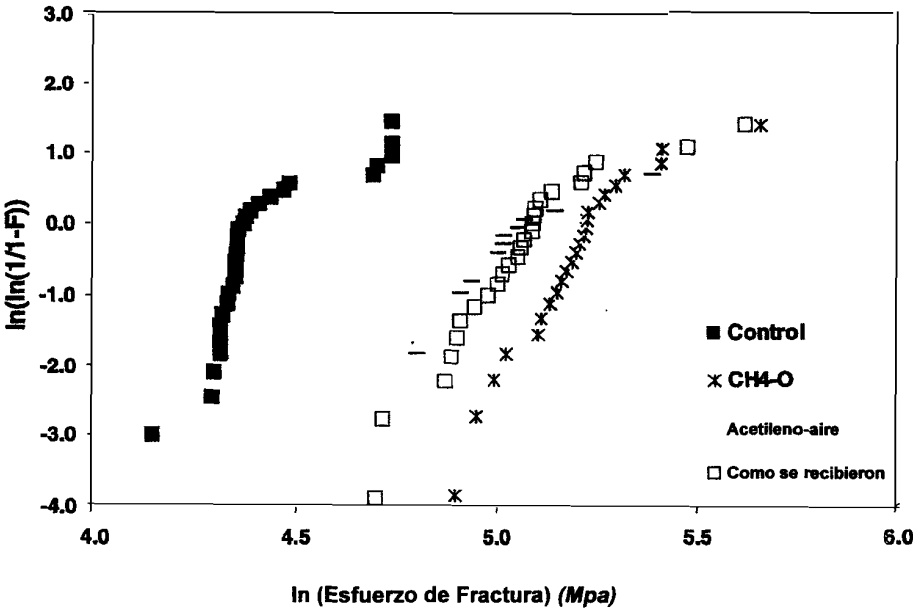


FIGURA 3

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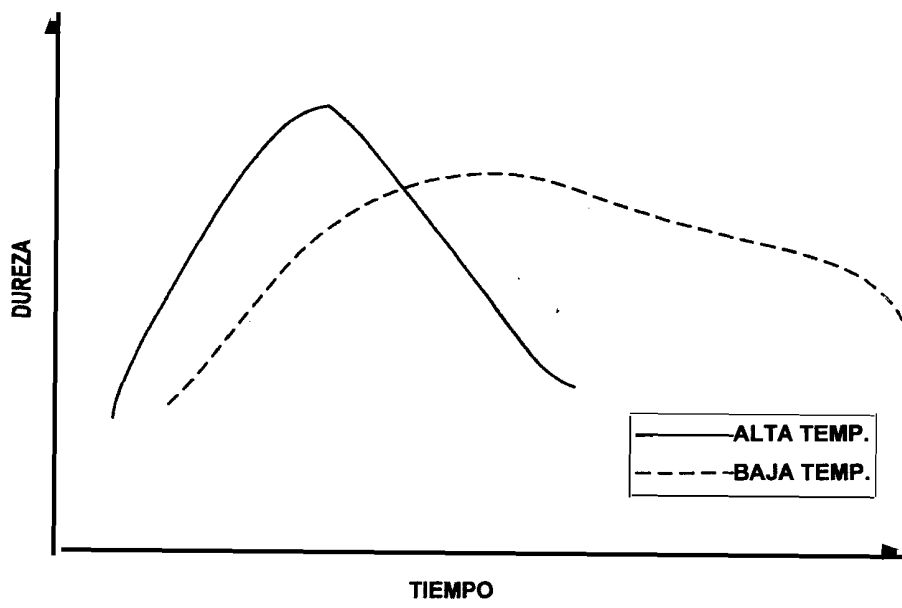
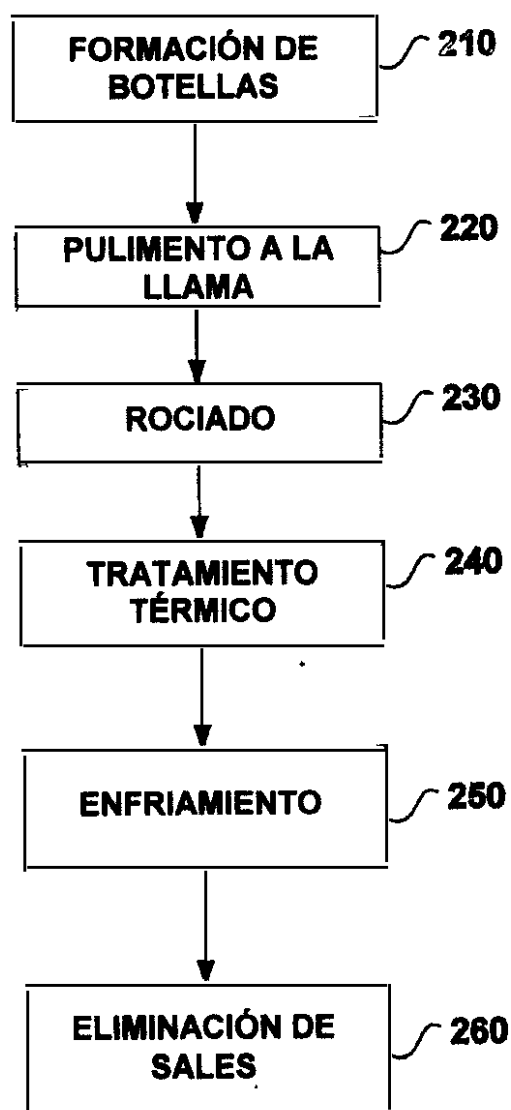


FIGURA 4

**FIGURA 5**

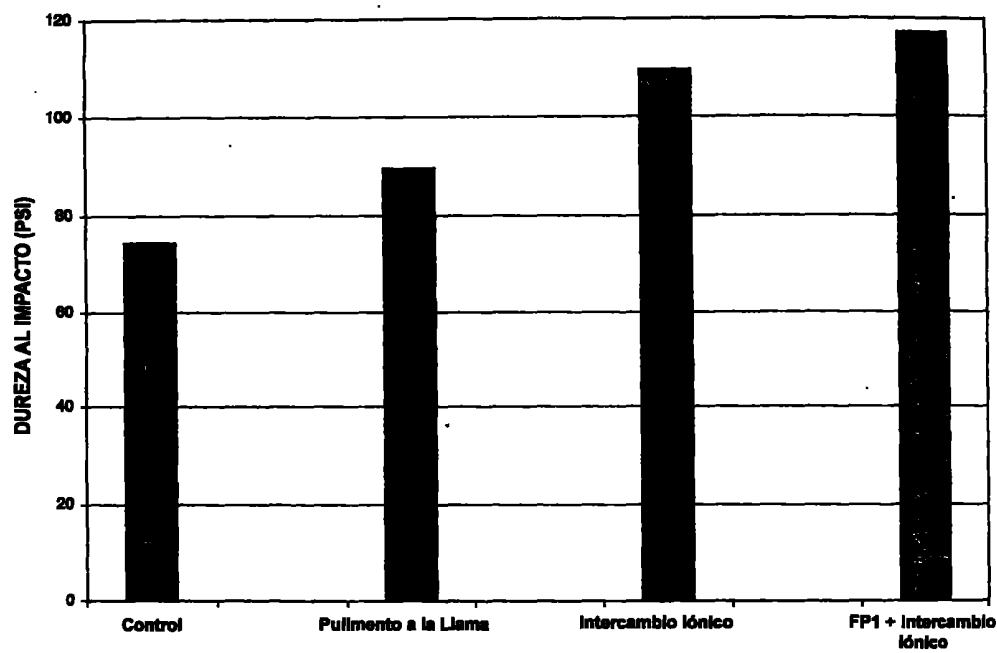
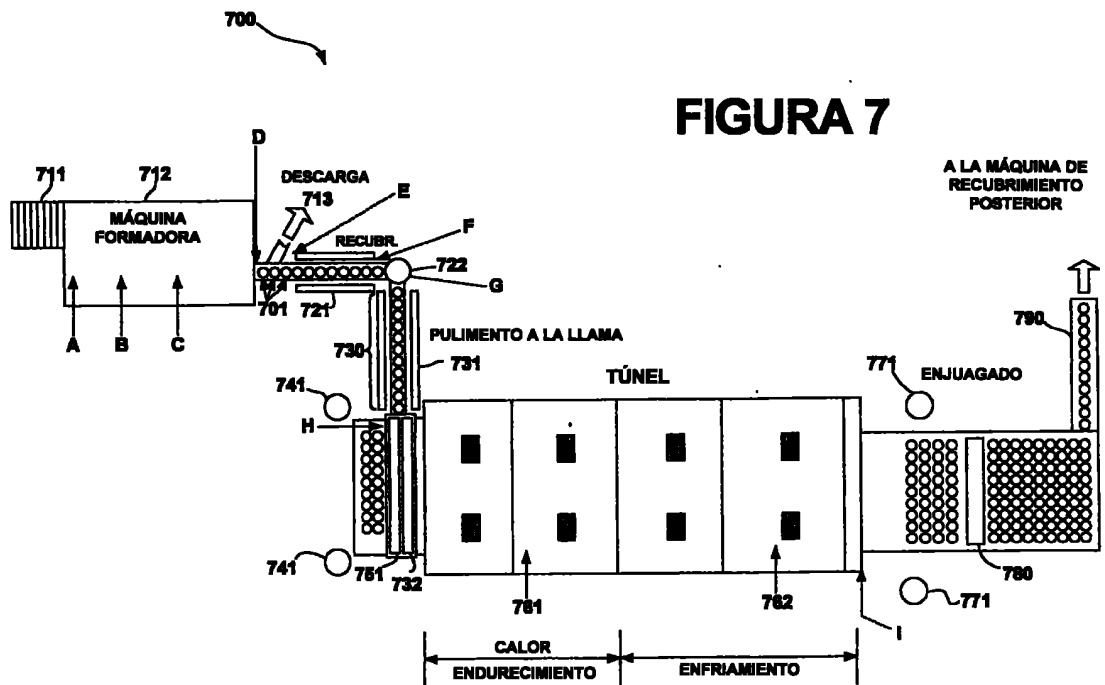


FIGURA 6

*[Handwritten signature]*

FIGURA 7



7/26

*[Handwritten signature]*

8 / 24

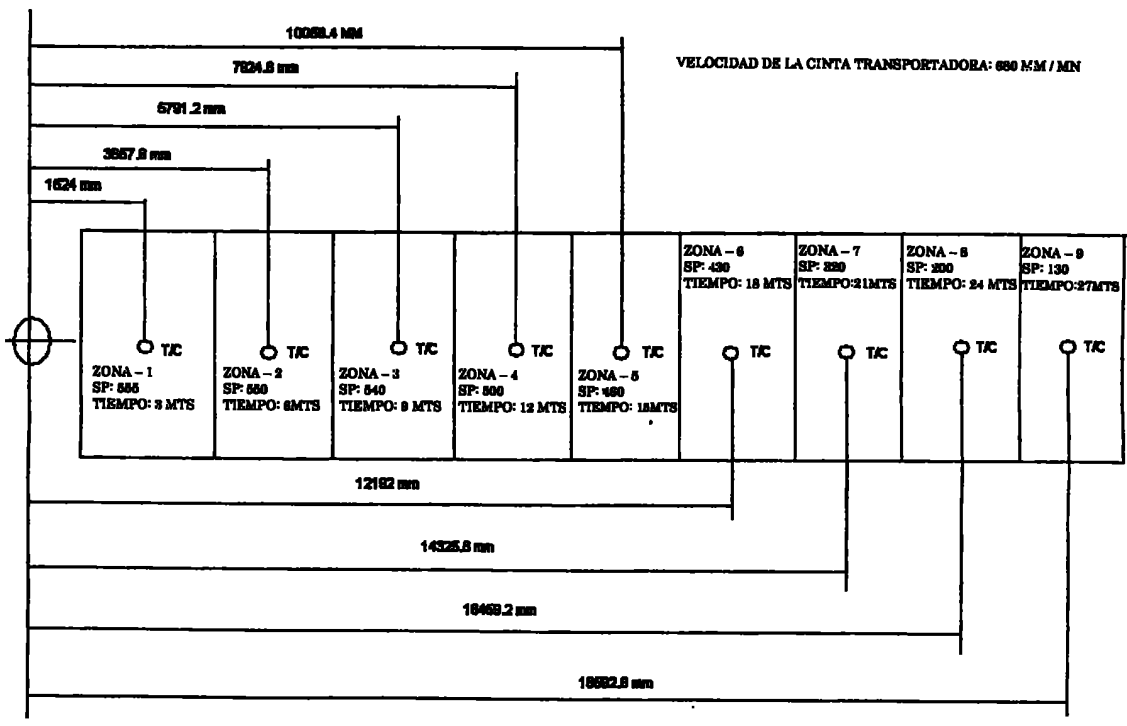


FIGURA 8A

*[Handwritten signature]*

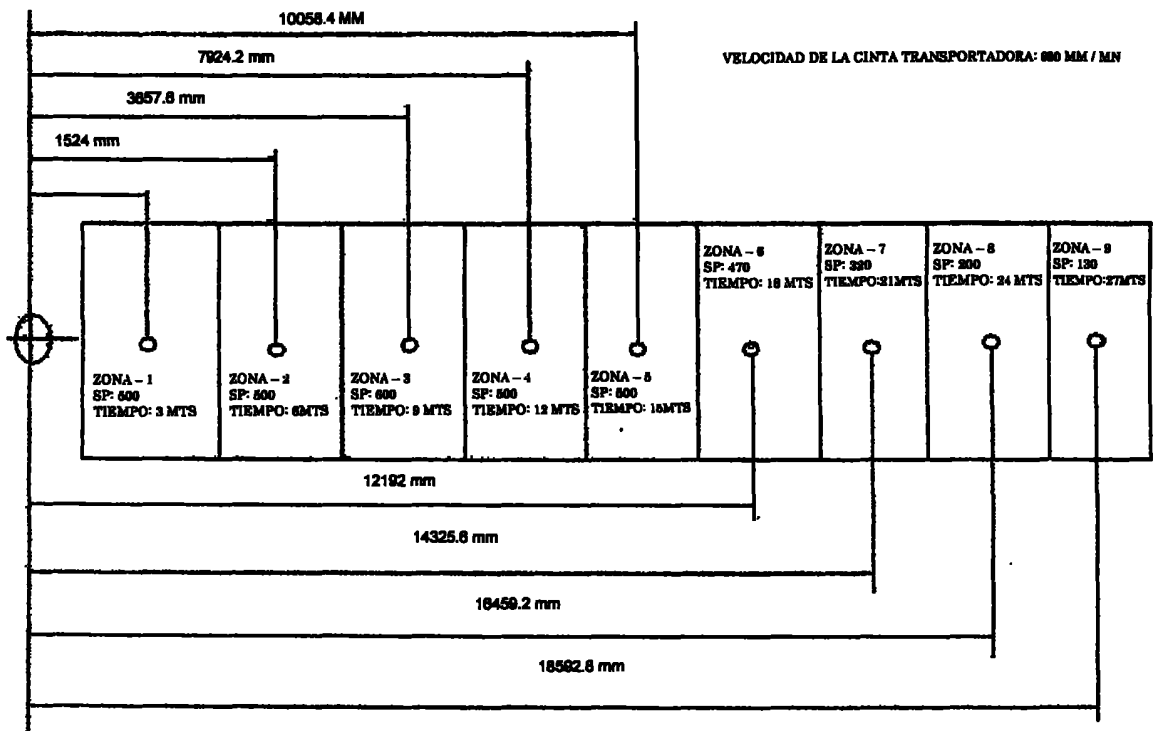


FIGURA 8B

24

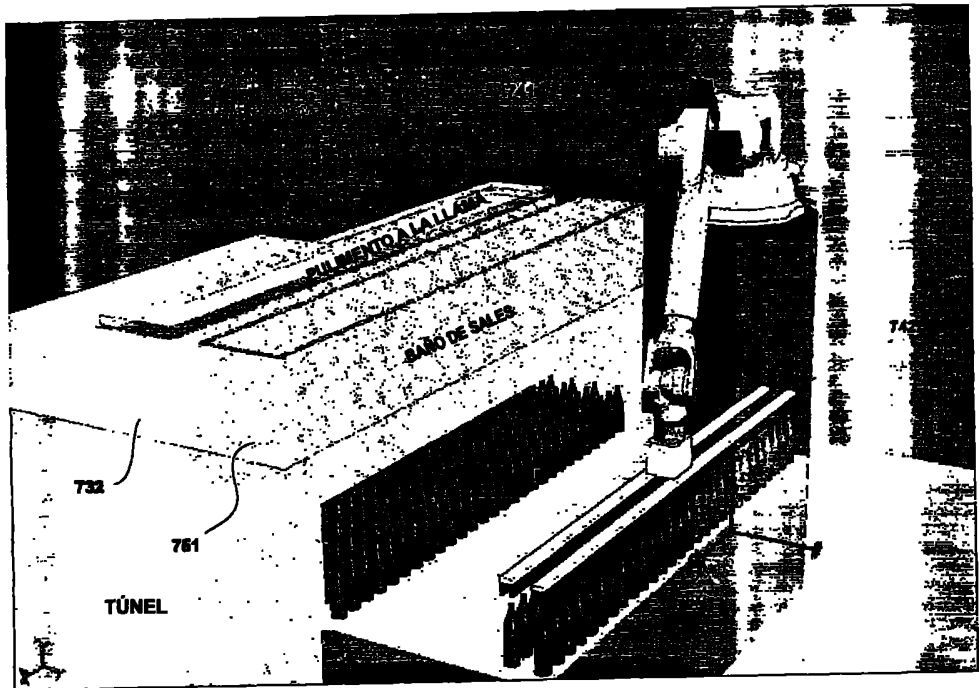


FIGURA 9

22

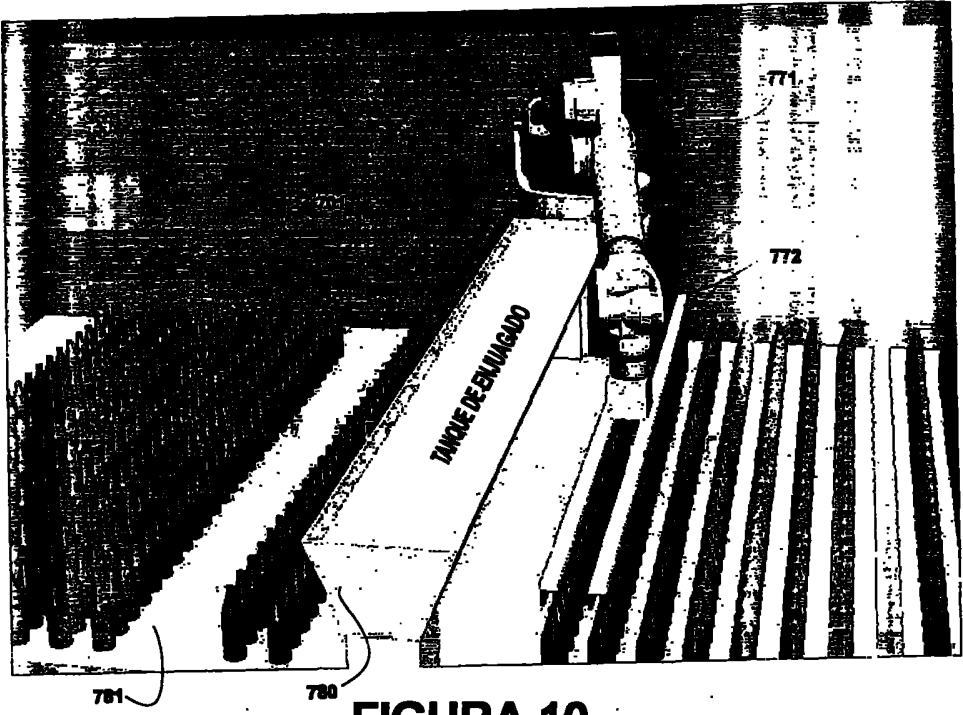


FIGURA 10

CICLO No. 1

Pre-calentamiento 1 m @ 510°C; Inmersión 600°C; pulimento a la llama – lado y fondo 4 in/seg; endurecimiento 20 m @ 520 °C

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PCT/US2004/008716

12 / 24

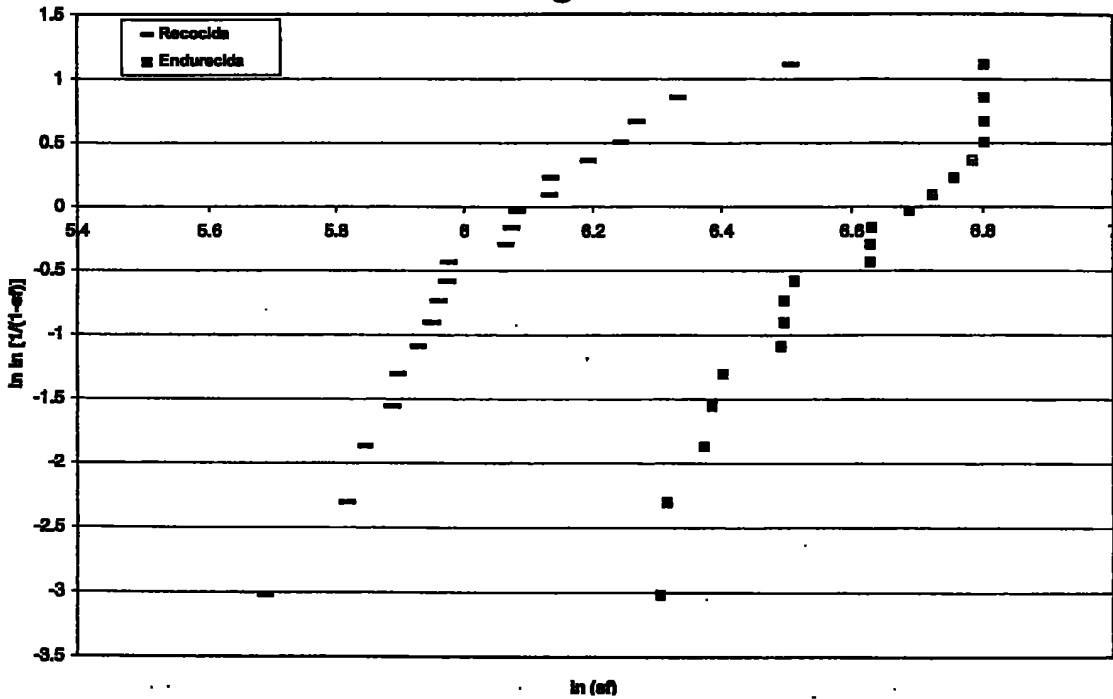


FIGURA 11

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CICLO No. 2

Pre-calentamiento 5 m @ 510°C; inmersión 630°C; pulimento a la llama – lado y fondo 4 in/seg; endurecimiento 20 m @ 520 °C

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~~24~~

13 / 24

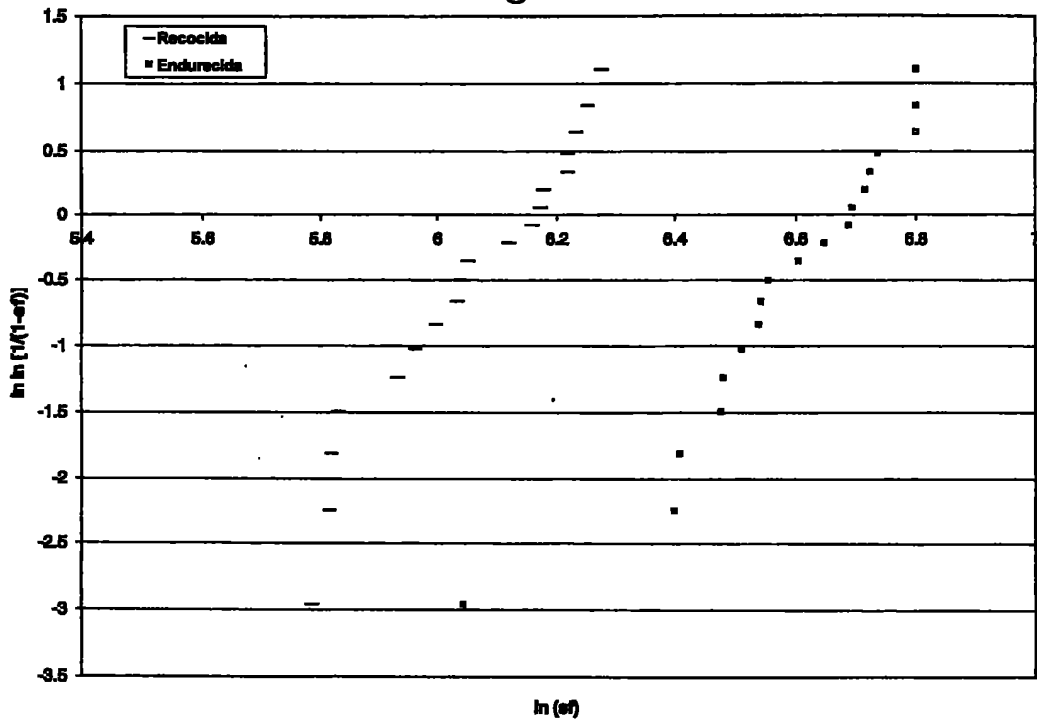
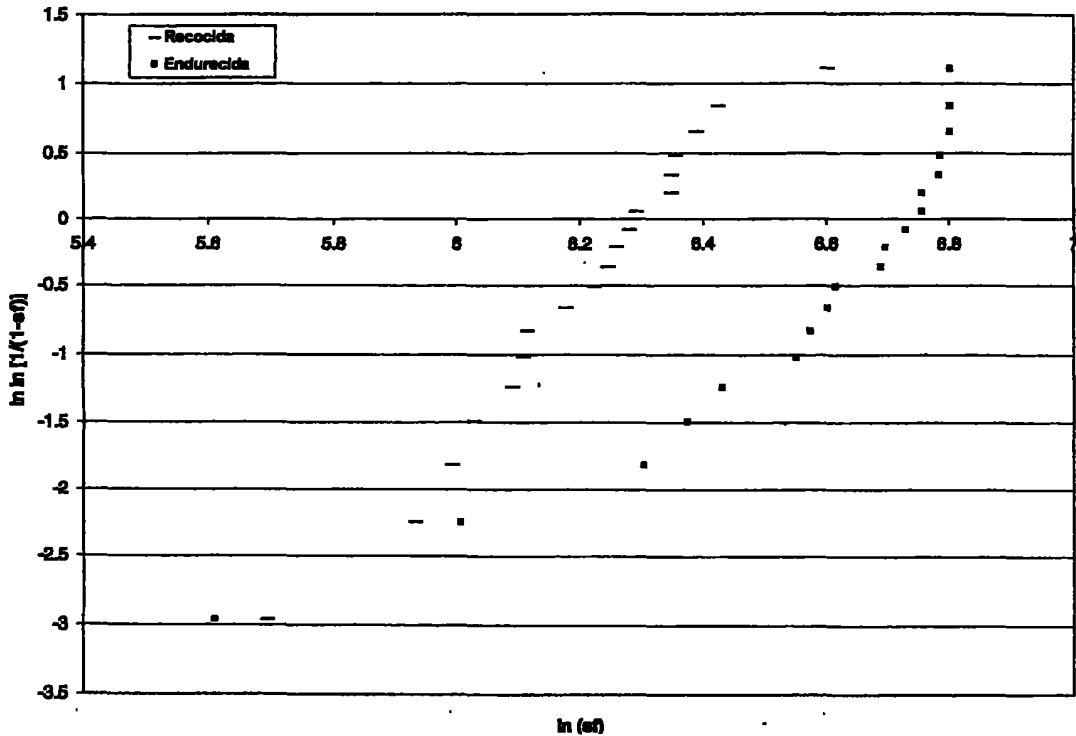


FIGURA 12

*[Handwritten signature]*

**CICLO No. 3**

Pre-calentamiento 5 m @ 550°C; Inmersión 615°C; endurecimiento 20 m @ 500 °C



**FIGURA 13**

CICLO N . 4

Pre-calentamiento 5 m @ 510°C; inmersión 600°C; pulimento a la llama – lado y fondo 4 in/seg; endurecimiento 20 m @ 480 °C

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16 / 24

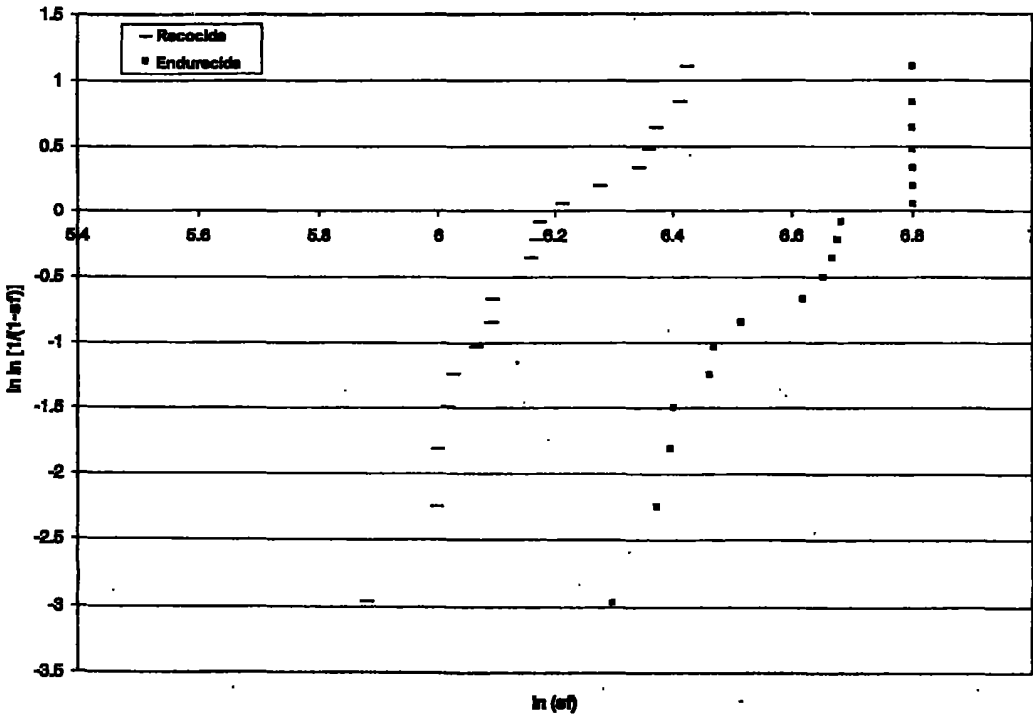


FIGURA 14

CICLO N . 5

Pre-calentamiento 5 m @ 510°C; inmersión 600°C; pulimento a la llama – lado y fondo 4 in/seg; endurecimiento 20 m @ 520 °C

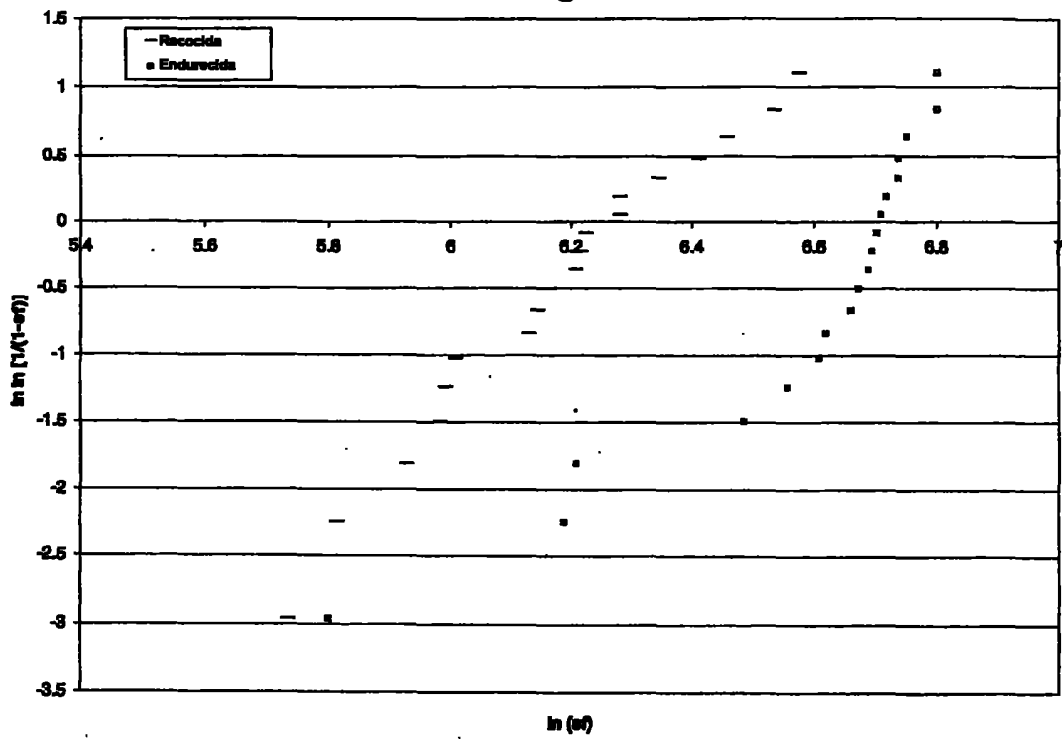


FIGURA 15

18 / 24

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127

*[Handwritten signature]*

# CICLO No. 6

Pre-calentamiento 1 m @ 550°C; Inmersión 615°C; endurecimiento 20 m @ 500 °C

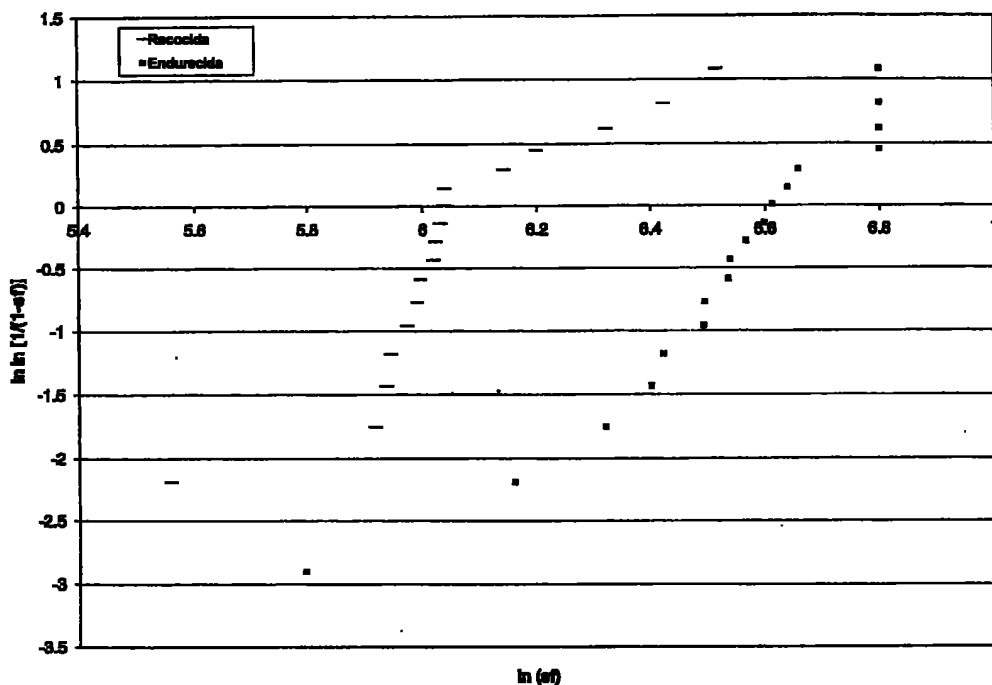


FIGURA 16

CICLO N . 7

Pre-calentamiento 1 m @ 510°C; inm rsión 600°C; pulimento a la llama – lado y fondo 4 in/seg; endurecimiento 20 m @ 480 °C

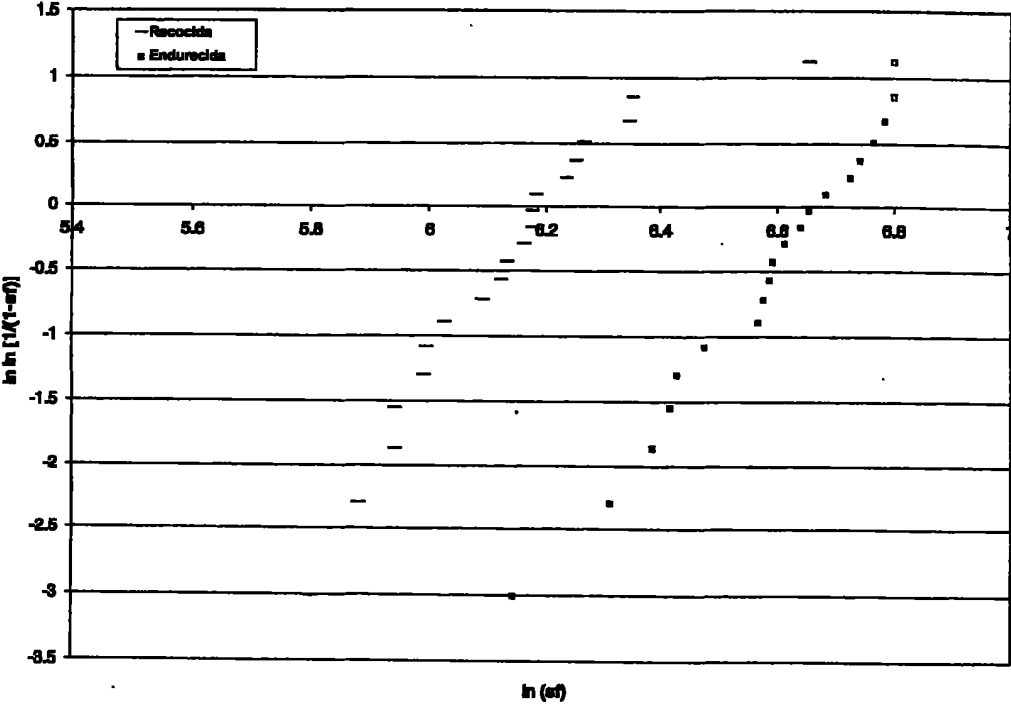


FIGURA 17

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# CICLO No. 8

Pre-calentamiento 5 m @ 510°C; inmersión 600°C; pulimento a la llama – lado y fondo 4 in/seg;  
endurecimiento 20 m @ 520 °C

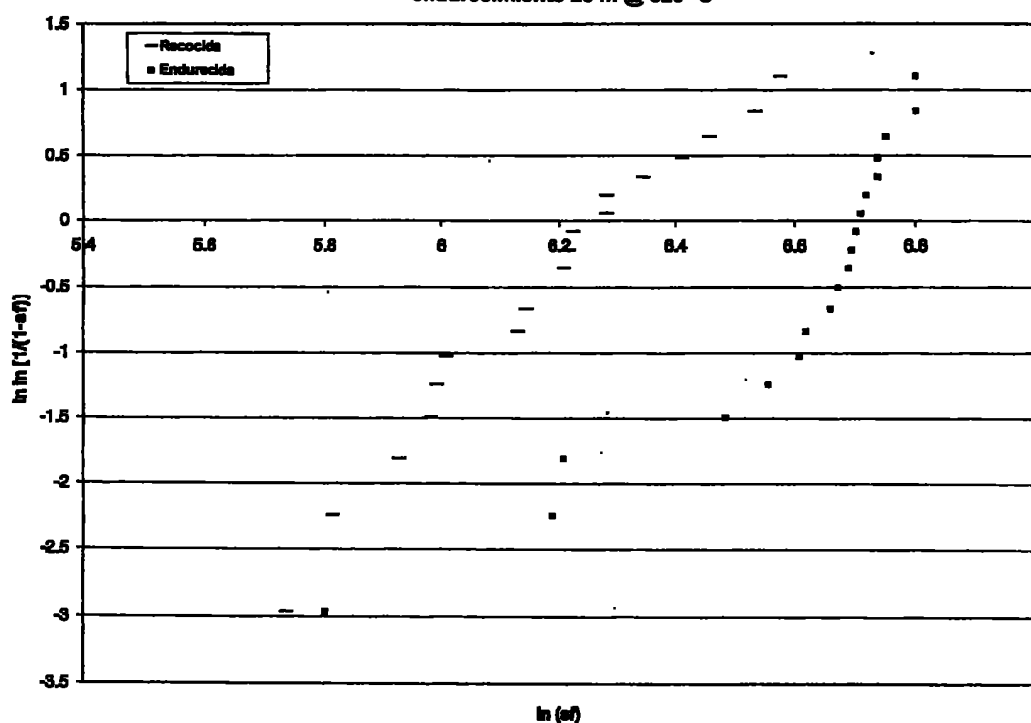


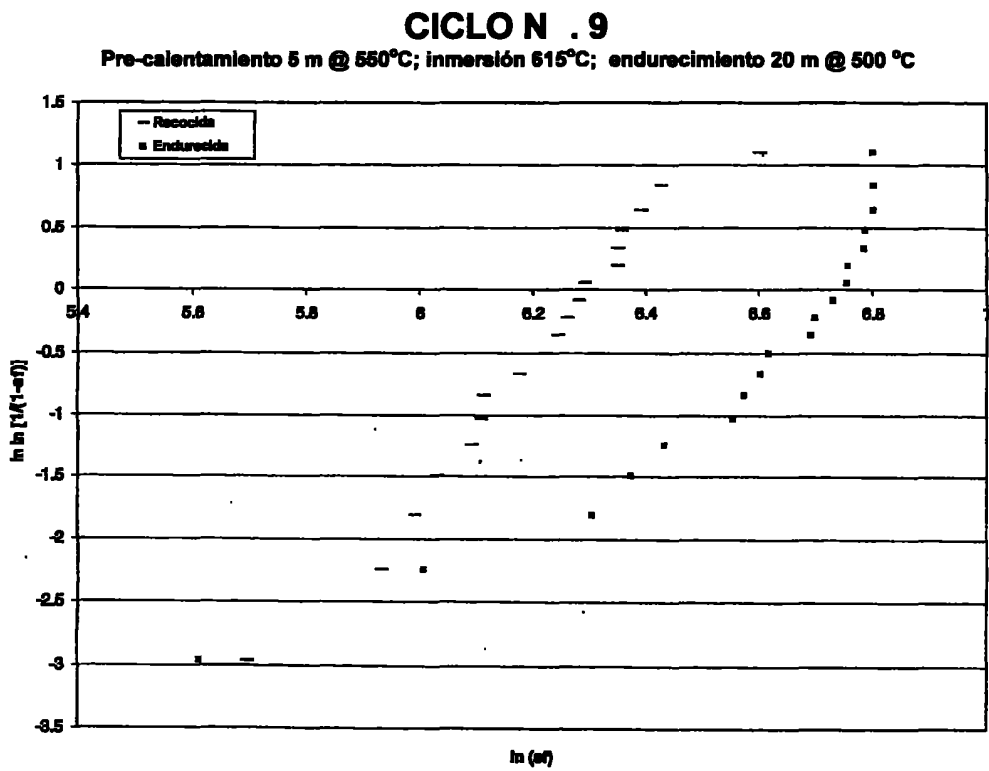
FIGURA 18

18 / 24

WO 2004/084328

PCT/US2004/008716

20 / 24



**FIGURA 19**

27

*[Handwritten signature]*

CICLO N . 10

Pre-calentamiento 5 m @ 550°C; Inmersión 615°C; endurecimiento 20 m @ 500 °C

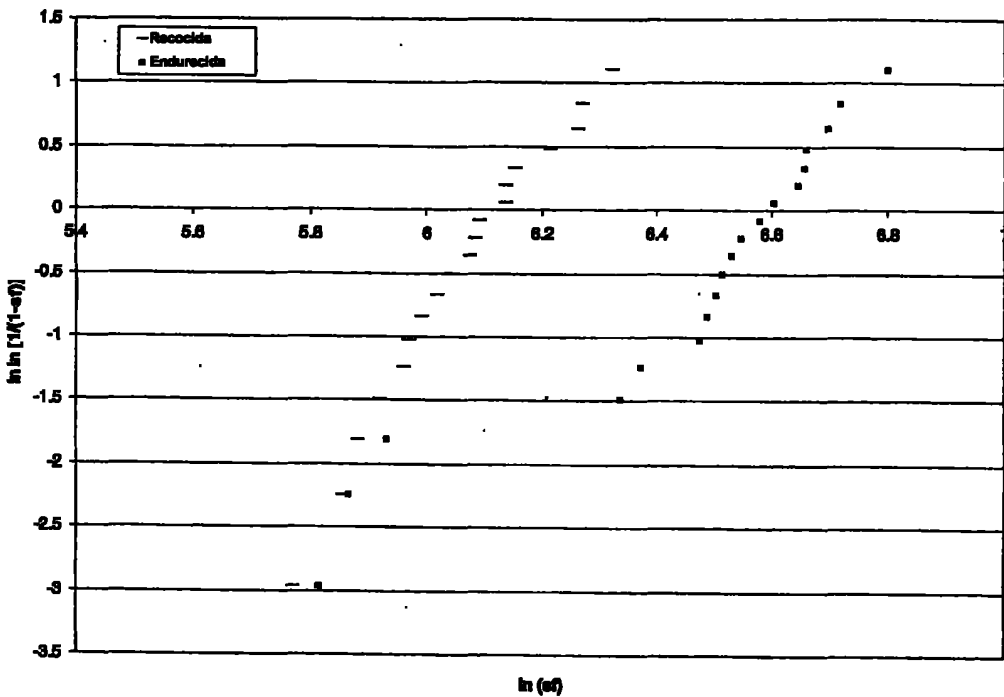
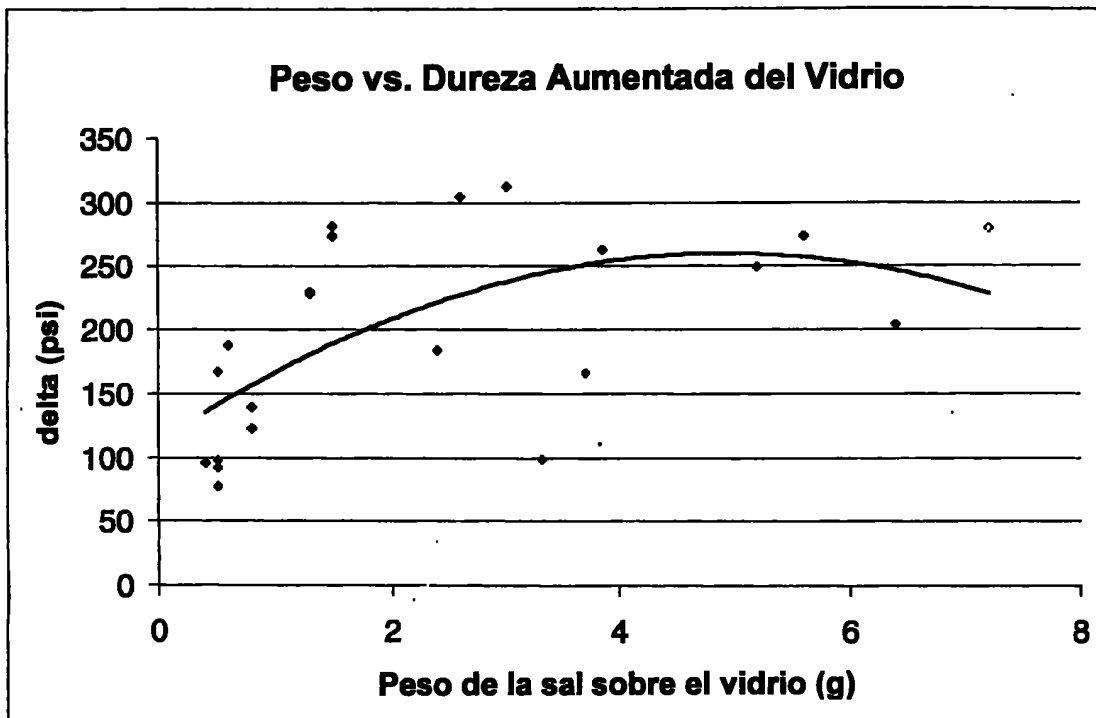


FIGURA 20

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**FIGURA 21**

Intercambi realizado a 520C durante 20 minutos lueg de inmersi nes en cualquiera de 48 m l % KNO<sub>3</sub> -52 m l % KCl ó 45 m l % KNO<sub>3</sub> - 55 mol % KCl

23 / 24

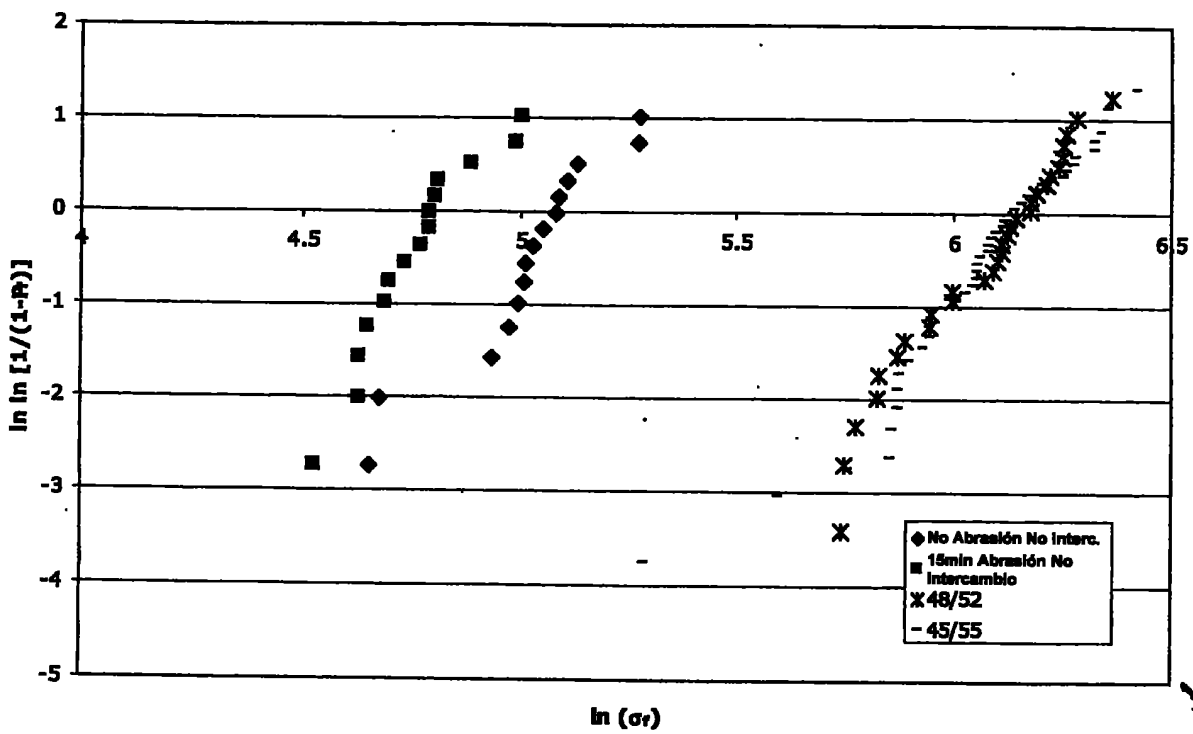


FIGURA 22

23

Vanillas c n intercambio a 520C durante 20 minutos n 26 3 m 1 % K2SO4, 73 7 m 1 % KCl y 20 2 m 1 % K2SO4, 56.7 m 1 % KCl y 23 1 mol % KNO3

24 / 24

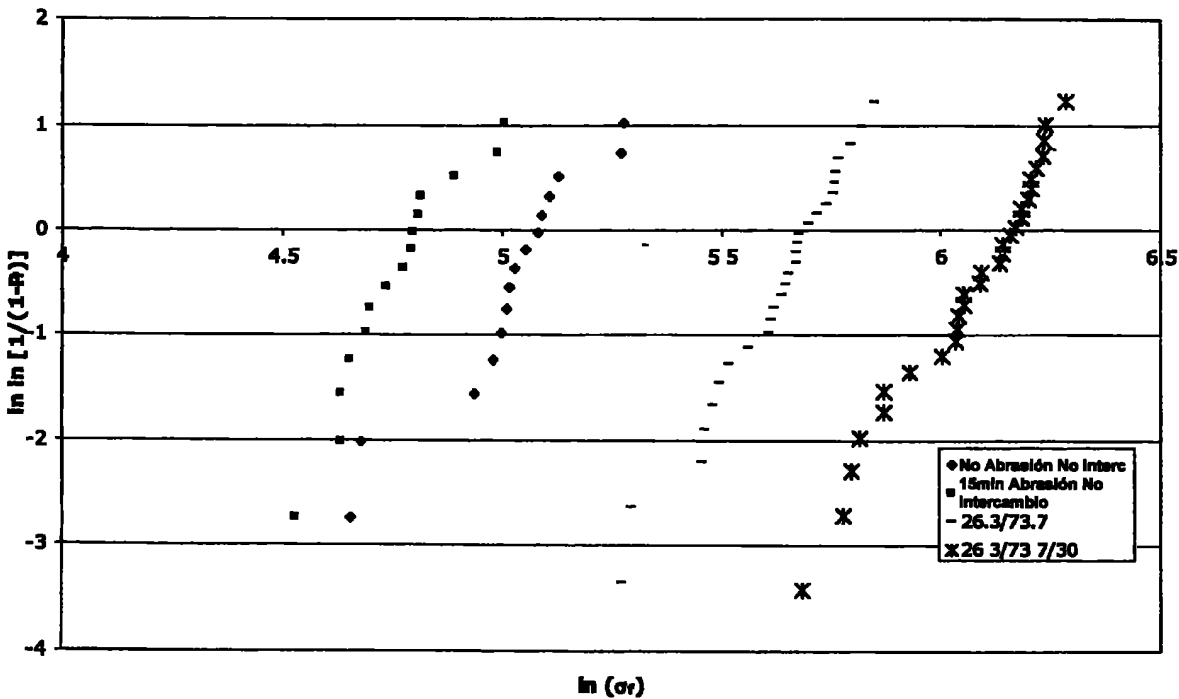


FIGURA 23

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## AMENDMENT TO THE CLAIMS

We Claim:

1. A method, comprising the steps of:

forming a glass article from molten glass, the glass having an annealing point temperature;

dipping the formed glass article in a molten salt bath, the salt bath comprising potassium ions wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the dipping step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, wherein the glass remains at a temperature greater than the annealing point temperature of the glass from the forming step to the dipping step.

2. The method of claim 1, wherein the surface temperature of the glass article is at least about 25°C above the annealing point temperature of the glass.

3. The method of claim 1, wherein the glass article is dipped in the salt bath for about 10 seconds or less.

4. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 0.5 second and about 30 seconds.

5. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

6. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

7. The method of claim 1, wherein the salt bath has a temperature of between about 550°C and about 750°C.
8. The method of claim 1, wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
9. The method of claim 1, further comprising:  
after the step of maintaining, cooling the glass article, removing residual salt from the glass article and applying a protective scuff resistant coating to the surface of the glass article.
10. An apparatus, comprising:  
a staging area;  
a glass article moving means for moving a glass article after forming of the glass article and prior to cooling the glass article to a temperature below the annealing point temperature of the glass article;  
a salt bath, the salt bath comprising molten salt, the glass article moving means being configured to move the glass article from the staging area and dip the glass article into the salt bath, the glass article moving means being configured to dip glass articles having a surface temperatures of at least the annealing point temperature of the glass, the glass article being configured to remain in the salt bath for less than about one minute; and  
a strengtheninglehr, the strengtheninglehr being configured to keep the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.
11. The apparatus of claim 10, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 0.5 second and about 30 seconds.
12. The apparatus of claim 10, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 3 and about 5 seconds.

13. The apparatus of claim 10, wherein the salt bath comprises potassium nitrate in the range of 40-60 mol% and potassium chloride in the range of 40-60 mol%.
14. The method of apparatus of claim 10, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
15. The apparatus of claim 10, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.
16. The apparatus of claim 10, wherein the strengthening Lehr is configured to keep the glass article at a temperature between the strain point temperature of the glass and about 130°C below the strain point temperature.
17. The apparatus of claim 10, wherein the strain point temperature is about 530°C.
18. The apparatus of claim 10, further comprising:  
flame polishing means, the flame polishing means being configured to flame polish the glass articles.
19. The apparatus of claim 18, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:  
a second flame polishing means configured to flame polish the bottoms of the glass articles.
20. The apparatus of claim 10, further comprising:  
a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengthening Lehr.
21. A method for strengthening a glass article, comprising:

~~139~~  
forming the glass article from molten glass, the glass having an annealing point temperature;

applying potassium ions to the surface of the glass article before the glass article cools below the annealing point of the glass following the formation of the glass article, wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the applying step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

22. The method of claim 21, wherein the glass article is dipped in the salt bath for about 0.5 second and about 30 seconds.

23. The method of claim 21, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for between about 3 and about 5 seconds.

24. The method of claim 21, wherein the step of applying potassium ions to the surface of the glass article is accomplished by spraying potassium ions on the surface of the glass article.

25. The method of claim 24, wherein the spraying step comprises at least one of power spraying, electrostatic spraying, and flame spraying.

26. The method of claim 21, wherein the step of applying potassium ions to the surface of the glass article is accomplished by chemical vapor deposition (CVD).

27. The method of claim 21, wherein the glass article is at a temperature of at least about 25°C above the annealing point of the glass during the applying step.

28. The method of claim 21, wherein the glass article is at a temperature of at least about 50°C above the annealing point of the glass during the applying step.

~~140~~

29. The method of claim 21, wherein the surface of the glass article is at a temperature of at least about 80°C above the annealing point of the glass during the applying step.

30. The method of claim 21 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.

31. The method of claim 21, wherein the strain point temperature is about 530°C.

32. The method of claim 21, further comprising:

after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.

33. A method comprising:

forming a glass article from molten glass;

dipping the formed glass article in a salt bath before the glass article cools below the annealing point of the glass following the formation of the glass article, the salt bath comprising potassium ions, the glass articles being dipped for less than about 30 seconds; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

34. The method of claim 33, wherein the glass article is dipped in the salt bath for about 20 seconds or less.

35. The method of claim 33, wherein the glass article is dipped in the salt bath for about 10 seconds or less.

36. The method of claim 33, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.

1111

37. The method of claim 33, wherein the salt bath comprises potassium nitrate in the range of 40-60 mol% and potassium chloride in the range of 40-60 mol%.
38. The method of claim 33, wherein the salt bath comprises potassium sulfate and potassium chloride.
39. The method of claim 61, further comprising:  
  
flame polishing the glass article prior to dipping the article in the salt bath.
40. The method of claim 33, further comprising:  
  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.
41. The method of claim 33, wherein the salt bath has a temperature of between about 550°C and about 750°C.
42. The method of claim 33, wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
43. The method of claim 33, wherein the strain point temperature is about 530°C.

~~142~~  
142

# **REIVINDICACIONES MODIFICADAS**

~~47~~ 143

## CORRECCIÓN A LAS REIVINDICACIONES

Reivindicamos:

1. Un método, que comprende los pasos de:

formar un artículo de vidrio de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;

sumergir el artículo de vidrio formado en un baño de sal fundida, comprendiendo el baño de sal iones de potasio en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de inmersión; y

mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos, en donde el vidrio permanece a una temperatura mayor que la temperatura del punto de recocido del vidrio desde el paso de formación hasta el paso de inmersión.

2. El método de la reivindicación 1, en donde la temperatura superficial del artículo de vidrio es por lo menos alrededor de 25°C por encima de la temperatura de punto de recocido del vidrio.

3. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 10 segundos o menos.

4. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 0.5 segundo y entre alrededor de 30 segundos.

5. El método de la reivindicación 1, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio

6. El método de la reivindicación 1, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

7. El método de la reivindicación 1, en donde el baño de sal tiene una temperatura de entre alrededor de 550°C y entre alrededor de 750°C.

8. El método de la reivindicación 1, en donde mantener el artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

9. El método de la reivindicación 1, que comprende además:

después del paso de mantenimiento, enfriar el artículo de vidrio, eliminar la sal residual del artículo de vidrio y aplicar a la superficie del artículo de vidrio un recubrimiento protector resistente al rayado.

10. Un aparato, que comprende:

un área de operaciones;

medios de traslado de artículos de vidrio para trasladar un artículo de vidrio después de la formación del artículo de vidrio y antes de enfriar el artículo de vidrio a una temperatura por debajo de la temperatura de punto de recocido del artículo de vidrio;

un baño de sal, baño de sal que comprende sal fundida, configurándose los medios de traslado del artículo de vidrio para mover el artículo de vidrio desde el área de operaciones y sumergir el artículo de vidrio en el baño de sal, configurándose los medios de traslado del artículo de vidrio para sumergir artículos de vidrio con temperaturas superficiales de por lo menos la temperatura de punto de recocido del vidrio, configurándose el artículo de vidrio para permanecer en el baño de sal

~~141~~ 145

durante menos de alrededor de un minuto; y

un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

11. El aparato de la reivindicación 10, en donde los medios de traslado del artículo de vidrio se configura para sumergir el artículo de vidrio en el baño de sal durante entre alrededor de 0.5 segundo y entre alrededor de 30 segundos.

12. El aparato de la reivindicación 10, en donde los medios de traslado del artículo de vidrio se configura para sumergir el artículo de vidrio en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

13. El aparato de la reivindicación 10, en donde el baño de sal comprende nitrato de potasio en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

14. El método de aparato de la reivindicación 10, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio.

15. El aparato de la reivindicación 10, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

16. El aparato de la reivindicación 10, en donde el túnel de endurecimiento se configura para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y

146  
~~146~~

entre alrededor de 130°C por debajo de la temperatura del punto de deformación

17. El aparato de la reivindicación 10, en donde la temperatura del punto de deformación es alrededor de 530°C.

18. El aparato de la reivindicación 10, que comprende además:  
medios de pulimento a la llama, configurándose los medios de pulimento a la llama para pulir a la llama los artículos de vidrio.

19. El aparato de la reivindicación 18, en donde los medios de pulimento a la llama es un primer medio de pulimento a la llama configurado para pulir a la llama los lados del artículo de vidrio, aparato que comprende además:

Un segundo medio de pulimento a la llama configurado para pulir a la llama los fondos de los artículo de vidrio.

20. El aparato de la reivindicación 10, que comprende además:  
un mecanismo de recubrimiento configurado para aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio después de que el artículo de vidrio se ha sacado del túnel de endurecimiento.

21. Un método para endurecer un artículo de vidrio, que comprende:  
formar el artículo de vidrio a partir de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;  
aplicar iones de potasio a la superficie del artículo de vidrio antes de que el artículo de vidrio se enfríe por debajo del punto de recocido del vidrio luego de la formación del artículo de vidrio, en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de aplicación; y  
mantener el artículo de vidrio a una temperatura entre la temperatura

~~147~~ 147

del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

22. El método de la reivindicación 21, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 0.5 segundo y entre alrededor de 30 segundos.

23. El método de la reivindicación 21, en donde el paso de aplicar los iones de potasio a la superficie del artículo de vidrio se lleva a cabo sumergiendo el artículo de vidrio en un baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

24. El método de la reivindicación 21, en donde el paso de aplicar iones de potasio a la superficie del artículo de vidrio se lleva a cabo rociando iones de potasio sobre la superficie del artículo de vidrio.

25. El método de la reivindicación 24, en donde el paso de rociar comprende por lo menos pulverización de polvo, pulverización electrostática, y pulverización a la llama.

26. El método de la reivindicación 21, en donde el paso de aplicar iones de potasio a la superficie del artículo de vidrio se lleva a cabo por deposición de vapor químico (CVD).

27. El método de la reivindicación 21, en donde el artículo de vidrio está a una temperatura de por lo menos alrededor de 25°C por encima del punto de recocido del vidrio durante el paso de aplicación.

28. El método de la reivindicación 21, en donde el artículo de vidrio está a una temperatura de por lo menos alrededor de 50°C por encima del punto de recocido del vidrio durante el paso de aplicación.

148

29. El método de la reivindicación 21, en donde la superficie del artículo de vidrio está a una temperatura de por lo menos alrededor de 80°C por encima del punto de recocido del vidrio durante el paso de aplicación.

30. El método de la reivindicación 21 en donde el mantenimiento del artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

31. El método de la reivindicación 21 en donde la temperatura del punto de deformación es alrededor de 530°C.

32. El método de la reivindicación 21, que comprende además:  
luego del paso de mantenimiento, aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio.

33. Un método, que comprende:  
formar un artículo de vidrio a partir de vidrio fundido;  
sumergir el artículo de vidrio formado en un baño de sal antes de que el artículo de vidrio se enfríe por debajo del punto de recocido del vidrio luego de la formación del artículo de vidrio, comprendiendo el baño de sal iones de potasio, sumergiéndose los artículo de vidrio durante menos de alrededor de 30 segundos; y

mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

34. El método de la reivindicación 33, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 20 segundos o menos.

35. El método de la reivindicación 33, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 10 segundos o menos.
36. El método de la reivindicación 33, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.
37. El método de la reivindicación 33, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.
38. El método de la reivindicación 33, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.
39. El método de la reivindicación 33, que comprende además:  
pulir a la llama el artículo de vidrio antes de sumergir el artículo en el baño de sal.
40. El método de la reivindicación 33, que comprende además:  
luego del paso de mantenimiento, aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio.
41. El método de la reivindicación 33, en donde el baño de sal tiene una temperatura de entre alrededor de 550°C y entre alrededor de 750°C.
42. El método de la reivindicación 33 en donde el mantenimiento del artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.
43. El método de la reivindicación 33 en donde la temperatura del punto de deformación es alrededor de 530°C.

From the INTERNATIONAL BUREAU

156

**PCT**NOTIFICATION CONCERNING  
TRANSMITTAL OF COPY OF INTERNATIONAL  
APPLICATION AS PUBLISHED OR REPUBLISHED

To:

BELL, Michael, J.  
Howrey Simon Arnold & White, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, VA 22042  
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22 April 2003 (22.04.2003)

Applicant

THE COCA-COLA COMPANY et al

The International Bureau transmits herewith the following documents:

- ☐ copy of the international application as published by the International Bureau on under No. WO
- ☒ copy of international application as republished by the International Bureau on 27 January 2005 (27.01.2005) under No. WO 2004/094329  
For an explanation as to the reason for this republication of the international application, reference is made to INID codes (15), (48) or (88) (as the case may be) on the front page of the attached document.

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HOWREY &amp; SIMON

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

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Athina Nickitas-Etienne

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(71) Applicant (for all designated States except US): THE  
COCA-COLA COMPANY [US/US]; One Coca-Cola  
Plaza, N.W., Atlanta, GA 30313 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): POSTUPACK,

Dennis [US/US]; 560 Waterview Trail, Alpharetta,  
GA 30022 (US). LACOURSE, William [US/US]; 15  
Reynolds Street, Alfred, NY 14802 (US).

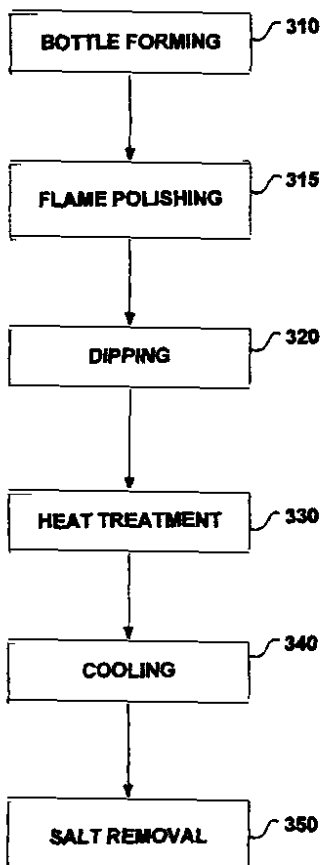
(74) Agents: BELL, Michael, J. et al.; Howrey Simon Arnold  
& White, LLP, 2941 Fairview Park Drive, Box 7, Falls  
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(54) Title: METHOD AND APPARATUS FOR STRENGTHENING GLASS



(57) Abstract: The invention relates to a method and apparatus for strengthening glass. A method according to one aspect of the invention strengthens glass by applying potassium ions to the surface of a glass article with the surface being at least the annealing point temperature of the glass and then keeping the temperature of the glass between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes to facilitate a more efficient ion-exchange reaction. In one embodiment, the glass articles may be dipped in a salt bath to apply the ions. In an alternative embodiment, the glass articles may be sprayed with molten potassium salt to apply the ions. As a result of the methods of the invention, the treated glass articles may be strengthened by having an increased surface stress or may contain less glass with no change in strength as compared to the same untreated glass article.

WO 2004/094329 A1



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**Published:**

— with international search report

— with amended claims and statement

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**AMENDED CLAIMS**

received by the International Bureau on 30 November 2004 (30.11.04): original claims 1 to 72 have been replaced by amended claims 1 to 72.

**CLAIMS**

We claim:

1. A method, comprising the steps of:  
  
forming a glass article from molten glass, the glass having an annealing point temperature;  
  
dipping the formed glass article in a molten salt bath, the salt bath comprising potassium ions wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the dipping step; and  
  
maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, wherein the glass remains at a temperature greater than the annealing point temperature of the glass from the forming step to the dipping step.
2. The method of claim 1, wherein the surface temperature of the glass article is at least about 25°C above the annealing point temperature of the glass.
3. The method of claim 1, wherein the glass article is dipped in the salt bath for less than about one minute.
4. The method of claim 1, wherein the glass article is dipped in the salt bath for about 10 seconds or less.

5. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 0.5 second and about 30 seconds.
6. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.
7. The method of claim 1, wherein the salt bath comprises potassium nitrate and potassium chloride.
8. The method of claim 7, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
9. The method of claim 1, wherein the salt bath comprises potassium sulfate and potassium chloride.
10. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
11. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

12. The method of claim 1, wherein the salt bath has a temperature of between about ~~550°C~~ <sup>570°C</sup> and about 750°C.
13. The method of claim 1, wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
14. The method of claim 1, wherein the strain point temperature is about 530°C.
15. The method of claim 1, further comprising:  
flame polishing the glass article prior to dipping the glass article in the salt bath.
16. The method of claim 1, further comprising:  
after the step of maintaining, cooling the glass article, removing residual salt from the glass article and applying a protective scuff resistant coating to the surface of the glass article.
17. An apparatus, comprising:  
a staging area;  
a glass article moving means for moving a glass article after forming of the glass article and prior to cooling the glass article to a temperature below the annealing point temperature of the glass article;  
a salt bath, the salt bath comprising molten salt, the glass article moving means being configured to move the glass article from the staging area and dip the glass article into the salt bath, the glass article moving means being configured to dip glass articles having a surface

temperatures of at least the annealing point temperature of the glass, the glass article being configured to remain in the salt bath for less than about one minute; and

a strengthening Lehr, the strengthening Lehr being configured to keep the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

18. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for about 10 seconds or less.

19. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 0.5 second and about 30 seconds.

20. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 3 and about 5 seconds.

21. The apparatus of claim 17, wherein the salt bath comprises potassium nitrate and potassium chloride.

22. The apparatus of claim 21, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

23. The apparatus of claim 17, wherein the salt bath comprises potassium sulfate and potassium chloride.

24. The method of apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
25. The apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.
26. The apparatus of claim 17, wherein the strengthening Lehr is configured to keep the glass article at a temperature between the strain point temperature of the glass and about 130°C below the strain point temperature
27. The apparatus of claim 17, wherein the strain point temperature is about 530°C.
28. The apparatus of claim 17, further comprising:  
flame polishing means, the flame polishing means being configured to flame polish the glass articles.
29. The apparatus of claim 28, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:  
a second flame polishing means configured to flame polish the bottoms of the glass articles.

30. The apparatus of claim 17, further comprising:  
a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengtheninglehr.
31. A glass manufacturing facility comprising a glass forming machine configured to form glass articles, and a strengtheninglehr, the improvement comprising:  
a salt bath comprising molten salt, the glass articles being dipped into the salt bath for less than about one minute, the glass articles having a surface temperature at least above the annealing point temperature of the glass while being dipped in the salt bath; and  
a strengtheninglehr, the strengtheninglehr being configured to maintain the temperature of the glass articles at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, the glass manufacturing facility being configured to dip the glass articles in the salt bath prior to the glass articles while the glass articles are still hot after being formed by the forming machine.
32. The glass manufacturing facility of claim 31, further comprising:  
a glass article handling means, the glass article handling means being configured to dip the glass articles in the salt bath.
33. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for about 10 seconds or less.

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34. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for between about 0.5second and about 30 seconds.

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35. The apparatus of claim 31, wherein the glass articles are dipped in the salt bath for between about 3 and about 5 seconds.

36. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium nitrate and potassium chloride.

37. The glass manufacturing facility of claim 31, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

38. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium sulfate and potassium chloride.

39. The glass manufacturing facility of claim 31, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

40. The glass manufacturing facility of claim 31, wherein the sale bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

41. The glass manufacturing facility of claim 31 wherein the strengtheninglehr is configured to maintain the glass articles at a temperature between the strain point temperature and about 130°C below the strain point temperature.
42. The glass manufacturing facility of claim 31 wherein the strain point temperature is about 530°C.
43. The glass manufacturing facility of claim 31, further comprising:  
flame polishing means, the flame polishing means being configured to flame polish the glass articles.
44. The glass manufacturing facility of claim 43, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:  
a second flame polishing means configured to flame polish the bottoms of the glass articles.
45. The glass manufacturing facility of claim 31, further comprising:  
a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengtheninglehr.
46. A method for strengthening a glass article, comprising:

forming the glass article from molten glass, the glass having an annealing point temperature;

applying potassium ions to the surface of the glass article before the glass article cools below the annealing point of the glass following the formation of the glass article, wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the applying step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

47. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for less than about 10 seconds.

48. The method of claim 46, wherein the glass article is dipped in the salt bath for about 0.5 second and about 30 seconds.

49. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for between about 3 and about 5 seconds.

50. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by spraying potassium ions on the surface of the glass article.

51. The method of claim 50, wherein spraying comprises flame spraying.
52. The method of claim 50, wherein the spraying comprises electrostatic spraying.
53. The method of claim 50, wherein the spraying step comprises power spraying.
54. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by chemical vapor deposition (CVD).
55. The method of claim 46, wherein the glass article is at a temperature of at least about 25°C above the annealing point of the glass during the applying step.
56. The method of claim 46, wherein the glass article is at a temperature of at least about 50°C above the annealing point of the glass during the applying step.
57. The method of claim 46, wherein the surface of the glass article is at a temperature of at least about 80°C above the annealing point of the glass during the applying step.
58. The method of claim 46 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
59. The method of claim 46 wherein the strain point temperature is about 530°C.

157  
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60. The method of claim 46, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.
61. A method, comprising:  
forming a glass article from molten glass;  
dipping the formed glass article in a salt bath before the glass article cools below the annealing point of the glass following the formation of the glass article, the salt bath comprising potassium ions, the glass articles being dipped for less than about 30 seconds; and  
maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.
62. The method of claim 61, wherein the glass article is dipped in the salt bath for about 20 seconds or less.
63. The method of claim 61, wherein the glass article is dipped in the salt bath for about 10 seconds or less.
64. The method of claim 61, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.
65. The method of claim 61, wherein the salt bath comprises potassium nitrate and potassium chloride.

66. The method of claim 65, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
67. The method of claim 61, wherein the salt bath comprises potassium sulfate and potassium chloride.
68. The method of claim 61, further comprising:  
flame polishing the glass article prior to dipping the article in the salt bath.
69. The method of claim 61, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.
70. The method of claim 61, wherein the salt bath has a temperature of between about 550°C and about 750°C.
71. The method of claim 61 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
72. The method of claim 61 wherein the strain point temperature is about 530°C.

158

**PATENT COOPERATION TREATY  
IN THE INTERNATIONAL BUREAU OF WIPO**

PCT International Patent Appl. No. PCT/US2004/009716

International Filing Date: 31 March 2004 (31.03.04)

Applicant: The Coca-Cola Company

Title: **Method and Apparatus for Strengthening Glass**

Attorney Docket No.: 1638.10.PC00

**STATEMENT UNDER PCT ARTICLE 19(1)**

International Bureau of WIPO  
34 chemin des Colombettes  
1211 Geneva 20  
SWITZERLAND  
Via facsimile to: 011 41 22 740 14 35

Dear Sir or Madam:

Upon entry of the amendment Under PCT Article 19, claims 1-72 are pending in this application. For the following reasons Applicants believe that the pending claims are both novel and meet the requirement of inventive step over the British patents to Pittsburgh Plate Glass Company and Saint-Gobain Industries.

Claims 1, 17, 31, 46, and 61 are independent claims. Each of these independent claims recite that salts are applied to the surfaces of the glass articles at a temperature greater than about the annealing point temperature of the glass. This is not disclosed or suggested by Reference D1. In fact, Reference D1 requires that the glass article be preheated to a temperature that is approximately the same as the temperature of the salt bath. Page 7, col. 2, line 86 to page 8, col. 1, line 7. As described throughout Reference D1, from the preheating step to the dipping step, the glass is always in a heating condition. Moreover, the invention disclosed in Reference D1 pertains to flat glass articles, such as, for example, windowpanes and windshields. Page 1, col. 1, lines 19-36. The methods disclosed in Reference D1 will be substantially complicated by non-uniform glass articles.

Because the present invention as recited in claims 1, 17, 31, 46, and 61 includes the forming of glass articles and then dipping them before the temperature of the glass falls below the annealing point of the glass, the present invention is both novel and has inventive step over the prior art method disclosed in Reference D1.

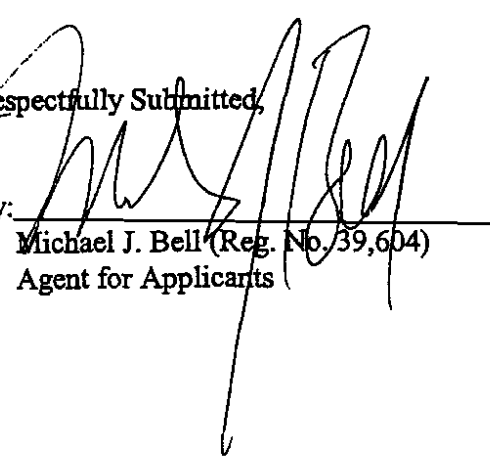
Claims 17, 31, and 61 all include "dipping" of glass articles. Unlike the present invention, where the glass articles are dipped for times of less than about 1 minute (claims 17 and 31), and less than about 30 seconds (claim 61), reference D2 discloses a standard prior art approach for strengthening glass articles in which the glass articles are soaked in a salt bath for significantly longer periods of time, such as "38 hours." Page 1, col. 2, lines 89-90. Reference D2 discloses glass strengthening using a two-step process for which the glass articles are soaked for a time of a total of 11 hours. Page 2, column 2, lines 109-112. Thus, the present invention permits mass production and strengthening of glass articles in a manner that distinguishes and significantly improves over prior art glass strengthening methods.

Claims 1 and 46 recite that the application of potassium ions to the surface of the glass article occurs before the glass article cools below the annealing point of the glass following the formation of the glass article. This is not disclosed or suggested by the prior art and once again provides significant advantages in permitting the mass production of glass articles.

Thus, claims 1, 17, 31, 46, and 61 are both novel and have inventive step over Reference D2.

Respectfully Submitted,

By:

  
Michael J. Bell (Reg. No. 39,604)  
Agent for Applicants

HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, Virginia 22042  
Telephone: 202-783-0800  
Facsimile: 703-336-6950  
Date: 30 November 2004 (30.11.04)

Because the present invention as recited in claims 1, 17, 31, 46, and 61 includes the forming of glass articles and then dipping them before the temperature of the glass falls below the annealing point of the glass, the present invention is both novel and has inventive step over the prior art method disclosed in Reference D1.

Claims 17, 31, and 61 all include "dipping" of glass articles. Unlike the present invention, where the glass articles are dipped for times of less than about 1 minute (claims 17 and 31), and less than about 30 seconds (claim 61), reference D2 discloses a standard prior art approach for strengthening glass articles in which the glass articles are soaked in a salt bath for significantly longer periods of time, such as "38 hours." Page 1, col. 2, lines 89-90. Reference D2 discloses glass strengthening using a two-step process for which the glass articles are soaked for a time of a total of 11 hours. Page 2, column 2, lines 109-112. Thus, the present invention permits mass production and strengthening of glass articles in a manner that distinguishes and significantly improves over prior art glass strengthening methods.

Claims 1 and 46 recite that the application of potassium ions to the surface of the glass article occurs before the glass article cools below the annealing point of the glass following the formation of the glass article. This is not disclosed or suggested by the prior art and once again provides significant advantages in permitting the mass production of glass articles.

Thus, claims 1, 17, 31, 46, and 61 are both novel and have inventive step over Reference D2.

Respectfully Submitted,

By:

Michael J. Bell (Reg. No. 39,604)  
Agent for Applicants

HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, Virginia 22042  
Telephone: 202-783-0800  
Facsimile: 703-336-6950  
Date: 30 November 2004 (30.11.04)

## PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

BELL, Michael J. et al.  
HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, VA 22042  
ETATS-UNIS D'AMERIQUE

NOTIFICATION OF TRANSMITTAL OF  
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REPORT ON PATENTABILITY

(PCT Rule 71.1)

Date of mailing  
(day/month/year)

19.09.2005

Applicant's or agent's file reference

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International filing date (day/month/year)

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Priority date (day/month/year)

22.04.2003

Applicant

THE COCA-COLA COMPANY et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international  
preliminary examining authority:



European Patent Office  
D-80298 Munich  
Tel. +49 89 2399 - 0 Tx: 523656 epmu d  
Fax: +49 89 2399 - 4465

Authorized Officer

Galatioto, M

Tel. +49 89 2399-7849



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**AMENDED  
CLAIMS**

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                    |                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| Applicant's or agent's file reference<br>xxx                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>FOR FURTHER ACTION</b><br>See Form PCT/PEA416                                                                                                                   |                                              |
| International application No.<br>PCT/US2004/009716                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | International filing date (day/month/year)<br>31.03.2004                                                                                                           | Priority date (day/month/year)<br>22.04.2003 |
| International Patent Classification (IPC) or national classification and IPC<br>C03C21/00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                    |                                              |
| Applicant<br>THE COCA-COLA COMPANY et al.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                    |                                              |
| <p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 7 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 12 sheets, as follows:</p> <p><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input checked="" type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p> |                                                                                                                                                                    |                                              |
| <p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                    |                                              |
| Date of submission of the demand<br><br>08.10.2004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Date of completion of this report<br><br>19.09.2005                                                                                                                |                                              |
| Name and mailing address of the international preliminary examining authority:<br> European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Authorized Officer<br><br>Somann, K<br><br>Telephone No. +49 89 2399-8586<br> |                                              |

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/US2004/009716

**Box No. 1 Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language, which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

**Description, Pages**

1-51 as originally filed

**Claims, Numbers**

1-72 as amended (together with any statement) under Art. 19 PCT

**Drawings, Sheets**

1/24-24/24 as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☒ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☒ the claims, Nos. 1-72
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/US2004/009716

163

**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

|                               |             |      |
|-------------------------------|-------------|------|
| Novelty (N)                   | Yes: Claims |      |
|                               | No: Claims  | 1-72 |
| Inventive step (IS)           | Yes: Claims |      |
|                               | No: Claims  | 1-72 |
| Industrial applicability (IA) | Yes: Claims | 1-72 |
|                               | No: Claims  |      |

2. Citations and explanations (Rule 70.7):

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

PCT/US2004/009716

**Re Item I**

**Basis of the report**

In a submission dated 30/11/2004 the applicant has made the mere assertion that the Article 19 PCT amendments he is filing and which he wishes to be considered for the international preliminary examination simply clarify the invention as claimed. In the letter accompanying the replacement sheets he has omitted to draw attention to the differences between the replaced sheets and the replacement sheets. Furthermore no reasons for the amendment were given in this letter other than for reasons of clarity. Clarity had never been an issue in the preceding written opinion. The applicant has also not indicated a basis in the originally filed version of the application for these amendments. Contrary to any ascertainable opinion of the applicant, the application has on account of the amendments become unclear in the case of claim 31 and are not regarded as mere clarifications. A facility in claim 31, which is configured to dip the glass articles in the salt bath prior to the glass articles while the glass articles are still hot is an obscure feature. No sense whatsoever can be made of prior to the glass articles. The amendments to the other claims now specify no cooling to below the annealing point of the glass to have taken place between the forming and the dipping step, whether intentional or unintentional. The skilled person is being present with information which had never been part of the original disclosure, where what happened to the surface temperature of the glass between the formation and dipping the step was not disclosed in any form. Consequently the applicant's comments filed with the accompanying letter are taken into account in the subsequent section of this report only insofar as they pertain to the originally filed version of the application.

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

D1 : GB 1 010 164 A (PITTSBURGH PLATE GLASS CO) 17 November 1965  
(1965-11-17)

D2 : GB 1 346 747 A (SAINT GOBAIN) 13 February 1974 (1974-02-13)

D3: US-A-3 938 977 (GLIEMEROTH GEORG) 17 February 1976 (1976-02-17)

165

**2 INDEPENDENT CLAIM 1**

- 2.1** The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 1 is not new in the sense of Article 33(2) PCT.  
Document D1 discloses (the references in parenthesis applying to this document):  
a method of dipping a glass article in a molten salt bath comprising potassium ions wherein the surface temperature of the glass is at least the annealing point temperature during the dipping step (1050°F - 565°C) and then maintaining the glass at a temperature at just below the strain point of the glass (950°F - 510°C) for at least 5 minutes (15 minutes) (example IV, samples 60 to 65, page 12, lines 33 to 36).
- 2.2** The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 1 is not new in the sense of Article 33(2) PCT.  
Document D2 discloses (the references in parenthesis applying to this document):  
a method of dipping a glass article in a molten salt bath comprising potassium ions wherein the surface temperature of the glass is at least the annealing point temperature (545.5°C) during the dipping step (600°C) and then maintaining the glass at a temperature (450°C) at just below the strain point of the glass (511.5°C) for at least 5 minutes (hours) (example on page 2, lines 49 to 78).

**3 INDEPENDENT CLAIM 17**

- 3.1** The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 17 is not new in the sense of Article 33(2) PCT.  
Document D1 discloses an apparatus comprising a staging area, glass article moving means, salt bath and a strengtheninglehr all of which fulfill the functions specified in Claim 1. This also applies with respect to document D2.

**4 INDEPENDENT CLAIM 31**

- 4.1** The present application does not meet the criteria of Article 33(1) PCT, because the

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

168  
International application No.

PCT/US2004/009716

subject-matter of Claim 31 is not new in the sense of Article 33(2) PCT (see point 3 above).

**5 INDEPENDENT CLAIM 46**

- 5.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 46 is not new in the sense of Article 33(2) PCT (see point 2 above).

**6 INDEPENDENT CLAIM 61**

- 6.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 61 is not new in the sense of Article 33(2) PCT (see point 3 above).

**7 DEPENDENT CLAIMS 2-16, 18-30, 32-45, 47-60, 62-72**

Dependent Claims 2-16, 18-30, 32-45, 47-60, 62-72 do not contain any features which, in combination with the features of any Claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT).

- 8 The disclosure in Document D3 is particularly pertinent to the specific salt bath formulations defined in Claim 7, 8, 21, 22, 36, 37, 65 and 66.

- 9 Applicant's response to the explanations given in view of document D1 do not deal with the basis for these observations, which is example IV of document D1, (see above). Thus the observations can only be maintained.

107/62

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

**PCT/US2004/009716**

- 10 Applicant's response to the explanations given in view of document D2 do not relate to the basis for these observations, which in this case is the novelty of the subject-matter of independent claims 1 and 42 only with respect to the example given in document D2. The only references in the response to these claims when considering document D2 relate to subject-matter not considered in this report (see item I above).

## SUBSTITUTE SHEET

## CLAIMS

We claim:

1. A method, comprising the steps of:

forming a glass article from molten glass, the glass having an annealing point temperature;

dipping the formed glass article in a molten salt bath, the salt bath comprising potassium ions wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the dipping step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, wherein the glass remains at a temperature greater than the annealing point temperature of the glass from the forming step to the dipping step.

2. The method of claim 1, wherein the surface temperature of the glass article is at least about 25°C above the annealing point temperature of the glass.

3. The method of claim 1, wherein the glass article is dipped in the salt bath for less than about one minute.

4. The method of claim 1, wherein the glass article is dipped in the salt bath for about 10 seconds or less.

## SUBSTITUTE SHEET

5. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 0.5 second and about 30 seconds.
6. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.
7. The method of claim 1, wherein the salt bath comprises potassium nitrate and potassium chloride.
8. The method of claim 7, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
9. The method of claim 1, wherein the salt bath comprises potassium sulfate and potassium chloride.
10. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
11. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

12. The method of claim 1, wherein the salt bath has a temperature of between about 550°C and about 750°C.
13. The method of claim 1, wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
14. The method of claim 1, wherein the strain point temperature is about 530°C.
15. The method of claim 1, further comprising:  
flame polishing the glass article prior to dipping the glass article in the salt bath.
16. The method of claim 1, further comprising:  
after the step of maintaining, cooling the glass article, removing residual salt from the glass article and applying a protective stuff resistant coating to the surface of the glass article.
17. An apparatus, comprising:  
a staging area;  
a glass article moving means for moving a glass article after forming of the glass article and prior to cooling the glass article to a temperature below the annealing point temperature of the glass article;  
a salt bath, the salt bath comprising molten salt, the glass article moving means being configured to move the glass article from the staging area and dip the glass article into the salt bath, the glass article moving means being configured to dip glass articles having a surface

## SUBSTITUTE SHEET

temperatures of at least the annealing point temperature of the glass, the glass article being configured to remain in the salt bath for less than about one minute; and

a strengthening lehr, the strengthening lehr being configured to keep the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

18. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for about 10 seconds or less.

19. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 0.5 second and about 30 seconds.

20. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 3 and about 5 seconds.

21. The apparatus of claim 17, wherein the salt bath comprises potassium nitrate and potassium chloride.

22. The apparatus of claim 21, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

23. The apparatus of claim 17, wherein the salt bath comprises potassium sulfate and potassium chloride.

172

11/11

24. The method of apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

25. The apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

26. The apparatus of claim 17, wherein the strengthening lahr is configured to keep the glass article at a temperature between the strain point temperature of the glass and about 130°C below the strain point temperature.

27. The apparatus of claim 17, wherein the strain point temperature is about 530°C.

28. The apparatus of claim 17, further comprising:

flame polishing means, the flame polishing means being configured to flame polish the glass articles.

29. The apparatus of claim 28, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:

a second flame polishing means configured to flame polish the bottoms of the glass articles.

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30. The apparatus of claim 17, further comprising:

a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengthening lehr.

31. A glass manufacturing facility comprising a glass forming machine configured to form glass articles, and a strengthening lehr, the improvement comprising:

a salt bath comprising molten salt, the glass articles being dipped into the salt bath for less than about one minute, the glass articles having a surface temperature at least above the annealing point temperature of the glass while being dipped in the salt bath; and

a strengthening lehr, the strengthening lehr being configured to maintain the temperature of the glass articles at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, the glass manufacturing facility being configured to dip the glass articles in the salt bath prior to the glass articles while the glass articles are still hot after being formed by the forming machine.

32. The glass manufacturing facility of claim 31, further comprising:

a glass article handling means, the glass article handling means being configured to dip the glass articles in the salt bath.

33. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for about 10 seconds or less.

110

34. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for between about 0.5 second and about 30 seconds.

35. The apparatus of claim 31, wherein the glass articles are dipped in the salt bath for between about 3 and about 5 seconds.

36. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium nitrate and potassium chloride.

37. The glass manufacturing facility of claim 31, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

38. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium sulfate and potassium chloride.

39. The glass manufacturing facility of claim 31, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

40. The glass manufacturing facility of claim 31, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

41. The glass manufacturing facility of claim 31 wherein the strengthening Lehr is configured to maintain the glass articles at a temperature between the strain point temperature and about 130°C below the strain point temperature.

42. The glass manufacturing facility of claim 31 wherein the strain point temperature is about 530°C.

43. The glass manufacturing facility of claim 31, further comprising:  
flame polishing means, the flame polishing means being configured to flame polish the glass articles.

44. The glass manufacturing facility of claim 43, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:

a second flame polishing means configured to flame polish the bottoms of the glass articles.

45. The glass manufacturing facility of claim 31, further comprising:  
a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengthening Lehr.

46. A method for strengthening a glass article, comprising:

forming the glass article from molten glass, the glass having an annealing point temperature;

applying potassium ions to the surface of the glass article before the glass article cools below the annealing point of the glass following the formation of the glass article, wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the applying step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

47. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for less than about 10 seconds.

48. The method of claim 46, wherein the glass article is dipped in the salt bath for about 0.5 second and about 30 seconds.

49. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for between about 3 and about 5 seconds.

50. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by spraying potassium ions on the surface of the glass article.

51. The method of claim 50, wherein spraying comprises flame spraying.
52. The method of claim 50, wherein the spraying comprises electrostatic spraying.
53. The method of claim 50, wherein the spraying step comprises power spraying.
54. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by chemical vapor deposition (CVD).
55. The method of claim 46, wherein the glass article is at a temperature of at least about 25°C above the annealing point of the glass during the applying step.
56. The method of claim 46, wherein the glass article is at a temperature of at least about 50°C above the annealing point of the glass during the applying step.
57. The method of claim 46, wherein the surface of the glass article is at a temperature of at least about 80°C above the annealing point of the glass during the applying step.
58. The method of claim 46 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
59. The method of claim 46 wherein the strain point temperature is about 530°C.

60. The method of claim 46, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.
61. A method, comprising:  
forming a glass article from molten glass;  
dipping the formed glass article in a salt bath before the glass article cools below the annealing point of the glass following the formation of the glass article, the salt bath comprising potassium ions, the glass articles being dipped for less than about 30 seconds; and  
maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.
62. The method of claim 61, wherein the glass article is dipped in the salt bath for about 20 seconds or less.
63. The method of claim 61, wherein the glass article is dipped in the salt bath for about 10 seconds or less.
64. The method of claim 61, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.
65. The method of claim 61, wherein the salt bath comprises potassium nitrate and potassium chloride.

66. The method of claim 65, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

67. The method of claim 61, wherein the salt bath comprises potassium sulfate and potassium chloride.

68. The method of claim 61, further comprising:  
flame polishing the glass article prior to dipping the article in the salt bath.

69. The method of claim 61, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.

70. The method of claim 61, wherein the salt bath has a temperature of between about 550°C and about 750°C.

71. The method of claim 61 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.

72. The method of claim 61 wherein the strain point temperature is about 530°C.

TRATADO SOBRE COOPERACIÓN INTERNACIONAL  
EN MATERIA DE PATENTES

Remitente:

OFICINA ENCARGADA DEL EXAMEN PRELIMINAR INTERNACIONAL

A:

BELL, Michael J. et al.  
HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, VA 22042  
ESTADOS UNIDOS DE AMÉRICA

PCT

COMUNICACIÓN SOBRE EL ENVÍO DEL  
INFORME DE EXAMEN PRELIMINAR  
INTERNACIONAL

(Regla 71.1 PCT)

Fecha de envío  
(Día/Mes/Año)

19.09.2004

No. de Expediente del Solicitante o Apoderado

01638.0010.00PC00

COMUNICACIÓN IMPORTANTE

No. de Solicitud Internacional

PCT/US2004/009716

Fecha Internacional de Presentación  
(día/mes/año)

31.03.2004

Fecha de Prioridad  
(día/mes/año)

22.04.2003

Solicitante

THE COCA-COLA COMPANY et al.

1. Se comunica al solicitante que la oficina encargada del examen preliminar internacional le envía con el presente el informe de examen preliminar internacional, elaborado para la solicitud internacional, en caso dado con los anexos correspondientes.
2. Una copia del informe, en caso dado con los anexos correspondientes se hace llegar a la Oficina Internacional para su envío posterior a todas las oficinas seleccionadas.
3. A solicitud de una oficina seleccionada, la Oficina Internacional preparará una traducción del informe (pero no de los anexos) al inglés y la remitirá a esta oficina.

4. RECORDATORIO

Para ingresar en la fase nacional el solicitante, dentro de los 30 meses a partir de la fecha de prioridad (o en algunas oficinas incluso después), tiene que realizar ante cada oficina seleccionada ciertos actos (entrega de traducciones y desembolso de honorarios nacionales) (Artículo 39 (1)) (véase también la información remitida por la Oficina Internacional en el Formulario PCT/IB/301).

Si se tiene que enviar a una oficina seleccionada una traducción de la solicitud internacional, entonces esta traducción tiene que incluir traducciones de todos los anexos al informe de examen preliminar internacional. Es obligación del solicitante elaborar dichas traducciones y hacerlas llegar directamente a las oficinas seleccionadas respectivas.

Mayores detalles en cuanto a los plazos normativos y los requisitos de las oficinas seleccionadas se desprenden del Volumen II de la guía PCT para solicitantes.

Se llama la atención del solicitante al Artículo 33(5), que establece que los criterios de novedad, actividad inventiva y posibilidad de aplicación industrial descritos en Artículo 33(2) a (4) sirven meramente los propósitos del examen preliminar internacional y que "todo Estado Contratante puede aplicar criterios adicionales o diferentes para efectos de decidir si la invención reivindicada es patentable o no" (véase también Artículo 27 (5)). Los criterios adicionales pueden incluir, por ejemplo, exención de patentabilidad y los requerimientos, si se permite la divulgación, y de claridad y soporte de las reivindicaciones.

Nombre y dirección postal de la Oficina Encargada del  
Examen Preliminar Internacional



Oficina Europea de Patentes  
D-80298 Munich  
Tel.: +49 89 2399 - 0 Tx: 523656 apmu d  
Fax: +49 89 2399 - 4465

Empleado Autorizado

Galatioto, M

Tel.: +49 89 2399-7849



# TRATADO DE COOPERACIÓN EN MATERIA DE PATENTES

## PCT

### INFORME DE EXAMEN PRELIMINAR INTERNACIONAL

(Capítulo II del Tratado de Cooperación en Materia de Patentes)

(Artículo 36 y Regla 70 PCT)

|                                                                                          |                                                                 |                                                |
|------------------------------------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------|
| No. de Expediente del Solicitante o Apoderado<br>xxx                                     | <b>PROCEDIMIENTO POSTERIOR</b><br>Véase formulario PCT/IPEA/418 |                                                |
| No. Solicitud Internacional<br>PCT/US2004/009718                                         | Fecha Internacional de Presentación (día/mes/año)<br>31.03.2004 | Fecha de Prioridad (día/mes/año)<br>22.04.2003 |
| Clasificación Internacional de Patente (IPC) o Clasificación Nacional e IPC<br>C03C21/00 |                                                                 |                                                |
| Solicitante<br>THE COCA-COLA COMPANY et al.                                              |                                                                 |                                                |

- El presente informe es el informe de examen preliminar internacional, establecido por esta Oficina Encargada del Examen Preliminar Internacional bajo Artículo 35 y transmitido a solicitante de acuerdo con el Artículo 38.
- El presente informe comprende un total de 7 hojas, incluye esta portada
- Este importe se acompaña igualmente por ANEXOS, que comprenden:
  - ☒ (enviado al solicitante y a la Oficina Internacional) un total de 12 hojas, como sigue:
    - ☐ hojas de la descripción, reivindicaciones y/o dibujos que se han corregido y constituyen la base de el presente informe y/o hojas que contienen rectificaciones autorizadas por esta Oficina (véase Regla 70.16 y Sección 807 de las Instrucciones Administrativas).
    - ☒ hojas que reemplazan hojas anteriores, pero que esta Oficina considera que contienen una corrección que va más allá de la divulgación en la solicitud internacional tal como se presentó, como se indica en el ítem 4 de Cuadro No. I y el Cuadro Adicional.
  - ☐ (enviado a la Oficina Internacional únicamente) un total de (indicar tipo y número de medios electrónicos) , que contiene un listado de secuencias y/o tablas relacionadas con este asunto, en formato de lectura por computador únicamente, como se indica en el Cuadro Adicional Relativo al Listado de Secuencias (véase Sección 802 de las Instrucciones Administrativas).

- El presente informe contiene datos con respecto a los siguientes puntos:
  - ☒ Cuadro No. I Base del Informe
  - ☐ Cuadro No. II Prioridad
  - ☐ Cuadro No. III Sin elaboración de un dictamen sobre novedad, actividad inventiva y posibilidad de aplicación industrial
  - ☐ Cuadro No. IV Uniformidad deficiente de la invención
  - ☒ Cuadro No. V Declaración justificada según Artículo 35(2) con respecto a la novedad, la actividad inventiva y la posibilidad de aplicación industrial; documentos y explicaciones que sustentan esta declaración
  - ☐ Cuadro No. VI Ciertos documentos enumerados
  - ☐ Cuadro No. VII Ciertas deficiencias del registro internacional
  - ☐ Cuadro No. VIII Ciertas observaciones relacionadas con la solicitud internacional

|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Fecha de presentación de la petición<br>08.10.2004                                                                                                                                                                                                                                                | Fecha de la preparación de el presente informe<br>19.09.2005                                                                                        |
| Nombre y dirección postal de la Oficina Encargada del Examen Preliminar Internacional<br> Oficina Europea de Patentes<br>D-80298 Munich<br>Tel.: +49 89 2399 - 0 Tlx: 523858 epmu d<br>Fax: +49 89 2399 - 4485 | Empleado Autorizado<br>Somann, K<br>Tel.: +49 89 2399-8588<br> |

Formulario PCT/IPEA/409 (portada) (Enero 2004)

**Cuadro No. 1 Base del Informe**

1. En lo concerniente al idioma: El presente Informe se basa en la solicitud internacional en el idioma en el cual se presentó, salvo indicación en contrario consignada bajo este punto.  
  
☐ El presente Informe se basa en traducciones del idioma original al siguiente idioma INGLÉS, que es el idioma de una traducción suministrada para los efectos de:  
☐ la búsqueda internacional (según las reglas 12.3 y 23.1 (b))  
☐ la publicación de la solicitud internacional (según la regla 12.4).  
☐ el examen preliminar internacional (según las reglas 55.2 y/o 55.3).
2. Con respecto a los elementos de la solicitud internacional, este Informe se basa en (hojas intercambiables que se han suministrado a la oficina receptora en respuesta a una invitación bajo Artículo 14 se tienen en este informe por "presentadas originalmente" y no se anexan a este informe):

**Descripción, páginas**

1-51                      versión original

**Reivindicaciones, No.**

1-72                      corregidas (junto con cualquier declaración) bajo Art. 19 PCT

**Dibujos, Hojas**

1/24-24/24              versión original

- ☐ Un listado de secuencias y/o cualquier tabla(s) relacionada(s)– véase Cuadro Adicional relativo al Listado de Secuencias
3. ☐ Las correcciones han resultado en la cancelación de:  
☐ la descripción, páginas  
☐ las reivindicaciones, Nos.:  
☐ los dibujos, hojas/figs.  
☐ el listado de secuencias (especificar)  
☐ cualquier tabla(s) relacionada con el listado de secuencias (especificar)
  4. ☒ El presente Informe se preparó como si no se hubieran hecho (algunas de) las correcciones anexadas a este Informe y enumeradas a continuación ya que éstas, por las razones aducidas, en concepto de la oficina van más allá del contenido de divulgación en la versión presentada originalmente (Regla 70.2 (c)).  
☐ la descripción, páginas:  
☒ las reivindicaciones, Nos.: 1-72  
☐ los dibujos, hojas/figs.  
☐ el listado de secuencias (especificar)  
☐ cualquier tabla(s) relacionada con el listado de secuencias (especificar)

\* Si se aplica el punto 4, algunas o todas estas hojas pueden estar marcadas como "reemplazadas."

**INFORME DE EXAMEN PRELIMINAR  
INTERNACIONAL**

Solicitud Internacional No. **165183**  
PCT/US2004/009716

**Cuadro No. V Declaración motivada bajo Artículo 35(2) en cuanto a la novedad, la actividad inventiva y la posibilidad de aplicación Industrial; documentos y explicaciones que sustentan esta declaración**

**1. DECLARACIÓN**

|                                                  |                                  |
|--------------------------------------------------|----------------------------------|
| <b>Novedad (N)</b>                               | <b>Sí: Reivindicaciones</b>      |
|                                                  | <b>No: Reivindicaciones 1-72</b> |
| <b>Actividad Inventiva (IS)</b>                  | <b>Sí: Reivindicaciones</b>      |
|                                                  | <b>No: Reivindicaciones 1-72</b> |
| <b>Posibilidad de Aplicación Industrial (IA)</b> | <b>Sí: Reivindicaciones 1-72</b> |
|                                                  | <b>No: Reivindicaciones</b>      |

**2. Documentos y explicaciones (Regla 70.7)**

**Véase hoja separada**

**Ref. Cuadro I**  
**Base del Informe**

En una alegación fechada el 30/11/2004, el solicitante se limitó a sostener que las correcciones del Artículo 19 PCT, que él presenta y desea que se consideren para el examen preliminar internacional, simplemente aclaran la invención como se reivindica. En la carta que acompaña las hojas sustitutivas, omitió llamar la atención a las diferencias entre las hojas sustituidas y las hojas reemplazantes. Además, no se adjugaron razones para la corrección en esta carta distintas a las razones de claridad. En el concepto escrito anterior la claridad no había sido la cuestión. En la versión de la solicitud presentada originalmente, el solicitante tampoco indicó un fundamento de esas correcciones. En contra de cualquier concepto verificable del solicitante, por cuenta de las correcciones la solicitud se ha tornado confusa en el caso de la reivindicación 31 y no se considera como simple aclaración. Una instalación en la reivindicación 31, que se configura para sumergir los artículos de vidrio en el baño de sal antes de los artículos de vidrio, mientras los artículos de vidrio estén aún calientes, es una característica confusa. No se puede formar una idea de la expresión antes de los artículos de vidrio. Las correcciones a las demás reivindicaciones no especifican ahora que haya tenido lugar enfriamiento a por debajo del punto de recocido del vidrio, entre el paso de formación e inmersión, intencional o no intencional. A la persona experta se la confronta con información que nunca había sido parte de la divulgación original, en la que no se divulga en manera alguna qué sucedió a la temperatura de la superficie del vidrio entre el paso de formación e inmersión. Por consiguiente, los comentarios del solicitante presentados con la carta acompañante se toman en cuenta en la sección subsiguiente de este informe, únicamente en la medida en que conciernen a la versión de la solicitud originalmente presentada.

**Ref. Cuadro V**

**Declaración justificada según Artículo 35(2) con respecto a la novedad, la actividad inventiva y la posibilidad de aplicación industrial; documentos y explicaciones que sustentan esta declaración**

- D1: GB 1 010 164 A (PITTSBURGH PLATE GLASS CO) 17 de noviembre de 1965 (1965-11-17)
- D2 : GB 1 346 747 A (SAINT GOBAIN) 13 de febrero de 1974 (1974-02-13)
- D3: US-A-3 938 977 (GLIEMEROTH GEORG) 17 de febrero de 1976 (1976-02-17)

**2. REIVINDICACIÓN INDEPENDIENTE 1**

- 2.1** La presente solicitud no satisface los criterios del Artículo 33(1) PCT, porque el asunto de la Reivindicación 1 no es nuevo en el sentido del Artículo 33(2) PCT. El Documento D1 divulga (las referencias entre paréntesis se aplican a este documento): un método de sumergir un artículo de vidrio en un baño de sal fundida, que comprende iones de potasio en donde la temperatura de la superficie del vidrio es por lo menos la temperatura del punto de recocido durante el paso de inmersión (1050°F - 565°C) y, luego, mantener el vidrio a una temperatura justo por debajo del punto de deformación del vidrio (950°F - 510°C) durante al menos 5 minutos (15 minutos) (ejemplo IV, muestras 80 a 85, página 12, renglones 33 a 36).
- 2.2** La presente solicitud no satisface los criterios del Artículo 33(1) PCT, porque el asunto de la Reivindicación 1 no es nuevo en el sentido del Artículo 33(2) PCT. El Documento D2 divulga (las referencias entre paréntesis se aplican a este documento): un método de sumergir un artículo de vidrio en un baño de sal fundida que comprende iones de potasio, en donde la temperatura de la superficie del vidrio está a por lo menos la temperatura del punto de recocido (545.5°C) durante el paso de inmersión (800°C) y, luego, mantener el vidrio a una temperatura (450°C) a justo por debajo del punto de deformación del vidrio (511.5°C) durante por lo menos 5 minutos (horas) (ejemplo en página 2, renglones 49 a 78).

**3. REIVINDICACIÓN INDEPENDIENTE 17**

- 3.1** La presente solicitud no satisface los criterios del Artículo 33(1) PCT, porque el asunto de la Reivindicación 17 no es nuevo en el sentido del Artículo 33(2) PCT. El Documento D1 divulga un aparato que comprende un área de operaciones ("*a staging area*"), medios de traslado del artículo de vidrio, baño de sal y un túnel de endurecimiento, todos los cuales cumplen las funciones especificadas en la Reivindicación 1. Esto se aplica asimismo respecto al documento D2.

**4. REIVINDICACIÓN INDEPENDIENTE 31**

- 4.1** La presente solicitud no satisface los criterios del Artículo 33(1) PCT, porque el asunto de la Reivindicación 31 no es nuevo en el sentido del Artículo 33(2) PCT (véase Punto 3 más arriba).

11/8/04

**5. REIVINDICACIÓN INDEPENDIENTE 46**

- 5.1 La presente solicitud no satisface los criterios del Artículo 33(1) PCT, porque el asunto de la Reivindicación 46 no es nuevo en el sentido del Artículo 33(2) PCT (véase Punto 2 más arriba).**

**6. REIVINDICACIÓN INDEPENDIENTE 61**

- 6.1 La presente solicitud no satisface los criterios del Artículo 33(1) PCT, porque el asunto de la Reivindicación 61 no es nuevo en el sentido del Artículo 33(2) PCT (véase Punto 3 más arriba).**

**7. REIVINDICACIONES DEPENDIENTES 2-16, 18-30, 32-45, 47-60, 62-72**

**Las Reivindicaciones Dependientes 2-16, 18-30, 32-45, 47-60, 62-72 no contienen características de ninguna clase que, en combinación con las características de cualquier Reivindicación a la cual se refieren, satisfagan los requerimientos del PCT con respecto a la novedad y/o actividad inventiva (Artículo 33(2) y (3) PCT).**

- 8. La divulgación en Documento D3 es particularmente pertinente a las formulaciones específicas del baño de sal, definidas en la Reivindicación 7, 8, 21, 22, 36, 37, 65 y 66.**
- 9. La respuesta del solicitante a las explicaciones dadas en vista del documento D1 no se ocupan de la base de estas observaciones, que es ejemplo IV de documento D1, (véase más arriba). Por lo tanto, solo se pueden sostener las observaciones.**

187

10. La respuesta del solicitante a las explicaciones dadas en vista del documento D2 no se relacionan con la base de estas observaciones, que este caso es la novedad del asunto de la reivindicaciones independientes 1 y 42, únicamente con respecto al ejemplo dado en el documento D2. Las únicas referencias en la respuesta a estas reivindicaciones, cuando se considera el documento D2, se relacionan con el asunto no considerado en este informe (véase Cuadro I más arriba).

10/188

## REIVINDICACIONES

### Reivindicamos:

1. Un método, que comprende los pasos de:  
formar un artículo de vidrio de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;  
sumergir el artículo de vidrio formado en un baño de sal fundida, baño de sal que comprende iones de potasio en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de inmersión; y  
mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos, en donde el vidrio permanece a una temperatura mayor que la temperatura de punto de recocido del vidrio, del paso de formación al paso de inmersión.
2. El método de la reivindicación 1, en donde la temperatura superficial del artículo de vidrio es por lo menos alrededor de 25°C por encima de la temperatura de punto de recocido del vidrio.
3. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante menos de alrededor de un minuto.
4. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 10 segundos o menos.
5. El método de la reivindicación 1, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 0.5 segundo y entre alrededor de 30 segundos.
6. El método de la reivindicación 1, en donde el artículo de vidrio se

189

sumerge en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

7. El método de la reivindicación 1, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

8. El método de la reivindicación 7, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

9. El método de la reivindicación 1, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

10. El método de la reivindicación 1, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio

11. El método de la reivindicación 1, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

12. El método de la reivindicación 1, en donde el baño de sal tiene una temperatura de entre alrededor de 550°C y entre alrededor de 750°C.

13. El método de la reivindicación 1, en donde mantener el artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

14. El método de la reivindicación 1, en donde la temperatura del punto de deformación es alrededor de 530°C.

190

15. El método de la reivindicación 1, que comprende además:

pulir a la llama el artículo de vidrio antes de sumergir el artículo de vidrio en el baño de sal.

16. El método de la reivindicación 1, que comprende además:

después del paso de mantenimiento, enfriar el artículo de vidrio, eliminar la sal residual del artículo de vidrio y aplicar a la superficie del artículo de vidrio un recubrimiento protector resistente al rayado.

17. Un aparato, que comprende:

un área de operaciones;

medios de traslado para trasladar un artículo de vidrio luego de formar el artículo de vidrio y antes de enfriar el artículo de vidrio a una temperatura por debajo de la temperatura de punto de recocido del artículo de vidrio;

un baño de sal, baño de sal que comprende sal fundida, configurándose los medios de traslado del artículo de vidrio para trasladar el artículo de vidrio desde el área de operaciones y sumergir el artículo de vidrio en el baño de sal, configurándose los medios de traslado del artículo de vidrio para sumergir artículos de vidrio con temperaturas superficiales de por lo menos la temperatura de punto de recocido del vidrio, configurándose el artículo de vidrio para permanecer en el baño de sal durante menos de alrededor de un minuto; y

un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

18. El aparato de la reivindicación 17, en donde los medios de traslado del artículo de vidrio se configuran para sumergir el artículo de vidrio en el

191

baño de sal durante alrededor de 10 segundos o menos.

19. El aparato de la reivindicación 17, en donde los medios de traslado del artículo de vidrio se configuran para sumergir el artículo de vidrio en el baño de sal durante entre alrededor de 0.5 segundo y entre alrededor de 30 segundos.

20. El aparato de la reivindicación 17, en donde los medios de traslado del artículo de vidrio se configuran para sumergir el artículo de vidrio en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

21. El aparato de la reivindicación 17, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

22. El aparato de la reivindicación 21, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

23. El aparato de la reivindicación 17, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

24. El método de aparato de la reivindicación 10, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio.

25. El aparato de la reivindicación 17, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

26. El aparato de la reivindicación 17, en donde el túnel de endurecimiento se configura para mantener el artículo de vidrio a una

192

temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 130°C por debajo de la temperatura del punto de deformación

27. El aparato de la reivindicación 17, en donde la temperatura del punto de deformación es alrededor de 530°C.

28. El aparato de la reivindicación 17, que comprende además:

medios de pulimento a la llama, configurándose los medios de pulimento a la llama para pulir a la llama los artículos de vidrio.

29. El aparato de la reivindicación 28, en donde los medios de pulimento a la llama son un primer medio de pulimento a la llama, configurado para pulir a la llama los lados del artículo de vidrio, aparato que comprende además:

un segundo medio de pulimento a la llama, configurado para pulir a la llama los fondos de los artículo de vidrio.

30. El aparato de la reivindicación 17, que comprende además:

un mecanismo de recubrimiento, configurado para aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio después de que el artículo de vidrio se ha sacado del túnel de endurecimiento.

31. Una instalación de manufactura de vidrio que comprende una máquina formadora de vidrio, configurada para formar artículos de vidrio, y un túnel de endurecimiento, mejora que comprende:

un baño de sal que comprende sal fundida, sumergiéndose los artículos de vidrio en el baño de sal durante menos de alrededor de un minuto, teniendo los artículos de vidrio una temperatura superficial por lo menos por encima de la temperatura de punto de recocido del vidrio, mientras están siendo sumergidos en el baño de sal; y

193

un túnel de endurecimiento, configurándose el túnel de endurecimiento para mantener la temperatura de los artículos de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos, configurándose la instalación de manufactura para sumergir los artículos de vidrio en el baño de sal antes de los artículos de vidrio, mientras los artículos de vidrio están aún calientes después de haberse formado por la máquina de formación.

32. El equipo de manufactura de vidrio de la reivindicación 31, que comprende además:

medios de manipulación del artículo de vidrio, configurándose los medios de manipulación del artículo de vidrio para sumergir los artículos de vidrio en el baño de sal.

33. El equipo de manufactura de vidrio de la reivindicación 31, en donde los artículos de vidrio se sumergen en el baño de sal durante alrededor de 10 segundos o menos.

34. El equipo de manufactura de vidrio de la reivindicación 31, en donde los artículos de vidrio se sumergen en el baño de sal durante entre alrededor de 0.5 segundos y entre alrededor de 30 segundos.

35. El aparato de la reivindicación 31, en donde los artículos de vidrio se sumergen en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

36. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

37. El equipo de manufactura de vidrio de la reivindicación 31, en donde

194

el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

38. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

39. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio.

40. El equipo de manufactura de vidrio de la reivindicación 31, en donde el baño de sal comprende una combinación de por lo menos dos de nitrato de potasio, cloruro de potasio y sulfato de potasio, teniendo la combinación un punto de fusión de por lo menos 550°C.

41. El equipo de manufactura de vidrio de la reivindicación 31 en donde el túnel de endurecimiento se configura para mantener los artículos de vidrio a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

42. El equipo de manufactura de vidrio de la reivindicación 31 en donde la temperatura del punto de deformación es alrededor de 530°C.

43. El equipo de manufactura de vidrio de la reivindicación 31, que comprende además:

medios de pulimento a la llama, configurándose los medios de pulimento a la llama para pulir a la llama los artículos de vidrio.

44. El equipo de manufactura de vidrio de la reivindicación 43, en donde los medios de pulimento a la llama es un primer medio de pulimento a la llama configurado para pulir a la llama los lados del artículo de vidrio,

10X 195

aparato que comprende además:

un segundo medio de pulimento a la llama configurado para pulir a la llama los fondos de los artículos de vidrio.

45. El equipo de manufactura de vidrio de la reivindicación 31, que comprende además:

un mecanismo de recubrimiento configurado para aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio después de que el artículo de vidrio se ha retirado del túnel de endurecimiento.

46. Un método para endurecer un artículo de vidrio, que comprende:

formar el artículo de vidrio a partir de vidrio fundido, teniendo el vidrio una temperatura de punto de recocido;

aplicar iones de potasio a la superficie del artículo de vidrio antes de que el artículo de vidrio se enfríe por debajo del punto de recocido del vidrio, luego de la formación del artículo de vidrio, en donde la temperatura superficial del artículo de vidrio es por lo menos la temperatura de punto de recocido del vidrio durante el paso de aplicación;

y

mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

47. El método de la reivindicación 46, en donde el paso de aplicar los iones de potasio a la superficie del artículo de vidrio se lleva a cabo sumergiendo el artículo de vidrio en un baño de sal durante menos de alrededor de 10 segundos.

48. El método de la reivindicación 46, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 0.5 segundo y entre

198 196

alrededor de 30 segundos.

49. El método de la reivindicación 46, en donde el paso de aplicar los iones de potasio a la superficie del artículo de vidrio se lleva a cabo sumergiendo el artículo de vidrio en un baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

50. El método de la reivindicación 46, en donde el paso de aplicar iones de potasio a la superficie del artículo de vidrio se lleva a cabo rociando iones de potasio sobre la superficie del artículo de vidrio.

51. El método de la reivindicación 50, en donde el rociado comprende pulverización a la llama.

52. El método de la reivindicación 50, en donde el rociado comprende pulverización electrostática.

53. El método de la reivindicación 50, en donde el paso de pulverización comprende pulverización de polvo.

54. El método de la reivindicación 46, en donde el paso de aplicar iones de potasio a la superficie del artículo de vidrio se lleva a cabo por deposición de vapor químico (CVD).

55. El método de la reivindicación 46, en donde el artículo de vidrio está a una temperatura de por lo menos alrededor de 25°C por encima del punto de recocido del vidrio durante el paso de aplicación.

56. El método de la reivindicación 46, en donde el artículo de vidrio está a una temperatura de por lo menos alrededor de 50°C por encima del punto de recocido del vidrio durante el paso de aplicación.

11/197

57. El método de la reivindicación 46, en donde la superficie del artículo de vidrio está a una temperatura de por lo menos alrededor de 80°C por encima del punto de recocido del vidrio durante el paso de aplicación.

58. El método de la reivindicación 46 en donde el mantenimiento del artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

59. El método de la reivindicación 46 en donde la temperatura del punto de deformación es alrededor de 530°C.

60. El método de la reivindicación 46, que comprende además:

luego del paso de mantenimiento, aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio.

61. Un método, que comprende:

formar un artículo de vidrio a partir de vidrio fundido;

sumergir el artículo de vidrio formado en un baño de sal antes de que el artículo de vidrio se enfríe por debajo del punto de recocido del vidrio luego de la formación del artículo de vidrio, baño de sal que comprende iones de potasio, sumergiéndose los artículo de vidrio durante menos de alrededor de 30 segundos; y

mantener el artículo de vidrio a una temperatura entre la temperatura del punto de deformación del vidrio y entre alrededor de 150°C por debajo de la temperatura del punto de deformación durante por lo menos alrededor de cinco minutos.

62. El método de la reivindicación 61, en donde el artículo de vidrio se sumerge en el baño de sal durante alrededor de 20 segundos o menos.

63. El método de la reivindicación 61, en donde el artículo de vidrio se

198

sumerge en el baño de sal durante alrededor de 10 segundos o menos.

64. El método de la reivindicación 61, en donde el artículo de vidrio se sumerge en el baño de sal durante entre alrededor de 3 y entre alrededor de 5 segundos.

65. El método de la reivindicación 61, en donde el baño de sal comprende nitrato de potasio y cloruro de potasio.

66. El método de la reivindicación 65, en donde el nitrato de potasio está en el margen de 40-60 mol% y el cloruro de potasio está en el margen de 40-60 mol%.

67. El método de la reivindicación 61, en donde el baño de sal comprende sulfato de potasio y cloruro de potasio.

68. El método de la reivindicación 61, que comprende además:  
pulir a la llama el artículo de vidrio antes de sumergir el artículo en el baño de sal.

69. El método de la reivindicación 61, que comprende además:  
luego del paso de mantenimiento, aplicar un recubrimiento protector, resistente al rayado, a la superficie del artículo de vidrio.

70. El método de la reivindicación 61, en donde el baño de sal tiene una temperatura de entre alrededor de 550°C y entre alrededor de 750°C.

71. El método de la reivindicación 61 en donde el mantenimiento del artículo de vidrio está a una temperatura entre la temperatura del punto de deformación y entre alrededor de 130°C por debajo de la temperatura del punto de deformación.

20199

72. El método de la reivindicación 61 en donde la temperatura del punto de deformación es alrededor de 530°C.

## PATENT COOPERATION TREATY

## PCT

200

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

|                                                              |                                                                                                  |                                                                |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Applicant's or agent's file reference<br><b>1638.10.PC00</b> | <b>FOR FURTHER ACTION</b><br>see Form PCT/ISA/220<br>as well as, where applicable, Item 5 below. |                                                                |
| International application No.<br><b>PCT/US2004/009716</b>    | International filing date (day/month/year)<br><b>31/03/2004</b>                                  | (Earliest) Priority Date (day/month/year)<br><b>22/04/2003</b> |
| Applicant<br><br><b>THE COCA-COLA COMPANY</b>                |                                                                                                  |                                                                |

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ The international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (See Box II).

3. ☐ Unity of invention is lacking (see Box III).

4. With regard to the title,

☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows:

**METHOD AND APPARATUS FOR STRENGTHENING GLASS**

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regards to the drawings,

a. the figure of the drawings to be published with the abstract is Figure No. 2

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 C03C21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                              | Relevant to claim No.              |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| X          | GB 1 010 164 A (PITTSBURGH PLATE GLASS CO)<br>17 November 1965 (1965-11-17)<br>page 4, line 35 - line 68<br>page 4, line 89 - line 116<br>page 5, line 58 - line 81<br>examples I, IV<br>page 16, line 4<br>claim 2<br>figure 1 | 1-72                               |
| X          | GB 1 346 747 A (SAINT GOBAIN)<br>13 February 1974 (1974-02-13)<br>page 2, line 49 - line 78<br>page 2, line 89 - line 92                                                                                                        | 1-72                               |
| A          | US 3 938 977 A (GLIEMEROTH GEORG)<br>17 February 1976 (1976-02-17)<br><br>column 4, line 57 - column 5, line 1                                                                                                                  | 7, 8, 21,<br>22, 36,<br>37, 65, 66 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"G" document member of the same patent family

Date of the actual completion of the international search

17 September 2004

Date of mailing of the international search report

30/09/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-3040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3018

Authorized officer

Somann, K

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/US2004/009716

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|----------------------------------------|------------------|-------------------------|------------------|
| GB 1010164                             | A                | 17-11-1965              | BE 637510 A      |
|                                        |                  |                         | DE 1496618 A1    |
|                                        |                  |                         | FR 1375282 A     |
|                                        |                  |                         | NL 298010 A      |
|                                        |                  |                         | SE 307434 B      |
| GB 1346747                             | A                | 13-02-1974              | FR 2146955 A1    |
|                                        |                  |                         | BE 786855 A1     |
|                                        |                  |                         | DE 2237226 A1    |
|                                        |                  |                         | ES 405225 A1     |
|                                        |                  |                         | IT 963431 B      |
|                                        |                  |                         | LU 65810 A1      |
|                                        |                  |                         | NL 7210423 A     |
|                                        |                  |                         | NO 128488 B      |
|                                        |                  |                         | SE 378099 B      |
|                                        |                  |                         |                  |
| US 3938977                             | A                | 17-02-1976              | DE 2230506 A1    |
|                                        |                  |                         | AT 329789 B      |
|                                        |                  |                         | AT 258873 A      |
|                                        |                  |                         | BE 801280 A1     |
|                                        |                  |                         | CS 172981 B2     |
|                                        |                  |                         | DD 104072 A5     |
|                                        |                  |                         | ES 416175 A1     |
|                                        |                  |                         | FR 2189337 A1    |
|                                        |                  |                         | GB 1424086 A     |
|                                        |                  |                         | IT 986441 B      |
|                                        |                  |                         | JP 49062518 A    |
|                                        |                  |                         | NL 7308535 A     |

287  
203

**PATENT COOPERATION TREATY  
IN THE INTERNATIONAL BUREAU OF WIPO**

PCT International Patent Appl. No. PCT/US2004/009716

International Filing Date: 31 March 2004 (31.03.04)

Applicant: The Coca-Cola Company

Title: Method and Apparatus for Strengthening Glass

Attorney Docket No.: 1638.10.PC00

**AMENDMENT UNDER PCT ARTICLE 19**

International Bureau of WIPO  
34 chemin des Colombettes  
1211 Geneva 20  
SWITZERLAND  
Via facsimile to: 011 41 22 740 14 35

Dear Sir or Madam:

Applicants request the Examiner to consider the following amendment. Applicants include herewith substitute pages for all amendments entered in this communication.

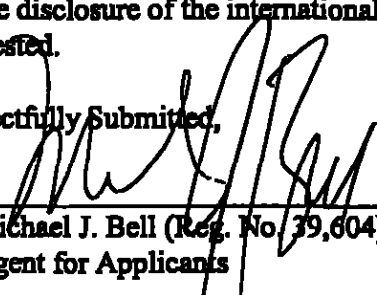
***In the Claims:***

Please amend claims 1, 17, 31, 46, and 61. The substitute pages 52-63 of the claims are attached herewith.

***Summary***

Applicants submit that the present amendment is simply to clarify the embodiment of the invention. This amendment does not go beyond the disclosure of the international application as filed. Entry of the amendment is respectfully requested.

Respectfully Submitted,

By: 

Michael J. Bell (Reg. No. 39,604)  
Agent for Applicants

HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, Virginia 22042  
Telephone: 202-783-0800  
Facsimile: 703-336-6950

Date: 30 November 2004 (30.11.04)

100  
104**CLAIMS****We claim:**

1. A method, comprising the steps of:

forming a glass article from molten glass, the glass having an annealing point

temperature;

dipping the formed glass article in a molten salt bath, the salt bath comprising potassium ions wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the dipping step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, wherein the glass remains at a temperature greater than the annealing point temperature of the glass from the forming step to the dipping step.

2. The method of claim 1, wherein the surface temperature of the glass article is at least about 25°C above the annealing point temperature of the glass.

3. The method of claim 1, wherein the glass article is dipped in the salt bath for less than about one minute.

4. The method of claim 1, wherein the glass article is dipped in the salt bath for about 10 seconds or less.

5. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 0.5 second and about 30 seconds.
6. The method of claim 1, wherein the glass article is dipped in the salt bath for between about 3 and about 5 seconds.
7. The method of claim 1, wherein the salt bath comprises potassium nitrate and potassium chloride.
8. The method of claim 7, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
9. The method of claim 1, wherein the salt bath comprises potassium sulfate and potassium chloride.
10. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.
11. The method of claim 1, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

12. The method of claim 1, wherein the salt bath has a temperature of between about 550°C and about 750°C.

106  
106

13. The method of claim 1, wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.

14. The method of claim 1, wherein the strain point temperature is about 530°C.

15. The method of claim 1, further comprising:  
flame polishing the glass article prior to dipping the glass article in the salt bath.

16. The method of claim 1, further comprising:  
after the step of maintaining, cooling the glass article, removing residual salt from the glass article and applying a protective scuff resistant coating to the surface of the glass article.

17. An apparatus, comprising:  
a staging area;  
a glass article moving means for moving a glass article after forming of the glass article and prior to cooling the glass article to a temperature below the annealing point temperature of the glass article;  
a salt bath, the salt bath comprising molten salt, the glass article moving means being configured to move the glass article from the staging area and dip the glass article into the salt bath, the glass article moving means being configured to dip glass articles having a surface

temperatures of at least the annealing point temperature of the glass, the glass article being configured to remain in the salt bath for less than about one minute; and

a strengthening Lehr, the strengthening Lehr being configured to keep the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

18. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for about 10 seconds or less.

19. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 0.5second and about 30 seconds.

20. The apparatus of claim 17, wherein the glass article moving means is configured to dip the glass article in the salt bath for between about 3 and about 5 seconds.

21. The apparatus of claim 17, wherein the salt bath comprises potassium nitrate and potassium chloride.

22. The apparatus of claim 21, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

23. The apparatus of claim 17, wherein the salt bath comprises potassium sulfate and potassium chloride.

D  
22  
208

24. The method of apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

25. The apparatus of claim 17, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

26. The apparatus of claim 17, wherein the strengthening Lehr is configured to keep the glass article at a temperature between the strain point temperature of the glass and about 130°C below the strain point temperature

27. The apparatus of claim 17, wherein the strain point temperature is about 530°C.

28. The apparatus of claim 17, further comprising:

flame polishing means, the flame polishing means being configured to flame polish the glass articles.

29. The apparatus of claim 28, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:

a second flame polishing means configured to flame polish the bottoms of the glass articles.

209

30. The apparatus of claim 17, further comprising:

a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengthening Lehr.

31. A glass manufacturing facility comprising a glass forming machine configured to form glass articles, and a strengthening Lehr, the improvement comprising:

a salt bath comprising molten salt, the glass articles being dipped into the salt bath for less than about one minute, the glass articles having a surface temperature at least above the annealing point temperature of the glass while being dipped in the salt bath; and

a strengthening Lehr, the strengthening Lehr being configured to maintain the temperature of the glass articles at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes, the glass manufacturing facility being configured to dip the glass articles in the salt bath prior to the glass articles while the glass articles are still hot after being formed by the forming machine.

32. The glass manufacturing facility of claim 31, further comprising:

a glass article handling means, the glass article handling means being configured to dip the glass articles in the salt bath.

33. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for about 10 seconds or less.

34. The glass manufacturing facility of claim 31, wherein the glass articles are dipped in the salt bath for between about 0.5second and about 30 seconds.

35. The apparatus of claim 31, wherein the glass articles are dipped in the salt bath for between about 3 and about 5 seconds.

36. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium nitrate and potassium chloride.

37. The glass manufacturing facility of claim 31, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.

38. The glass manufacturing facility of claim 31, wherein the salt bath comprises potassium sulfate and potassium chloride.

39. The glass manufacturing facility of claim 31, wherein the salt bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate.

40. The glass manufacturing facility of claim 31, wherein the sale bath comprises a combination of at least two of potassium nitrate, potassium chloride, and potassium sulfate, the combination having a melting point of at least 550°C.

41. The glass manufacturing facility of claim 31 wherein the strengthening Lehr is configured to maintain the glass articles at a temperature between the strain point temperature and about 130°C below the strain point temperature.

42. The glass manufacturing facility of claim 31 wherein the strain point temperature is about 530°C.

43. The glass manufacturing facility of claim 31, further comprising:  
flame polishing means, the flame polishing means being configured to flame polish the glass articles.

44. The glass manufacturing facility of claim 43, wherein the flame polishing means is a first flame polishing means configured to flame polish the sides of the glass article, the apparatus further comprising:

a second flame polishing means configured to flame polish the bottoms of the glass articles.

45. The glass manufacturing facility of claim 31, further comprising:

a coating mechanism configured to apply a protective scuff resistant coating to the surface of the glass article after the glass article has been removed from the strengthening Lehr.

46. A method for strengthening a glass article, comprising:

forming the glass article from molten glass, the glass having an annealing point temperature;

applying potassium ions to the surface of the glass article before the glass article cools below the annealing point of the glass following the formation of the glass article, wherein the surface temperature of the glass article is at least the annealing point temperature of the glass during the applying step; and

maintaining the glass article at a temperature between the strain point temperature of the glass and about 150°C below the strain point temperature for at least about five minutes.

47. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for less than about 10 seconds.

48. The method of claim 46, wherein the glass article is dipped in the salt bath for about 0.5 second and about 30 seconds.

49. The method of claim 46, wherein the step of applying the potassium ions to the surface of the glass article is accomplished by dipping the glass article in a salt bath for between about 3 and about 5 seconds.

50. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by spraying potassium ions on the surface of the glass article.

1  
213

51. The method of claim 50, wherein spraying comprises flame spraying.
52. The method of claim 50, wherein the spraying comprises electrostatic spraying.
53. The method of claim 50, wherein the spraying step comprises power spraying.
54. The method of claim 46, wherein the step of applying potassium ions to the surface of the glass article is accomplished by chemical vapor deposition (CVD).
55. The method of claim 46, wherein the glass article is at a temperature of at least about 25°C above the annealing point of the glass during the applying step.
56. The method of claim 46, wherein the glass article is at a temperature of at least about 50°C above the annealing point of the glass during the applying step.
57. The method of claim 46, wherein the surface of the glass article is at a temperature of at least about 80°C above the annealing point of the glass during the applying step.
58. The method of claim 46 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
59. The method of claim 46 wherein the strain point temperature is about 530°C.

2/14

60. The method of claim 46, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of  
the glass article.
61. A method, comprising:  
forming a glass article from molten glass;  
dipping the formed glass article in a salt bath before the glass article cools below the  
annealing point of the glass following the formation of the glass article, the salt bath comprising  
potassium ions, the glass articles being dipped for less than about 30 seconds; and  
maintaining the glass article at a temperature between the strain point temperature of the  
glass and about 150°C below the strain point temperature for at least about five minutes.
62. The method of claim 61, wherein the glass article is dipped in the salt bath for about 20  
seconds or less.
63. The method of claim 61, wherein the glass article is dipped in the salt bath for about 10  
seconds or less.
64. The method of claim 61, wherein the glass article is dipped in the salt bath for between  
about 3 and about 5 seconds.
65. The method of claim 61, wherein the salt bath comprises potassium nitrate and potassium  
chloride.

215

66. The method of claim 65, wherein the potassium nitrate is in the range of 40-60 mol% and the potassium chloride is in the range of 40-60 mol%.
67. The method of claim 61, wherein the salt bath comprises potassium sulfate and potassium chloride.
68. The method of claim 61, further comprising:  
flame polishing the glass article prior to dipping the article in the salt bath.
69. The method of claim 61, further comprising:  
after the step of maintaining, applying a protective scuff resistant coating to the surface of the glass article.
70. The method of claim 61, wherein the salt bath has a temperature of between about 550°C and about 750°C.
71. The method of claim 61 wherein maintaining the glass article is at a temperature between the strain point temperature and about 130°C below the strain point temperature.
72. The method of claim 61 wherein the strain point temperature is about 530°C.

216

**PATENT COOPERATION TREATY  
IN THE INTERNATIONAL BUREAU OF WIPO**

PCT International Patent Appl. No. PCT/US2004/009716

International Filing Date: 31 March 2004 (31.03.04)

Applicant: The Coca-Cola Company

Title: *Method and Apparatus for Strengthening Glass*

Attorney Docket No.: 1638.10.PC00

**LETTER UNDER SECTION 205(b)  
TRANSMITTING AMENDMENT UNDER PCT ARTICLE 19**

International Bureau of WIPO  
34 chemin des Colombettes  
1211 Geneva 20  
SWITZERLAND  
Via facsimile to: 011 41 22 740 14 35

Dear Sir or Madam:

The applicants respectfully request that the International Bureau amend the claims of the above-captioned PCT international application by replacing sheets 52 through 63 of the claims as originally filed with the sheets 52 through 63 submitted herewith.

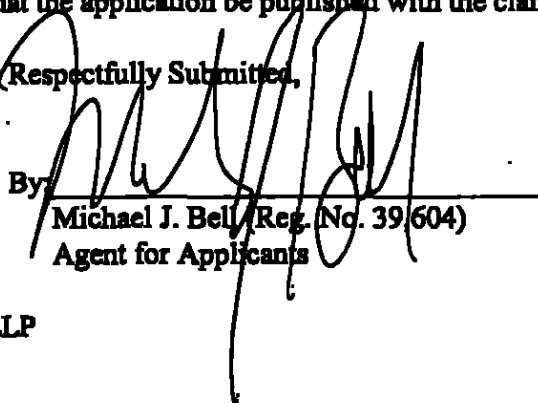
Claims 1, 17, 31, 46, and 61 have been replaced by amended claims bearing the same numbers.

The undersigned hereby confirms that the amended claims do not include matter that goes beyond the disclosure of the international application as filed.

The applicants respectfully request that the application be published with the claims as amended.

(Respectfully Submitted,

By

  
Michael J. Bell (Reg. No. 39/604)  
Agent for Applicants

HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, Virginia 22042  
Telephone: 202-783-0800  
Facsimile: 703-336-6950

Date: 30 November 2004 (30.11.04)

217

**PATENT COOPERATION TREATY  
IN THE INTERNATIONAL BUREAU OF WIPO**

PCT International Patent Appl. No. PCT/US2004/009716

International Filing Date: 31 March 2004 (31.03.04)

Applicant: The Coca-Cola Company

Title: Method and Apparatus for Strengthening Glass

Attorney Docket No.: 1638.10.PC00

**STATEMENT UNDER PCT ARTICLE 19(1)**

International Bureau of WIPO  
34 chemin des Colombettes  
1211 Geneva 20  
SWITZERLAND  
Via facsimile to: 011 41 22 740 14 35

Dear Sir or Madam:

Upon entry of the amendment Under PCT Article 19, claims 1-72 are pending in this application. For the following reasons Applicants believe that the pending claims are both novel and meet the requirement of inventive step over the British patents to Pittsburgh Plate Glass Company and Saint-Gobain Industries.

Claims 1, 17, 31, 46, and 61 are independent claims. Each of these independent claims recite that salts are applied to the surfaces of the glass articles at a temperature greater than about the annealing point temperature of the glass. This is not disclosed or suggested by Reference D1. In fact, Reference D1 requires that the glass article be preheated to a temperature that is approximately the same as the temperature of the salt bath. Page 7, col. 2, line 86 to page 8, col. 1, line 7. As described throughout Reference D1, from the preheating step to the dipping step, the glass is always in a heating condition. Moreover, the invention disclosed in Reference D1 pertains to flat glass articles, such as, for example, windowpanes and windshields. Page 1, col. 1, lines 19-36. The methods disclosed in Reference D1 will be substantially complicated by non-uniform glass articles.

20  
218

Because the present invention as recited in claims 1, 17, 31, 46, and 61 includes the forming of glass articles and then dipping them before the temperature of the glass falls below the annealing point of the glass, the present invention is both novel and has inventive step over the prior art method disclosed in Reference D1.

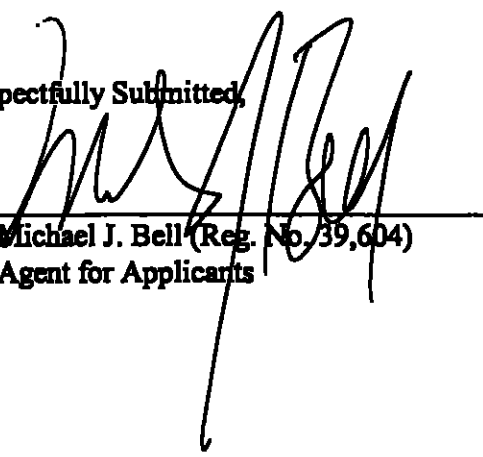
Claims 17, 31, and 61 all include "dipping" of glass articles. Unlike the present invention, where the glass articles are dipped for times of less than about 1 minute (claims 17 and 31), and less than about 30 seconds (claim 61), reference D2 discloses a standard prior art approach for strengthening glass articles in which the glass articles are soaked in a salt bath for significantly longer periods of time, such as "38 hours." Page 1, col. 2, lines 89-90. Reference D2 discloses glass strengthening using a two-step process for which the glass articles are soaked for a time of a total of 11 hours. Page 2, column 2, lines 109-112. Thus, the present invention permits mass production and strengthening of glass articles in a manner that distinguishes and significantly improves over prior art glass strengthening methods.

Claims 1 and 46 recite that the application of potassium ions to the surface of the glass article occurs before the glass article cools below the annealing point of the glass following the formation of the glass article. This is not disclosed or suggested by the prior art and once again provides significant advantages in permitting the mass production of glass articles.

Thus, claims 1, 17, 31, 46, and 61 are both novel and have inventive step over Reference D2.

Respectfully Submitted,

By:

  
Michael J. Bell (Reg. No. 39,604)  
Agent for Applicants

HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, Virginia 22042  
Telephone: 202-783-0800  
Facsimile: 703-336-6950  
Date: 30 November 2004 (30.11.04)

# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

**PCT**

*219*

To:  
**HOWREY, SIMON, ARNOLD & WHITE LLP**  
 Attn. Bell, Michael J.  
 1299 Pennsylvania Avenue, N.W.  
 Box 34  
 Washington D.C. 20004-2402  
 UNITED STATES OF AMERICA

**NOTIFICATION OF TRANSMITTAL OF  
 THE INTERNATIONAL SEARCH REPORT AND  
 THE WRITTEN OPINION OF THE INTERNATIONAL  
 SEARCHING AUTHORITY, OR THE DECLARATION**

(PCT Rule 44.1)

|                                                              |                                                                 |
|--------------------------------------------------------------|-----------------------------------------------------------------|
| Applicant's or agent's file reference<br><b>1638.10.PC00</b> | Date of mailing<br>(day/month/year) <b>30/09/2004</b>           |
| International application No.<br><b>PCT/US2004/009716</b>    | International filing date<br>(day/month/year) <b>31/03/2004</b> |
| Applicant<br><b>THE COCA-COLA COMPANY</b>                    |                                                                 |

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

**Filing of amendments and statement under Article 18:**

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

**Where?** Directly to the International Bureau of WIPO, 34 chemin des Colombettes  
 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

**4. Reminders**

Shortly after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within 18 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise, the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 18 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

|                                                                                                                                                                                                                                                                                                                      |                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Name and mailing address of the International Searching Authority<br> <b>European Patent Office, P.B. 5818 Patentstein 2</b><br><b>NL-2280 HV Rijswijk</b><br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax (+31-70) 340-3018 | Authorized officer<br><b>Véronique Baillou</b> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|

**DOCKETED**  
*10/4/04*

## NOTES TO FORM PCT/ISA/220

220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

### INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

#### What parts of the international application may be amended?

Under Article 18, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

#### When?

Within 2 months from the date of transmittal of the international search report or 18 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

#### Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 48.2).

Where a demand for international preliminary examination has been filed, see below.

#### How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

#### What documents necessarily accompany the amendments?

Letter (Section 208(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

221

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:  
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:  
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:  
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or  
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:  
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

**"Statement under article 19(1)" (Rule 45.4)**

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)".

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

**Consequence if a demand for international preliminary examination has already been filed**

If, at the time of filing any amendments under Article 18, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 92.2(a), first sentence).

**Consequence with regard to translation of the international application for entry into the national phase**

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 18 may have to be furnished to the designated/selected Office, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/selected Office, see Volume II of the PCT Applicant's Guide.

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

PCT

22/222

To:

see form PCT/ISA/220

## WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing  
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference  
see form PCT/ISA/220

**FOR FURTHER ACTION**  
See paragraph 2 below

International application No.  
PCT/US2004/009718

International filing date (day/month/year)  
31.03.2004

Priority date (day/month/year)  
22.04.2003

International Patent Classification (IPC) or both national classification and IPC  
C03C21/00

Applicant  
THE COCA-COLA COMPANY

### 1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

### 2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 68.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

### 3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



European Patent Office  
D-80298 Munich  
Tel. +49 89 2369 - 0 Tx: 523656 epmu d  
Fax: +49 89 2369 - 4485

Authorized Officer

Somann, K  
Telephone No. +49 89 2369-8586



**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

International application No.  
PCT/US2004/009716

123

**Box No. I Basis of the opinion**

1. With regard to the language, this opinion has been established on the basis of the International application in the language in which it was filed, unless otherwise indicated under this item.  
☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of International search (under Rules 12.3 and 23.1(b)).
2. With regard to any nucleotide and/or amino acid sequence disclosed in the International application and necessary to the claimed invention, this opinion has been established on the basis of:
  - a. type of material:  
☐ a sequence listing  
☐ table(s) related to the sequence listing
  - b. format of material:  
☐ in written format  
☐ in computer readable form
  - c. time of filing/furnishing:  
☐ contained in the international application as filed.  
☐ filed together with the International application in computer readable form.  
☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

  
International application No.  
PCT/US2004/009716

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**Box No. II Priority**

---

1. ☒ The following document has not been furnished:

- ☒ copy of the earlier application whose priority has been claimed (Rule 43bis.1 and 66.7(a)).
- ☐ translation of the earlier application whose priority has been claimed (Rule 43bis.1 and 66.7(b)).

Consequently it has not been possible to consider the validity of the priority claim. This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43bis.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

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**Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

|                               |             |      |
|-------------------------------|-------------|------|
| Novelty (N)                   | Yes: Claims |      |
|                               | No: Claims  | 1-72 |
| Inventive step (IS)           | Yes: Claims |      |
|                               | No: Claims  | 1-72 |
| Industrial applicability (IA) | Yes: Claims | 1-72 |
|                               | No: Claims  |      |

2. Citations and explanations

see separate sheet

**Re Item V.**

**1 The following documents are referred to in this communication:**

**D1 : GB 1 010 164 A (PITTSBURGH PLATE GLASS CO) 17 November 1965  
(1965-11-17)**

**D2 : GB 1 346 747 A (SAINT GOBAIN) 13 February 1974 (1974-02-13)**

**D3: US-A-3 938 977 (GLIEMEROTH GEORG) 17 February 1976 (1976-02-17)**

**2 INDEPENDENT CLAIM 1**

**2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 1 is not new in the sense of Article 33(2) PCT. Document D1 discloses (the references in parenthesis applying to this document): a method of dipping a glass article in a molten salt bath comprising potassium ions wherein the surface temperature of the glass is at least the annealing point temperature during the dipping step (1050°F - 565°C) and then maintaining the glass at a temperature at just below the strain point of the glass (950°F - 510°C) for at least 5 minutes (15 minutes) (example IV, samples 60 to 65, page 12, lines 33 to 36).**

**2.2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 1 is not new in the sense of Article 33(2) PCT. Document D2 discloses (the references in parenthesis applying to this document): a method of dipping a glass article in a molten salt bath comprising potassium ions wherein the surface temperature of the glass is at least the annealing point temperature (545.5°C) during the dipping step (600°C) and then maintaining the glass at a temperature (450°C) at just below the strain point of the glass (511.5°C) for at least 5 minutes (hours) (example on page 2, lines 49 to 78).**

**3 INDEPENDENT CLAIM 17**

**3.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 17 is not new in the sense of Article 33(2) PCT. Document D1 discloses an apparatus comprising a staging area, glass article**

moving means, salt bath and a strengthening lehr all of which fulfill the functions specified in Claim 1. This also applies with respect to document D2.

**4 INDEPENDENT CLAIM 31**

- 4.1** The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 31 is not new in the sense of Article 33(2) PCT (see point 3 above).

**5 INDEPENDENT CLAIM 46**

- 5.1** The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 46 is not new in the sense of Article 33(2) PCT (see point 2 above).

**6 INDEPENDENT CLAIM 61**

- 6.1** The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 61 is not new in the sense of Article 33(2) PCT (see point 2 above).

**7 DEPENDENT CLAIMS 2-16, 18-30, 32-45, 47-60, 62-72**

Dependent Claims 2-16, 18-30, 32-45, 47-60, 62-72 do not contain any features which, in combination with the features of any Claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT).

- 8** The disclosure in Document D3 is particularly pertinent to the specific salt bath formulations defined in Claim 7, 8, 21, 22, 36, 37, 65 and 66.

24  
127

**PATENT COOPERATION TREATY  
IN THE INTERNATIONAL BUREAU OF WIPO**

PCT International Patent Appl. No. PCT/US2004/009716

International Filing Date: 31 March 2004 (31.03.04)

Applicant: The Coca-Cola Company

Title: Method and Apparatus for Strengthening Glass

Attorney Docket No.: 1638.10.PC00

**RESPONSE TO WRITTEN OPINION**

European Patent Office  
D-80298 Munich  
GERMANY  
Via facsimile to: 011 49 89 2399 4465

Dear Sir or Madam:

In reply to the Written Opinion mailed 30 September 2004 (30.09.04), Applicants hereby request the Examiner to consider the following reply. Upon entry of the amendment Under PCT Article 19, claims 1-72 are pending in this application (copy of amendment attached herewith). For the following reasons Applicants believe that the pending claims are both novel and meet the requirement of inventive step over the British patents to Pittsburgh Plate Glass Company and Saint-Gobain Industries.

The Examiner has indicated that claims 1-72 lack both novelty and inventive step over GB 1,010,164 to Pittsburgh Plate Glass Company (Reference D1). Applicants believe, however, that the claims are patentable over Reference D1.

Claims 1, 17, 31, 46, and 61 are independent claims. Each of these independent claims recite that salts are applied to the surfaces of the glass articles at a temperature greater than about the annealing point temperature of the glass. This is not disclosed or suggested by Reference D1. In fact, Reference D1 requires that the glass article be preheated to a temperature that is approximately the same as the temperature of the salt bath. Page 7, col. 2, line 86 to page 8, col. 1, line 7. As described throughout Reference D1, from the preheating step to the dipping step, the glass is always in a heating condition. Moreover, the invention disclosed in Reference D1

228

pertains to flat glass articles, such as, for example, windowpanes and windshields. Page 1, col. 1, lines 19-36. The methods disclosed in Reference D1 will be substantially complicated by non-uniform glass articles.

Thus, because the present invention as recited in claims 1, 17, 31, 46, and 61 includes the forming of glass articles and then dipping them before the temperature of the glass falls below the annealing point of the glass, the present invention is both novel and has inventive step over the prior art method disclosed in Reference D1. The remainder of the claims are dependent claims are likewise both novel and have inventive step over Reference for D1 for at least the reasons set forth above.

The Examiner has indicated that claims 1-72 lack both novelty and inventive step over GB 1346747 to Saint-Gobain Industries (Reference D2). Applicants believe, however, that the claims are patentable over Reference D2.

Claims 17, 31, and 61 all include "dipping" of glass articles. Unlike the present invention, where the glass articles are dipped for times of less than about 1 minute (claims 17 and 31), and less than about 30 seconds (claim 61), reference D2 discloses a standard prior art approach for strengthening glass articles in which the glass articles are soaked in a salt bath for significantly longer periods of time, such as "38 hours." Page 1, col. 2, lines 89-90. Reference D2 discloses that this 38 hour soak time is unacceptable, and therefore, significantly improves over this 38 hour dip time by using a two-step process for which the glass articles are soaked for a time of a total of 11 hours. Page 2, column 2, lines 109-112. Thus, the present invention permits mass production and strengthening of glass articles in a manner that distinguishes and significantly improves over prior art glass strengthening methods.

Claims 1 and 46 recite that the application of potassium ions to the surface of the glass article occurs before the glass article cools below the annealing point of the glass following the formation of the glass article. This is not disclosed or suggested by the prior art and once again provides significant advantages in permitting the mass production of glass articles.

7.

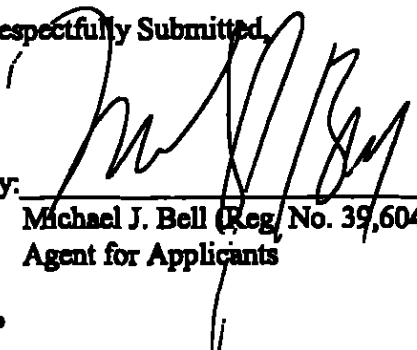
229

Thus, claims 1, 17, 31, 46, and 61 are both novel and have inventive step over Reference D2. The remainder of the claims are dependent claims are likewise both novel and have inventive step over Reference for D2 for at least the reasons set forth above.

In response to the Examiner's indication that a copy of the earlier application to which priority is claimed is outstanding, it is respectfully noted that upon filing the international application priority was claimed to two U.S. applications. Applicants respectfully note that a copy of the first claimed priority application, U.S. Serial No. 60/464,356 (filed 22 April 2003), was received by the International Bureau on 04 June 2004 (copy of Form PCT/IB/3004 attached herewith). With respect to the second claimed priority, U.S. Serial No. 10/813,435 (filed 31 March 2004), it is acknowledged by the applicant that the filing date of this U.S. application does not fall within the period of 12 months preceding the filing of the subject international application and, therefore, the U.S. Receiving Office will not transmit a copy of U.S. Serial No. 10/813,435 to the International Bureau.

Respectfully Submitted,

By:

  
Michael J. Bell (Reg. No. 39,604)  
Agent for Applicants

HOWREY SIMON ARNOLD & WHITE, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, Virginia 22042  
Telephone: 202-783-0800  
Facsimile: 703-336-6950

Date: 30 November 2004 (30.11.04)

## PATENT COOPERATION TREATY

RECEIVED  
DOCKET DEPT.  
HOWREY SIMON ARNOLD & WHITE

JUL 01 2004

PCT

WASHINGTON, DC.

NOTIFICATION CONCERNING  
SUBMISSION OR TRANSMITTAL  
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

From the INTERNATIONAL BUREAU

To:

BELL, Michael, J.  
Howrey Simon Arnold & White, LLP  
1299 Pennsylvania Avenue, N.W.  
Box 34  
Washington, DC 20004-2402  
United States of America

|                                                                      |                                                                          |
|----------------------------------------------------------------------|--------------------------------------------------------------------------|
| Date of mailing (day/month/year)<br>21 June 2004 (21.06.2004)        |                                                                          |
| Applicant's or agent's file reference<br>1638.10.PC00                | IMPORTANT NOTIFICATION                                                   |
| International application No.<br>PCT/US2004/009716                   | International filing date (day/month/year)<br>31 March 2004 (31.03.2004) |
| International publication date (day/month/year)<br>Not yet published | Priority date (day/month/year)<br>22 April 2003 (22.04.2003)             |
| Applicant<br>THE COCA-COLA COMPANY et al                             |                                                                          |

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. (If applicable) The letters "NR" appearing in the right-hand column denote a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
3. (If applicable) An asterisk (\*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b) (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

| Priority date              | Priority application No. | Country or regional Office<br>or PCT receiving Office | Date of receipt<br>of priority document |
|----------------------------|--------------------------|-------------------------------------------------------|-----------------------------------------|
| 22 April 2003 (22.04.2003) | 60/484,356               | US                                                    | 04 June 2004 (04.06.2004)               |
| 31 March 2004 (31.03.2004) |                          | US                                                    | NR                                      |

|                                                                                                                                               |                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <p>The International Bureau of WIPO<br/>34, chemin des Colombettes<br/>1211 Geneva 20, Switzerland</p> <p>Facsimile No. (41-22) 338.88.85</p> | <p>Authorized officer</p> <p>Marina BIARGE-THURRE (Fax 338-71-30)</p> <p>Telephone No. (41-22) 338 8573</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|

Form PCT/IB/304 (January 2004)

006314327

DOCKETED  
P. 7/1/04

From the INTERNATIONAL BUREAU

**PCT****INFORMATION CONCERNING ELECTED  
OFFICES NOTIFIED OF THEIR ELECTION**

(PCT Article 31(7) and Rule 61.3)

To:

BELL, Michael, J.  
Howrey Simon Arnold & White, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, VA 22042  
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year)

06 January 2005 (06.01.2005)

Applicant's or agent's file reference

1638.10.PC00

**IMPORTANT INFORMATION**

International application No.

PCT/US2004/009716

International filing date (day/month/year)

31 March 2004 (31.03.2004)

Priority date (day/month/year)

22 April 2003 (22.04.2003)

Applicant

THE COCA-COLA COMPANY et al

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP: AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR

National: BG, CA, CN, CZ, DE, JP, KP, KR, MN, NO, PL, RO, RU, SK, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

AP: BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW

EA: AM, AZ, BY, KG, KZ, MD, RU, TJ, TM

OA: BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG

National: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BR, BW, BY, BZ, CH, CO, CR, CU, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MW, MX, MZ, NA, NI, NZ, OM, PG, PH, PT, SC, SD, SE, SG, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW

3. Since the election(s) was (were) made before the expiration of 19 months from the priority date, the applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary report on patentability (Chapter II of the Patent Cooperation Treaty) (Article 36(3)(b) and Rule 74.1).

Some Offices have fixed time limits expiring later than the above-mentioned time limit. See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the PCT Applicant's Guide, Volume II, National Chapters, the PCT Newsletter and the WIPO Internet site, updated regularly.

**Received****JAN 11 2005****Howrey Simon Arnold & White LLP  
Docketing Dept.**

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Authorized officer

**Athina Nickitas-Etienne**

Facsimile No. +41 22 740 14 35

Facsimile No. +41 22 338 89 95

Form PCT/IB/332 (January 2004)

## PATENT COOPERATION TREATY

PCT

**NOTIFICATION CONCERNING  
THE FILING OF AMENDMENTS OF THE CLAIMS**  
(PCT Administrative Instructions, Section 417)

From the INTERNATIONAL BUREAU

To:

BELL, Michael, J.  
Howrey Simon Arnold & White, LLP  
2941 Fairview Park Drive, Box 7  
Falls Church, VA 22042  
United States of America

|                                                                   |                                                                          |
|-------------------------------------------------------------------|--------------------------------------------------------------------------|
| Date of mailing<br>(day/month/year) 15 December 2004 (15.12.2004) |                                                                          |
| Applicant's or agent's file reference<br>1638.10.PC00             | IMPORTANT NOTIFICATION                                                   |
| International application No.<br>PCT/US2004/009716                | International filing date<br>(day/month/year) 31 March 2004 (31.03.2004) |
| Applicant<br>THE COCA-COLA COMPANY et al                          |                                                                          |

1. The applicant is hereby notified that amendments to the claims under Article 18 were received by the International Bureau on:

30 November 2004 (30.11.2004)

2. This date is within the time limit under Rule 48.1.

Consequently, the international publication of the international application will contain the amended claims according to Rule 48.2(f), (h) and (i).

3. The applicant is reminded that the international application (description, claims and drawings) may be amended during the international preliminary examination under Chapter II, according to Article 34, and in any case, before each of the designated Offices, according to Article 28 and Rule 62, or before each of the elected Offices, according to Article 41 and Rule 78.

**Received****DEC 29 2004****Howrey Simon Arnold & White LLP  
Docketing Dept.**

|                                                                                                                                  |                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| The International Bureau of WIPO<br>34, chemin des Colombettes<br>1211 Geneva 20, Switzerland<br>Facsimile No. (41-22) 338.89.95 | Authorized officer<br><br>Marina BIARGE-THURRE (Fax 338-71-30)<br>Telephone No. (41-22) 338 8373 |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|

Form PCT/IB/348 (September 1983)

6539107

**DOCKETED**

# TRANSMITTAL LETTER TO THE UNITED STATES RECEIVING OFFICE

|                               |                          |
|-------------------------------|--------------------------|
| Date                          | 31 March 2004 (31.03.04) |
| International Application No. | To Be Assigned           |
| Attorney Docket No.           | 1638.10.PC00             |

## I. Certification under 37 CFR 1.10 (if applicable)

|                             |
|-----------------------------|
| Express Mail mailing number |
|-----------------------------|

|                 |
|-----------------|
| Date of Deposit |
|-----------------|

I hereby certify that the application/correspondence attached hereto is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to Mail Stop PCT, Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450.

|                                            |
|--------------------------------------------|
| Signature of person mailing correspondence |
|--------------------------------------------|

|                                                        |
|--------------------------------------------------------|
| Typed or printed name of person mailing correspondence |
|--------------------------------------------------------|

## II. ☒ New International Application

|       |                                              |
|-------|----------------------------------------------|
| TITLE | METHOD AND APPARATUS FOR STRENGTHENING GLASS |
|-------|----------------------------------------------|

|                                         |
|-----------------------------------------|
| Earliest priority date (Day/Month/Year) |
| 22 April 2003 (22.04.03)                |

**SCREENING DISCLOSURE INFORMATION:** In order to assist in screening the accompanying international application for purposes of determining whether a license for foreign transmittal should and could be granted and for other purposes, the following information is supplied. (Note: check as many boxes as apply):

- A. ☐ The invention disclosed was not made in the United States.  
 B. ☐ There is no prior U.S. application relating to this invention.  
 C. ☒ The following prior U.S. application(s) contain subject matter which is related to the invention disclosed in the attached international application. (NOTE: priority to these applications may or may not be claimed on form PCT/RO/101 (Request) and this listing does not constitute a claim for priority.)

|     |                 |            |          |                          |
|-----|-----------------|------------|----------|--------------------------|
| (1) | application no. | 60/464,356 | filed on | 22 April 2003 (22.04.03) |
| (2) | application no. | TBA        | filed on | 31 March 2004 (31.03.04) |

- D. ☒ The present international application contains additional subject matter not found in the prior U.S. application(s) identified in paragraph C. above. The additional subject matter is found on pages throughout and ☐ DOES NOT ALTER ☐ MIGHT BE CONSIDERED TO ALTER the general nature of the invention in a manner which would require the U.S. application to have been made available for inspection by the appropriate defense agencies under 35 U.S.C. 181 and 37 CFR 5.1. See 37 CFR 5.15. Pertains to (1) above

## III. ☐ A Response to an invitation from the RO/US. The following document(s) is (are) enclosed:

- A. ☐ A Request for An Extension of Time to File a Response  
 B. ☐ A Power of Attorney (General or Regular)  
 C. ☐ Replacement pages:

|       |                             |       |                 |
|-------|-----------------------------|-------|-----------------|
| pages | of the request (PCT/RO/101) | pages | of the figures  |
| pages | of the description          | pages | of the abstract |
| pages | of the claims               |       |                 |

- D. ☐ Submission of Priority Documents

|                   |                   |
|-------------------|-------------------|
| Priority document | Priority document |
|-------------------|-------------------|

- E. ☐ Fees as specified on attached Fee Calculation sheet form PCT/RO/101 annex

## IV. ☐ A Request for Rectification under PCT 81 ☐ A Petition ☐ A Sequence Listing Diskette

## V. ☒ Other (please specify): PCT Request (5 Sheets); Fee Calculation Sheet (in duplicate); Two Return Post Cards

|                                      |                                                                      |                     |
|--------------------------------------|----------------------------------------------------------------------|---------------------|
| The person signing this form is the: | <input type="checkbox"/> Applicant                                   | Anthony I. Meola    |
|                                      | <input checked="" type="checkbox"/> Attorney/Agent (Reg. No.) 44,936 | Typed name of agent |
|                                      | <input type="checkbox"/> Common Representative                       | Signature           |

## PCT

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) 1638.10.PC00

## Box No. I TITLE OF INVENTION

METHOD AND APPARATUS FOR STRENGTHENING GLASS

## Box No. II APPLICANT

☐ This person is also inventor

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence (if no State of residence is indicated below.)

THE COCA-COLA COMPANY  
One Coca-Cola Plaza, N.W.  
Atlanta, GA 30313  
United States of America

Telephone No.

Facsimile No.

Teleprinter No.

Applicant's registration No. with the Office

State (that is, country) of nationality:

US

State (that is, country) of residence:

US

This person is applicant  
for the purposes of:

☐ all designated  
States☒ all designated States except  
the United States of America☐ the United States  
of America only☐ the States indicated in  
the Supplemental Box

## Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence (if no State of residence is indicated below.)

POSTUPACK, Dennis  
560 Waterview Trail  
Alpharetta, GA 30022  
United States of America

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (if this check-box is  
marked, do not fill in below.)

Applicant's registration No. with the Office

State (that is, country) of nationality:

US

State (that is, country) of residence:

US

This person is applicant  
for the purposes of:

☐ all designated  
States☐ all designated States except  
the United States of America☒ the United States  
of America only☐ the States indicated in  
the Supplemental Box☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

## Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf  
of the applicant(s) before the competent International Authorities as:

☒ agent☐ common  
representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

BELL, Michael J.  
HOWREY SIMON ARNOLD & WHITE, LLP  
1299 Pennsylvania Avenue, N.W.  
BOX 34  
Washington, D.C. 20004-2402  
United States of America

Telephone No.

202-783-0800

Facsimile No.

202-383-7195

Teleprinter No.

Agent's registration No. with the Office

39,604

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

230  
235

| <b>Continuation of Box No. III    FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)</b>                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>If none of the following sub-boxes is used, this sheet should not be included in the request.</i>                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                  |
| <b>Name and address:</b> <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i><br><br><b>LaCOURSE, William</b><br><b>15 Reynolds Street</b><br><b>Alfred, New York 14802</b><br><b>United States of America</b> | <b>This person is:</b><br><input type="checkbox"/> applicant only<br><input checked="" type="checkbox"/> applicant and inventor<br><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i><br><br><b>Applicant's registration No. with the Office</b> |
| <b>State (that is, country) of nationality:</b><br><div style="text-align: center;"><b>US</b></div>                                                                                                                                                                                                                                                                                                                                                                    | <b>State (that is, country) of residence:</b><br><div style="text-align: center;"><b>US</b></div>                                                                                                                                                                                                |
| <b>This person is applicant for the purposes of:</b> <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box                                                                                                                                     |                                                                                                                                                                                                                                                                                                  |
| <b>Name and address:</b> <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i><br><br>                                                                                                                          | <b>This person is:</b><br><input type="checkbox"/> applicant only<br><input type="checkbox"/> applicant and inventor<br><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i><br><br><b>Applicant's registration No. with the Office</b>            |
| <b>State (that is, country) of nationality:</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>State (that is, country) of residence:</b>                                                                                                                                                                                                                                                    |
| <b>This person is applicant for the purposes of:</b> <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box                                                                                                                                                |                                                                                                                                                                                                                                                                                                  |
| <b>Name and address:</b> <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i><br><br>                                                                                                                          | <b>This person is:</b><br><input type="checkbox"/> applicant only<br><input type="checkbox"/> applicant and inventor<br><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i><br><br><b>Applicant's registration No. with the Office</b>            |
| <b>State (that is, country) of nationality:</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>State (that is, country) of residence:</b>                                                                                                                                                                                                                                                    |
| <b>This person is applicant for the purposes of:</b> <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box                                                                                                                                                |                                                                                                                                                                                                                                                                                                  |
| <b>Name and address:</b> <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i><br><br>                                                                                                                          | <b>This person is:</b><br><input type="checkbox"/> applicant only<br><input type="checkbox"/> applicant and inventor<br><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i><br><br><b>Applicant's registration No. with the Office</b>            |
| <b>State (that is, country) of nationality:</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>State (that is, country) of residence:</b>                                                                                                                                                                                                                                                    |
| <b>This person is applicant for the purposes of:</b> <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box                                                                                                                                                |                                                                                                                                                                                                                                                                                                  |
| <input type="checkbox"/> Further applicants and/or (further) inventors are indicated on another continuation sheet.                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                  |

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**Supplemental Box**

*If the Supplemental Box is not used, this sheet should not be included in the request.*

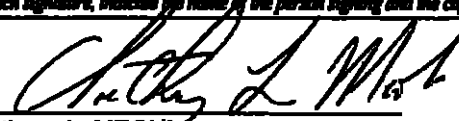
1. *If, in any of the Boxes, except Boxes Nos. VIII(f) to (v) for which a special continuation box is provided, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ...." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*
  - (i) *If more than two persons are to be indicated as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*
  - (ii) *If, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*
  - (iii) *If, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*
  - (iv) *If, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*
  - (v) *If, in Box No. VI, there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI.*
2. *If the applicant intends to make an indication of the wish that the international application be treated, in certain designated States, as an application for a patent of addition, certificate of addition, inventor's certificate of addition or utility certificate of addition: in such a case, write the name or two-letter code of each designated State concerned and the indication "patent of addition," "certificate of addition," "inventor's certificate of addition" or "utility certificate of addition," the number of the parent application or parent patent or other parent grant and the date of grant of the parent patent or other parent grant or the date of filing of the parent application (Rules 4.11(a)(iii) and 49bis.1(a) or (b)).*
3. *If the applicant intends to make an indication of the wish that the international application be treated, in the United States of America, as a continuation or continuation-in-part of an earlier application: in such a case, write "United States of America" or "US" and the indication "continuation" or "continuation-in-part" and the number and the filing date of the parent application (Rules 4.11(a)(iv) and 49bis.1(d)).*

**CONTINUATION OF BOX NO. IV**

CHEN, Anderson (Reg. No. 44,436)  
CHEN, Jenny W. (Reg. No. 44,804)  
GRIMALDI, Alan M. (Reg. No. 26,599)  
JARDIEU, Derek J. (Reg. No. 44,483)  
MEOLA, Anthony L. (Reg. No. 44,936)  
OWENS, David P. (Reg. No. 43,344)  
RASSER, Jacobus C. (Reg. No. 37,043)  
STIMSON, Michael J. (Reg. No. 45,429)

237

| <b>Box No. V DESIGNATIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|------------------------------------------------|--------------------------------------------------------|-------------------------------|------------------------------------------------|---|--------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------|----|--------------------------|------------------|--------------------------------------------------------------------------------|---|--|--|--|
| <p>The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.</p> <p>However,</p> <p><input type="checkbox"/> DE Germany is not designated for any kind of national protection</p> <p><input type="checkbox"/> KR Republic of Korea is not designated for any kind of national protection</p> <p><input type="checkbox"/> RU Russian Federation is not designated for any kind of national protection</p> <p><i>(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <b>Box No. VI PRIORITY CLAIM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <p>The priority of the following earlier application(s) is hereby claimed:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 20%;">Filing date of earlier application<br/>(day/month/year)</th> <th rowspan="2" style="width: 20%;">Number of earlier application</th> <th colspan="3" style="width: 60%;">Where earlier application is:</th> </tr> <tr> <th style="width: 20%;">national application:<br/>country or Member of WTO</th> <th style="width: 20%;">regional application:<br/>regional Office</th> <th style="width: 20%;">international application:<br/>receiving Office</th> </tr> </thead> <tbody> <tr> <td>Item (1)<br/>22 April 2003<br/>(22.04.03)</td> <td>60/464,356</td> <td>US</td> <td></td> <td></td> </tr> <tr> <td>Item (2)<br/>31 March 2004<br/>(31.03.04)</td> <td>TBA</td> <td>US</td> <td></td> <td></td> </tr> <tr> <td>Item (3)</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p><input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.</p> <p>The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office) identified above as:</p> <p><input checked="" type="checkbox"/> all items    <input type="checkbox"/> item (1)    <input type="checkbox"/> item (2)    <input type="checkbox"/> item (3)    <input type="checkbox"/> other, see Supplemental Box</p> <p><i>* Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)): ....</i></p> |                               |                                                                                                                                      |                                          |                                                | Filing date of earlier application<br>(day/month/year) | Number of earlier application | Where earlier application is:                  |   |                          | national application:<br>country or Member of WTO | regional application:<br>regional Office                                                                                 | international application:<br>receiving Office | Item (1)<br>22 April 2003<br>(22.04.03) | 60/464,356         | US                                                                                                                                   |   |                          | Item (2)<br>31 March 2004<br>(31.03.04) | TBA                                                                                                    | US |                          |                  | Item (3)                                                                       |   |  |  |  |
| Filing date of earlier application<br>(day/month/year)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Number of earlier application | Where earlier application is:                                                                                                        |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                               | national application:<br>country or Member of WTO                                                                                    | regional application:<br>regional Office | international application:<br>receiving Office |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| Item (1)<br>22 April 2003<br>(22.04.03)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 60/464,356                    | US                                                                                                                                   |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| Item (2)<br>31 March 2004<br>(31.03.04)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | TBA                           | US                                                                                                                                   |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| Item (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <b>Box No. VII INTERNATIONAL SEARCHING AUTHORITY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <p>Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):</p> <p>ISA / EP .....</p> <p>Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):</p> <p>Date (day/month/year)                      Number                      Country (or regional Office)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <b>Box No. VIII DECLARATIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               |                                                                                                                                      |                                          |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <p>The following declarations are contained in Boxes Nos. VIII (i) to (v) (mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):</p> <table style="width: 100%;"> <tr> <td style="width: 10%;"><input type="checkbox"/></td> <td style="width: 30%;">Box No. VIII (i)</td> <td style="width: 50%;">Declaration as to the identity of the inventor</td> <td style="width: 10%; text-align: right;">:</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VIII (ii)</td> <td>Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent</td> <td style="text-align: right;">:</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VIII (iii)</td> <td>Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application</td> <td style="text-align: right;">:</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VIII (iv)</td> <td>Declaration of inventorship (only for the purposes of the designation of the United States of America)</td> <td style="text-align: right;">:</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VIII (v)</td> <td>Declaration as to non-prejudicial disclosures or exceptions to lack of novelty</td> <td style="text-align: right;">:</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                               |                                                                                                                                      |                                          |                                                | <input type="checkbox"/>                               | Box No. VIII (i)              | Declaration as to the identity of the inventor | : | <input type="checkbox"/> | Box No. VIII (ii)                                 | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent | :                                              | <input type="checkbox"/>                | Box No. VIII (iii) | Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application | : | <input type="checkbox"/> | Box No. VIII (iv)                       | Declaration of inventorship (only for the purposes of the designation of the United States of America) | :  | <input type="checkbox"/> | Box No. VIII (v) | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty | : |  |  |  |
| <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Box No. VIII (i)              | Declaration as to the identity of the inventor                                                                                       | :                                        |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Box No. VIII (ii)             | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent             | :                                        |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Box No. VIII (iii)            | Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application | :                                        |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Box No. VIII (iv)             | Declaration of inventorship (only for the purposes of the designation of the United States of America)                               | :                                        |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |
| <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Box No. VIII (v)              | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty                                                       | :                                        |                                                |                                                        |                               |                                                |   |                          |                                                   |                                                                                                                          |                                                |                                         |                    |                                                                                                                                      |   |                          |                                         |                                                                                                        |    |                          |                  |                                                                                |   |  |  |  |

| Box No. IX CHECK LIST; LANGUAGE OF FILING                                                                                                                              |    |                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>This international application contains:</b>                                                                                                                        |    | <b>This international application is accompanied by the following item(s) (mark the applicable check-boxes below and indicate in right column the number of each item):</b>                                                   |
| (a) In paper form, the following number of sheets:                                                                                                                     |    |                                                                                                                                                                                                                               |
| request (including declaration sheets)                                                                                                                                 | 5  | 1. <input checked="" type="checkbox"/> fee calculation sheet (in duplicate)                                                                                                                                                   |
| description (excluding sequence listing and/or tables related thereto)                                                                                                 | 51 | 2. <input type="checkbox"/> original separate power of attorney                                                                                                                                                               |
| claims                                                                                                                                                                 | 12 | 3. <input type="checkbox"/> original general power of attorney                                                                                                                                                                |
| abstract                                                                                                                                                               | 1  | 4. <input type="checkbox"/> copy of general power of attorney; reference number, if any: .....                                                                                                                                |
| drawings                                                                                                                                                               | 24 | 5. <input type="checkbox"/> statement explaining lack of signature                                                                                                                                                            |
| Sub-total number of sheets                                                                                                                                             | 93 | 6. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): .....                                                                                                                                   |
| sequence listing                                                                                                                                                       |    | 7. <input type="checkbox"/> translation of international application into (language): .....                                                                                                                                   |
| tables related thereto                                                                                                                                                 |    | 8. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material                                                                                                              |
| (for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c) below)                                         |    | 9. <input type="checkbox"/> sequence listing in computer readable form (Indicate type and number of carriers)                                                                                                                 |
| Total number of sheets                                                                                                                                                 | 93 | (i) <input type="checkbox"/> copy submitted for the purposes of international search under Rule 13ter only (and not as part of the international application)                                                                 |
| (b) <input type="checkbox"/> only in computer readable form (Section 801(a)(i))                                                                                        |    | (ii) <input type="checkbox"/> (only where check-box (b)(i) or (c)(i) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Rule 13ter              |
| (i) <input type="checkbox"/> sequence listing                                                                                                                          |    | (iii) <input type="checkbox"/> together with relevant statement as to the identity of the copy or copies with the sequence listing mentioned in left column                                                                   |
| (ii) <input type="checkbox"/> tables related thereto                                                                                                                   |    | 10. <input type="checkbox"/> tables in computer readable form related to sequence listing (Indicate type and number of carriers)                                                                                              |
| (c) <input type="checkbox"/> also in computer readable form (Section 801(a)(ii))                                                                                       |    | (i) <input type="checkbox"/> copy submitted for the purposes of international search under Section 802(b-quater) only (and not as part of the international application)                                                      |
| (i) <input type="checkbox"/> sequence listing                                                                                                                          |    | (ii) <input type="checkbox"/> (only where check-box (b)(ii) or (c)(ii) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Section 802(b-quater) |
| (ii) <input type="checkbox"/> tables related thereto                                                                                                                   |    | (iii) <input type="checkbox"/> together with relevant statement as to the identity of the copy or copies with the tables mentioned in left column                                                                             |
| Type and number of carriers (discette, CD-ROM, CD-R or other) on which are contained the                                                                               |    | 11. <input checked="" type="checkbox"/> other (specify): 2 return post cards; transmittal letter .....                                                                                                                        |
| <input type="checkbox"/> sequence listing: .....                                                                                                                       |    |                                                                                                                                                                                                                               |
| <input type="checkbox"/> tables related thereto: .....                                                                                                                 |    |                                                                                                                                                                                                                               |
| (additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)                                                                                   |    |                                                                                                                                                                                                                               |
| Figure of the drawings which should accompany the abstract                                                                                                             | 2  | Language of filing of the international application: English                                                                                                                                                                  |
| <b>Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE</b>                                                                                                |    |                                                                                                                                                                                                                               |
| Need to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request). |    |                                                                                                                                                                                                                               |
| By: <br>Anthony L. MEOLA<br>Agent for Applicants                                    |    |                                                                                                                                                                                                                               |

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|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1. Date of actual receipt of the purported international application:                                                                       | 2. Drawings:<br><input type="checkbox"/> received:<br><br><input type="checkbox"/> not received: |
| 3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application: |                                                                                                  |
| 4. Date of timely receipt of the required corrections under PCT Article 11(2):                                                              |                                                                                                  |
| 5. International Searching Authority (if two or more are competent): ISA /                                                                  | 6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid          |

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| Date of receipt of the record copy by the International Bureau: |

239

# PCT

## FEE CALCULATION SHEET

Annex to the Request

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International Application No.

Applicant's or agent's  
file reference

1638.10.PC00

Date stamp of the receiving Office

Applicant

THE COCA-COLA COMPANY

### CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . 300 T

2. SEARCH FEE . . . . . 1,818 S

International search to be carried out by ISA/EP  
(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FILING FEE

Where items (b) and/or (c) of Box No. IX apply, enter Sub-total number of sheets } 93  
Where items (b) and (c) of Box No. IX do not apply, enter Total number of sheets }

i1 first 30 sheets . . . . . 1035 i1

i2  $\frac{63}{\text{number of sheets in excess of 30}} \times \frac{11}{\text{fee per sheet}} = 693$  i2

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Receiving Office: RO/ US

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Date: 31 March 2004 (31.03.04)

Name: Anthony J. MEOLA

Signature: [Signature]



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\*700090070A\*

JUNE 09, 2004

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HOWREY SIMON ARNOLD & WHITE, LLP  
1299 PENNSYLVANIA AVENUE, N.W.  
BOX 34  
WASHINGTON, DC 20004

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NOTICE OF RECORDATION OF ASSIGNMENT DOCUMENT

THE ENCLOSED DOCUMENT HAS BEEN RECORDED BY THE ASSIGNMENT DIVISION OF THE U.S. PATENT AND TRADEMARK OFFICE. A COMPLETE MICROFILM COPY IS AVAILABLE AT THE ASSIGNMENT SEARCH ROOM ON THE REEL AND FRAME NUMBER REFERENCED BELOW.

PLEASE REVIEW ALL INFORMATION CONTAINED ON THIS NOTICE. THE INFORMATION CONTAINED ON THIS RECORDATION NOTICE REFLECTS THE DATA PRESENT IN THE PATENT AND TRADEMARK ASSIGNMENT SYSTEM. IF YOU SHOULD FIND ANY ERRORS OR HAVE QUESTIONS CONCERNING THIS NOTICE, YOU MAY CONTACT THE EMPLOYEE WHOSE NAME APPEARS ON THIS NOTICE AT 703-308-9723. PLEASE SEND REQUEST FOR CORRECTION TO: U.S. PATENT AND TRADEMARK OFFICE, ASSIGNMENT DIVISION, BOX ASSIGNMENTS, CG-4, 1213 JEFFERSON DAVIS HWY, SUITE 320, WASHINGTON, D.C. 20231.

RECORDATION DATE: 06/08/2004

REEL/FRAME: 014708/0256  
NUMBER OF PAGES: 3

BRIEF: ASSIGNMENT OF ASSIGNOR'S INTEREST (SEE DOCUMENT FOR DETAILS).

ASSIGNOR:

POSTUPACK, DENNIS

DOC DATE: 06/03/2004

ASSIGNOR:

LACOURSE, WILLIAM

DOC DATE: 06/03/2004

ASSIGNEE:

COCA-COLA COMPANY, THE  
P.O. BOX 1734  
ATLANTA, GEORGIA 30301

SERIAL NUMBER: 60464356

FILING DATE: 04/22/2003

PATENT NUMBER:

ISSUE DATE:

TITLE: METHODS AND APPARATUS FOR STRENGTHENING GLASS

014708/0256 PAGE 2

SERIAL NUMBER: 10813435

FILING DATE: 03/31/2004

PATENT NUMBER:

ISSUE DATE:

TITLE: METHOD AND APPARATUS FOR STRENGTHENING GLASS

MARCUS KIRK, EXAMINER  
ASSIGNMENT DIVISION  
OFFICE OF PUBLIC RECORDS

258/201

HO [REDACTED] 08/08/2004  
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| <div style="display: flex; justify-content: space-between;"> <span>Form PTO-1586 (09)</span> <span>U.S. Department of Commerce, U.S. Patent and Trademark Office</span> </div> <div style="text-align: center;"> <b>RECORDATION FORM COVER SHEET</b><br/> <b>PATENTS ONLY</b> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------|
| To the Honorable Commissioner of Patents and Trademarks: Please review the attached original document or copy thereof                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
| <b>1. Name of conveying party(ies):</b><br>Dennis POSTUPACK<br>William LaCOURSE<br><br>Additional name(s) of conveying party(ies) attached? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>2. Name and address of receiving party(ies):</b><br><br>Name: The Coca-Cola Company<br>Street Address: P.O.Box 1734<br>City: Atlanta State GA: Zip Code: 30301<br>Country: USA<br><br>Additional name(s) & address(es) attached? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no |                                                                                                             |                         |
| <b>3. Nature of Conveyance:</b><br><br><div style="display: flex; justify-content: space-between;"> <span><input checked="" type="checkbox"/> Assignment</span> <span><input type="checkbox"/> Merger</span> </div> <div style="display: flex; justify-content: space-between;"> <span><input type="checkbox"/> Security Agreement</span> <span><input type="checkbox"/> Change of Name</span> </div> <div style="display: flex; justify-content: space-between;"> <span><input type="checkbox"/> Other _____</span> </div><br>Execution Date(s): June 3, 2004                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
| <b>4. Application number(s) or patent number(s):</b><br><br>If this document is being filed together with a new application, the execution date of the application is <table style="width: 100%; margin-top: 10px;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>A. Patent Application No(s).</b><br/>           60/464,356, filed April 22, 2003<br/>           10/813,435, filed March 31, 2004         </td> <td style="width: 50%; vertical-align: top;"> <b>B. Patent No(s).</b> </td> </tr> </table>                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                         | <b>A. Patent Application No(s).</b><br>60/464,356, filed April 22, 2003<br>10/813,435, filed March 31, 2004 | <b>B. Patent No(s).</b> |
| <b>A. Patent Application No(s).</b><br>60/464,356, filed April 22, 2003<br>10/813,435, filed March 31, 2004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>B. Patent No(s).</b>                                                                                                                                                                                                                                                                                 |                                                                                                             |                         |
| Additional numbers attached? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
| <b>5. Name and address of party to whom correspondence concerning document should be mailed:</b><br><br>Name: BROWNEY SIMON ARNOLD & WHITE, LLP<br><br>Internal Address<br><br>Street Address: 1299 Pennsylvania Avenue, N.W.<br>Box 34<br><br>Washington State DC Zip Code: 20004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>6. Total number of applications and patents involved</b><br><div style="text-align: center; margin-top: 10px;">1</div><br><b>7. Total fee (37 C.F.R. § 3.41).....\$ 80.00</b><br><br>Enclosed<br><br><input checked="" type="checkbox"/> Authorized to be charged to Deposit Account                 |                                                                                                             |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>8. Deposit Account Number 08-3038</b>                                                                                                                                                                                                                                                                |                                                                                                             |                         |
| <b>DO NOT USE THIS SPACE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
| <b>9. Statement and signature.</b><br><br>To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document. <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div style="width: 30%;"> <b>Michael J. Stinson</b><br/>             Name of Person Signing<br/>             Registration No. 45,429           </div> <div style="width: 30%; text-align: center;"> <br/>             Signature           </div> <div style="width: 30%; text-align: center;"> <u>6/8/04</u><br/>             Date           </div> </div> <div style="text-align: center; margin-top: 10px;">             Total number of pages (including cover sheet, attachments and document.)           </div> |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
| <b>Case No. 6511-011 (imp.4/p)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |
| Mail document to be recorded with required cover sheet information to:<br>Commissioner of Patents and Trademarks, Box 446000<br>Washington, D.C. 20531                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                         |                                                                                                             |                         |

*243*

# ASSIGNMENT

In consideration of the sum of One Dollar (\$1.00) or equivalent and other good and valuable consideration paid to each of the undersigned: POSTUPACK, Dennis and LeCOURSE, William, the undersigned hereby sells and assigns to The Coca-Cola Company, a Delaware Corporation, the Assignee, his/her entire right, title and interest

check applicable box(es) ☒ for the United States of America (as defined in 35 U.S.C. § 100),  
☒ and throughout the world,

in the inventions known as Method and Apparatus For Strengthening Glass for which applications for patent in the United States of America (also known as United States Application Nos: 60/464,356, filed April 22, 2003 and 10/813,435, filed March 31, 2004) have been executed by the undersigned, in any and all applications thereon, in any and all Letters Patents therefor, and in any and all reissues, extensions, renewals, reexaminations of such applications or Letters Patents and divisional and continuation applications thereof, to the full end of the term or terms for which such Letters Patents issue, including all claims, if any, that may have arisen for infringement prior to the date of this assignment, such entire right, title and interest to be held and enjoyed by the above-named Assignee to the same extent as they would have been held and enjoyed by the undersigned had this assignment and sale not been made.

The undersigned agree to execute all papers necessary in connection with the application and any continuing (continuation, divisional, or continuation-in-part), reissue, reexamination or corresponding applications thereof and also to execute separate assignments in connection with such applications as the Assignee may deem necessary or expedient.

The undersigned agree to execute all papers necessary in connection with any interference that may be declared concerning the application or any continuing (continuation, divisional, or continuation-in-part), reissue or reexamination application thereof and to cooperate with the Assignee in every way possible in obtaining evidence and going forward with such interference.

The undersigned hereby represents that the undersigned has full right to convey the entire interest herein assigned, and that the undersigned has not executed, and will not execute, any agreement in conflict therewith.

The undersigned hereby grant:

|                   |                 |                     |                 |
|-------------------|-----------------|---------------------|-----------------|
| Bell, Michael J.  | Reg. No. 39,604 | Meola, Anthony L.   | Reg. No. 44,936 |
| Orizaldi, Alan    | Reg. No. 26,599 | Stinson, Michael J. | Reg. No. 45,429 |
| Jardieu, Derek J. | Reg. No. 44,483 |                     |                 |

of HOWREY SIMON ARNOLD & WHITE, LLP, BOX No. 34, 1299 Pennsylvania Ave., N.W., Washington, D.C. 20004-2402, power to insert in this Assignment any further identification that may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office for recordation of this document.

IN WITNESS WHEREOF, executed by the undersigned on the dates opposite their names.

Inventor: POSTUPACK, Dennis

Signature *Dennis Postupack* Date: *June 3, 2004*

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Inventor: LaCOURSE, William

Signature William LaCourse Date: June 3, 2008

240205



# Apostille

(Convention de La Haye du 5 octobre 1961)

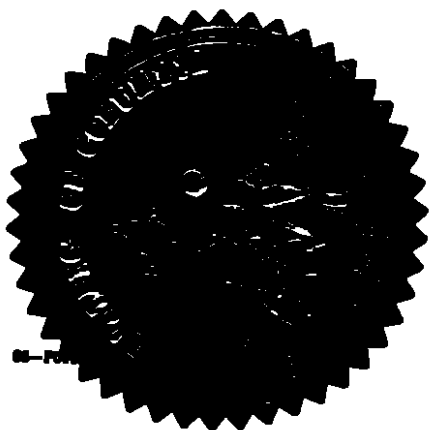
1. *District of Columbia*  
*United States of America*

2. This public document has been signed by KATHLEEN M. SRNIK
3. acting in the capacity of NOTARY PUBLIC IN AND FOR THE DISTRICT OF COLUMBIA

4. bears the seal/stamp of KATHLEEN M. SRNIK, NOTARY PUBLIC, D.C.

## CERTIFIED

5. at Washington, D.C.  
21<sup>st</sup> OCTOBER 2005
6. the \_\_\_\_\_ day of \_\_\_\_\_
7. by Secretary of the District of Columbia
8. No. 148502
9. Seal/Stamp



10. Signature

Sherril H. Newman  
SHERREL H. NEWMAN

NOTARIZED STATEMENT

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I, Elena Sergeev, hereby affirm that the attached hereto is a true copy of the original Worldwide Assignment document along with a true copy of the Notice of Recordation document, which was recorded with the United States Patent and Trademark Office on June 8, 2004 at Reel/Frame 014708/0256. The Worldwide Assignment is relevant to the patent applications entitled "Method and Apparatus for Strengthening Glass", having serial numbers 10/813,435 and 60/464,356, filed on March 31, 2004 and April 22, 2003, respectively.

IN WITNESS WHEREOF, I have hereunto set my hand this 20th day of October 2005.

  
\_\_\_\_\_  
Elena Sergeev

DISTRICT OF COLUMBIA

)  
) ss:  
)

On this 20<sup>th</sup> day of October 2005, before me, a Notary Public, personally appeared Elena Sergeev, to me known to be the individual described in and who executed the foregoing instrument, and duly acknowledged to me that he executed the same for the purpose therein set forth.

  
\_\_\_\_\_  
Notary Public

(SEAL)

Kathleen M. Smik  
Notary Public, District of Columbia  
My Commission Expires May 14, 2010



UNITED STATES DEPARTMENT OF COMMERCE  
Patent and Trademark Office  
ASSISTANT SECRETARY AND COMMISSIONER  
OF PATENTS AND TRADEMARKS  
Washington, D.C. 20231

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\*7000900704\*

JUNE 09, 2004

PTAS

HOWREY SIMON ARNOLD & WHITE, LLP  
1299 PENNSYLVANIA AVENUE, N.W.  
BOX 34  
WASHINGTON, DC 20004

UNITED STATES PATENT AND TRADEMARK OFFICE  
NOTICE OF RECORDATION OF ASSIGNMENT DOCUMENT

THE ENCLOSED DOCUMENT HAS BEEN RECORDED BY THE ASSIGNMENT DIVISION OF THE U.S. PATENT AND TRADEMARK OFFICE. A COMPLETE MICROFILM COPY IS AVAILABLE AT THE ASSIGNMENT SEARCH ROOM ON THE REEL AND FRAME NUMBER REFERENCED BELOW.

PLEASE REVIEW ALL INFORMATION CONTAINED ON THIS NOTICE. THE INFORMATION CONTAINED ON THIS RECORDATION NOTICE REFLECTS THE DATA PRESENT IN THE PATENT AND TRADEMARK ASSIGNMENT SYSTEM. IF YOU SHOULD FIND ANY ERRORS OR HAVE QUESTIONS CONCERNING THIS NOTICE, YOU MAY CONTACT THE EMPLOYEE WHOSE NAME APPEARS ON THIS NOTICE AT 703-308-9723. PLEASE SEND REQUEST FOR CORRECTION TO: U.S. PATENT AND TRADEMARK OFFICE, ASSIGNMENT DIVISION, BOX ASSIGNMENTS, CG-4, 1213 JEFFERSON DAVIS HWY, SUITE 320, WASHINGTON, D.C. 20231.

RECORDATION DATE: 06/08/2004

REEL/FRAME: 014708/0256  
NUMBER OF PAGES: 3

BRIEF: ASSIGNMENT OF ASSIGNOR'S INTEREST (SEE DOCUMENT FOR DETAILS).

ASSIGNOR:

POSTUPACK, DENNIS

DOC DATE: 06/03/2004

ASSIGNOR:

LACOURSE, WILLIAM

DOC DATE: 06/03/2004

ASSIGNEE:

COCA-COLA COMPANY, THE  
P.O. BOX 1734  
ATLANTA, GEORGIA 30301

SERIAL NUMBER: 60464356

FILING DATE: 04/22/2003

PATENT NUMBER:

ISSUE DATE:

TITLE: METHODS AND APPARATUS FOR STRENGTHENING GLASS

25-248

014708/0256 PAGE 2

SERIAL NUMBER: 10813435

FILING DATE: 03/31/2004

PATENT NUMBER:

ISSUE DATE:

TITLE: METHOD AND APPARATUS FOR STRENGTHENING GLASS

MARCUS KIRK, EXAMINER  
ASSIGNMENT DIVISION  
OFFICE OF PUBLIC RECORDS

JUN. 8. 2004 4:18PM

HC

.Y]SIMON WHITE

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P. 4

08/08/2004

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------|
| Form PTO-1005 6-93                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                  | U.S. Department of Commerce, U.S. Patent and Trademark Office                                                                                                                                                                                                                                     |  |                                                                                                      |                                                                                                  |                |
| RECORDATION FORM COVER SHEET<br>PATENTS ONLY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
| To the Honorable Commissioner of Patents and Trademarks: Please insert the attached original document or copy thereof.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
| 1. Name of conveying party(ies):<br>Dennis POSTUPACK<br>William LaCOURSE<br><br>Additional name(s) of conveying party(ies) attached? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                  | 2. Name and address of receiving party(ies):<br><br>Name: The Coca-Cola Company<br>Street Address: P.O. Box 1734<br>City: Atlanta State GA: Zip Code: 30301<br>Country: USA<br><br>Additional name(s) & address(es) attached? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no |  |                                                                                                      |                                                                                                  |                |
| 3. Nature of Conveyance:<br><br><input checked="" type="checkbox"/> Assignment <input type="checkbox"/> Merger<br><input type="checkbox"/> Security Agreement <input type="checkbox"/> Change of Name<br><input type="checkbox"/> Other _____<br><br>Execution Date(s): June 3, 2004                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
| 4. Application number(s) or patent number(s):<br><br>If this document is being filed together with a new application, the execution date of the application is<br><br><table border="0"> <tr> <td>           A. Patent Application No(s).<br/>           60/444,356, filed April 22, 2003<br/>           10/813,435, filed March 31, 2004         </td> <td>           B. Patent No(s).         </td> </tr> </table>                                                                                                                                                                                                               |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  | A. Patent Application No(s).<br>60/444,356, filed April 22, 2003<br>10/813,435, filed March 31, 2004 | B. Patent No(s).                                                                                 |                |
| A. Patent Application No(s).<br>60/444,356, filed April 22, 2003<br>10/813,435, filed March 31, 2004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | B. Patent No(s).                                                                                 |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
| Additional numbers attached? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
| 5. Name and address of party to whom correspondence concerning document should be mailed:<br><br>Name: ROWREY SIMON ARNOLD & WHITE, LLP<br><br>Internal Address:<br><br>Street Address: 1299 Pennsylvania Avenue, N.W.<br>Box 34<br><br>Washington State DC Zip Code: 20004                                                                                                                                                                                                                                                                                                                                                        |                                                                                                  | 6. Total number of applications and patents involved<br>1<br><br>7. Total fee (37 C.F.R. § 3.41).....\$ 80.00<br><br>Enclosed<br><br><input checked="" type="checkbox"/> Authorized to be charged to Deposit Account<br><br>8. Deposit Account Number: 08-3038                                    |  |                                                                                                      |                                                                                                  |                |
| DO NOT USE THIS SPACE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |
| 9. Statement and signature.<br><br>To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.<br><br><table border="0"> <tr> <td>           Michael J. Simon<br/>           Name of Person Signing<br/>           Registration No. 45,429         </td> <td> <br/>           Signature         </td> <td>           6/8/04<br/>           Date         </td> </tr> </table> Total number of pages including cover sheet, attachments and documents: 1 |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  | Michael J. Simon<br>Name of Person Signing<br>Registration No. 45,429                                | <br>Signature | 6/8/04<br>Date |
| Michael J. Simon<br>Name of Person Signing<br>Registration No. 45,429                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <br>Signature | 6/8/04<br>Date                                                                                                                                                                                                                                                                                    |  |                                                                                                      |                                                                                                  |                |
| COMB MD. 04/1-0011 (rev. 4/90)<br><br>This document is to be recorded with required cover sheet information to:<br>Commissioner of Patents and Trademarks, Box Assignments<br>Washington, D.C. 20531                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                  |                                                                                                                                                                                                                                                                                                   |  |                                                                                                      |                                                                                                  |                |

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# ASSIGNMENT

In consideration of the sum of One Dollar (\$1.00) or equivalent and other good and valuable consideration paid to each of the undersigned: POSTUPACK, Dennis and LaCOURSE, William, the undersigned hereby sells and assigns to The Coca-Cola Company, a Delaware Corporation, the Assignee, his/her entire right, title and interest

check applicable box(es) ☒ for the United States of America (as defined in 35 U.S.C. § 100),  
☒ and throughout the world,

In the inventions known as Method and Apparatus For Strengthening Glass for which applications for patent in the United States of America (also known as United States Application Nos: 60/464,356, filed April 22, 2003 and 10/813,435, filed March 31, 2004) have been executed by the undersigned, in any and all applications thereon, in any and all Letters Patents therefor, and in any and all reissues, extensions, renewals, reexaminations of such applications or Letters Patents and divisional and continuation applications thereof, to the full end of the term or terms for which such Letters Patents issue, including all claims, if any, that may have arisen for infringement prior to the date of this assignment, such entire right, title and interest to be held and enjoyed by the above-named Assignee to the same extent as they would have been held and enjoyed by the undersigned had this assignment and sale not been made.

The undersigned agree to execute all papers necessary in connection with the application and any continuing (continuation, divisional, or continuation-in-part), reissue, reexamination or corresponding applications thereof and also to execute separate assignments in connection with such applications as the Assignee may deem necessary or expedient.

The undersigned agree to execute all papers necessary in connection with any interference that may be declared concerning the application or any continuing (continuation, divisional, or continuation-in-part), reissue or reexamination application thereof and to cooperate with the Assignee in every way possible in obtaining evidence and going forward with such interference.

The undersigned hereby represents that the undersigned has full right to convey the entire interest herein assigned, and that the undersigned has not executed, and will not execute, any agreement in conflict therewith.

The undersigned hereby grant:

|                   |                 |                     |                 |
|-------------------|-----------------|---------------------|-----------------|
| Bell, Michael J.  | Reg. No. 39,604 | Moala, Anthony L.   | Reg. No. 44,936 |
| Grimaldi, Alan    | Reg. No. 26,599 | Stinson, Michael J. | Reg. No. 45,429 |
| Jardieu, Derek J. | Reg. No. 44,483 |                     |                 |

of HOWREY SIMON ARNOLD & WHITE, LLP, Box No. 34, 1299 Pennsylvania Ave., N.W., Washington, D.C. 20004-2402, power to insert in this Assignment any further identification that may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office for recordation of this document.

IN WITNESS WHEREOF, executed by the undersigned on the dates opposite their names.

Inventor: POSTUPACK, Dennis

Signature  Date: June 3, 2004

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Inventor: LeCOURSE, William

Signature William LeCourse Date: June 3, 2008

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**TRADUCCION AL ESPAÑOL del Documento de Cesión a The Coca-Cola  
Company domiciliada en Atlanta, GA, Estados Unidos..**

---

**APOSTILLA**

1. Distrito de Columbia  
Estados Unidos de América
2. Este documento público ha sido firmado por KATHLEEN M. SRNIK
3. actuando en capacidad de NOTARIO PÚBLICO EN Y PARA EL  
DISTRITO DE COLUMBIA
4. Lleva el sello/timbre de KATHLEEN M. SRNIK, NOTARIO PUBLICO,  
D.C.

**CERTIFICADO**

5. en Washington D.C.
6. el 21° día de OCTUBRE de 2005
7. por el Secretario del Distrito de Columbia
8. No. 148502
9. Sello/timbre

10. Firma

(Firma)

**SHERYL H. NEWMAN**

253

**DECLARACION NOTARIZADA**

Yo, Elena Sergeev, por la presente afirmo que el anexo a éste es una copia verdadera del documento mundial de cesión original junto con una copia del documento de notificación de registro, la cual fue registrada en la Oficina de Marcas y Patentes de Estados Unidos el 8 de junio de 2004 en el Rollo/cuadro 014708/0256. El documento mundial de cesión es relevante a la solicitud de patente titulada "Método y aparato para fortalecer vidrio", que tiene el número de serie 10/813,435 y 60/484,356, presentadas el 31 de marzo de 2004 y 22 de abril de 2003, respectivamente.

EN TESTIMONIO DE LO CUAL, he puesto mi firma a la presente este 20 de octubre de 2005.

\_\_\_\_\_(Firma)\_\_\_\_\_  
Elena Sergeev

DISTRITO DE COLUMBIA       )  
                                          )     ss.  
                                          )

Este 20 de octubre de 2005, ante mi, un notario público, apareció personalmente Elena Sergeev, a quien conozco como el individuo descrito en y quien ejecutó el instrumento anterior, y debidamente reconoció que ejecutó el mismo para el propósito allí establecido.

\_\_\_\_\_(Firma)\_\_\_\_\_  
Notario Público

(SELLO)

Kathleen M. Smik  
Notario Público, Distrito de Columbia  
Mi comisión expira Mayo 14 de 2010

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JUNIO 09 DE 2004

HOWREY SIMON ARNOLD & WHITE, LLP  
1299 PENNSYLVANIA AVENUE, N. W.  
CASILLA 34  
WASHINGTON, DC 20004

OFICINA DE MARCAS Y PATENTES DE LOS ESTADOS UNIDOS  
INFORME DE GRABACIÓN DE DOCUMENTO DE CESION

EL DOCUMENTO ADJUNTO HA SIDO GRABADO POR LA DIVISIÓN DE CESIONES DE LA OFICINA DE MARCAS Y PATENTES DE LOS ESTADOS UNIDOS. HAY DISPONIBLE UNA COPIA COMPLETA EN MICROFILME EN EL CUARTE DE BÚSQUEDA DE CESIONES EN EL NÚMERO DE ROLLO Y CUADRO REFERENCIADOS ABAJO.

POR FAVOR REVISE TODA LA INFORMACIÓN CONTENIDA EN ESTE INFORME. LA INFORMACIÓN CONTENIDA EN ESTE INFORME DE GRABACIÓN REFLEJA LOS DATOS PRESENTES EN EL SISTEMA DE ASIGNACIÓN DE PATENTES Y MARCAS. SI USTED ENCUENTRA CUALQUIER ERROR O TIENE PREGUNTAS CONCERNIENTES A ESTE INFORME, PUEDE CONTACTAR AL EMPLEADO CUYO NOMBRE APARECE EN ESTE INFORME AL 703-308-9723. POR FAVOR ENVÍE LA SOLICITUD DE CORRECCIÓN A: OFICINA DE MARCAS Y PATENTES DE LOS ESTADOS UNIDOS, DIVISIÓN DE CESIONES, ASIGNACIÓN DE CASILLAS, CG-4, 1213 JEFFERSON DAVIS HWY, SUITE 320, WASHINGTON, D.C.20231.

FECHA DE GRABACIÓN: 06/08/2004

ROLLO/CUADRO: 014708/0256  
NÚMERO DE PÁGINAS: 3

RESUMEN: CESIÓN DE INTERÉS DEL CEDENTE (VER DOCUMENTO PARA DETALLES).

CEDENTE:

POSTUPACK, DENNIS

FECHA DE DOC: 06/03/2004

CEDENTE:

LACOURSE, WILLIAM

FECHA DE DOC: 06/03/2004

CESIONARIO:

COCA-COLA COMPANY  
CASILLA POSTAL 1734  
ATLANTA, GEORGIA 30301

NÚMERO DE SERIE: 604643564  
NÚMERO DE PATENTE:

FECHA DE PRESENTACIÓN: 04/22/2003  
FECHA DE EMISIÓN:

TITULO: METODOS Y APARATOS PARA FORTALECER VIDRIO

4/3/255

014708/0256 PAGINA 2

NÚMERO DE SERIE: 10813435  
NÚMERO DE PATENTE:

FECHA DE PRESENTACIÓN: 03/31/2004  
FECHA DE EMISIÓN:

TITULO: METODO Y APARATO PARA FORTALECER VIDRIO

MARCUS KIRK, EXAMINADOR  
DIVISIÓN DE CESIONES  
OFICINA DE REGISTROS PÚBLICOS

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div>HOJA DE PORTADA DEL FORMULARIO DE<br/>REGISTRO<br/>SOLAMENTE PATENTES</div> <div>Comisionado Asistente para patentes: Por favor archive los documentos originales anexos o copias de los mismos</div>                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                     | <div>Departamento de Comercio<br/>Oficina de Marcas y Patentes<br/>Expediente de abogado No. PR2027</div>                                                                                                                                                                         |
| <div>1. Nombre de la(s) parte(s) cedente(s):<br/>Dennis POSTUPACK<br/>William LAcourse</div> <div>¿Se anexan nombre(s) de parte(s) cedente(s) adicionales? <input type="checkbox"/> SI <input checked="" type="checkbox"/> No</div>                                                                                                                                                                                                                                                                 | <div>2. Nombre y dirección de la(s) parte(s) receptora(s)<br/>Nombre: The Coca-Cola Company<br/>Dirección Interna: Casilla Postal 1734<br/>Ciudad: Atlanta Estado: GA Código ZIP: 30301<br/>País: ESTADOS UNIDOS DE AMÉRICA</div> <div>¿Se anexan Nombre(s) y dirección(es) adicional(es)? <input type="checkbox"/> SI <input checked="" type="checkbox"/> No</div> |                                                                                                                                                                                                                                                                                   |
| <div>3. Naturaleza del traspaso:<br/><input checked="" type="checkbox"/> Cesión <input type="checkbox"/> Fusión<br/><input type="checkbox"/> Acuerdo de seguridad <input type="checkbox"/> Cambio de nombre<br/><input type="checkbox"/> Otro</div>                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                   |
| <div>4. Número(s) de solicitud o número(s) de patente:<br/><br/>Si este documento se presenta junto con una solicitud nueva, la fecha de ejecución de la solicitud es:<br/><div><div>A. Solicitud de patente No(s).<br/>60/464,356, presentada en abril 22 de 2003<br/>10/813,435, presentada en marzo 31 de 2003</div><div>B. Patente No(s).</div></div><div>Se anexan otros números? <input type="checkbox"/> SI <input checked="" type="checkbox"/> No</div></div>                               |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                   |
| <div>5. Nombre y dirección de la parte a quien se le debe enviar la correspondencia:<br/>Nombre: HOWREY SIMON ARNOLD &amp; WHITE, LLP<br/>Dirección Interna:<br/><br/>Dirección: 1299 Pennsylvania Avenue, N.W.<br/>Casilla 34<br/><br/>Washington Estado: DC Código ZIP: 20004</div>                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                     | <div>6. Número total de solicitudes y patentes involucradas: 1</div> <div>7. Tarifa total (37 C.F.R 3.41): \$80.00<br/>Adjunta<br/><br/><input checked="" type="checkbox"/> Autorizado para cargarla a una cuenta de depósito</div> <div>8. Cuenta de depósito No.: 08-3038</div> |
| <div>NO USE ESTE ESPACIO</div> <div>9. Declaración y firma<br/><br/>Hasta donde se y creo, la información anterior es verdadera y correcta y cualquier copia anexa es una copia verdadera del documento original.<br/><div><div>Michael J. Stimson</div><div>(Firma)</div><div>6/8/04</div></div><div><div>Nombre de la persona que firma</div><div>Firma</div><div>Fecha</div></div><div>Registro No. 45429</div><div>Número total de página incluyendo portada, anexos y documento: 3</div></div> |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                   |
| <div>OMB NO. 0651-0011 (exp. 4/94)</div> <div>Documentos enviados por correo para que sean registrados requieren la información de la portada a:<br/>Comisionado de Patentes y Marcas, Casilla de Cesiones<br/>Washington, D.C. 20231</div>                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                   |

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Expediente de Abogado No.: 01638.0010.NPUS02

### CESIÓN

En consideración a la suma de un dólar (\$1.00) o equivalente y otra consideración buena y valiosa pagada a cada uno de los suscritos: POSTUPACK, Dennis y LaCOURSE, William, los suscritos por la presente venden y ceden a The Coca-Cola Company, una corporación de Delaware, el Cesionario, la totalidad de su derecho, título e interés

llene la(s) casilla(s) aplicable(s) ☒ para Estados Unidos de América (como se define en 35 U.S.C. § 100)

☒ y alrededor del mundo,

en la invención conocida como Método y aparato para fortalecer vidrio, para la cual los suscritos ejecutaron solicitudes de patente en Estados Unidos de América (también conocidas como Solicitudes de Estados Unidos Nos.: 60/464,356, presentada el 22 de abril de 2003 y 10/813,435, presentada el 31 de marzo de 2004), en cualquiera y todas las solicitudes sobre la misma, en cualquiera y todas las patentes para la misma, y en cualquiera y todas las reemisiones, extensiones, renovaciones, reexaminaciones de tales solicitudes de patente y solicitudes divisionales y de continuación de las mismas, hasta la totalidad del término o términos para los cuales se emitan tales patentes, incluyendo todas las reivindicaciones, de haber, que puedan haber surgido por violación antes de la fecha de esta cesión, tal derecho, título e interés total serán tenidos y disfrutados por el arriba nombrado Cesionario hasta la misma extensión que serían tenidos y disfrutados por los suscritos si no se hubiere hecho esta cesión.

Los suscritos acuerdan ejecutar todos los documentos necesarios en conexión con la solicitud y cualquier solicitud de continuación (continuación, divisional, o continuación parcial), reemisión, reexaminación o solicitudes correspondientes de las mismas y también a ejecutar cesiones separadas en conexión con tales solicitudes que el Cesionario considere necesarias o convenientes.

Los suscritos acuerdan ejecutar todos los documentos necesarios en conexión con cualquier interferencia que pueda declararse concerniente a la solicitud o cualquier solicitud de continuación (continuación, divisional, o continuación parcial), reemisión, o reexaminación de la misma y a cooperar con el cesionario en cualquier forma posible en obtener evidencia y avanzar con tal Interferencia.

Los suscritos por la presente manifiestan que los suscritos tiene pleno derecho para ceder la totalidad del interés aquí cedido, y que los suscritos no han ejecutado, y no ejecutarán, ningún acuerdo en conflicto cono éste.

26x 258

Los suscritos por la presente otorgan a:

|                   |                  |                     |                  |
|-------------------|------------------|---------------------|------------------|
| Bell, Michael J.  | Reg. No.: 39,604 | Meola, Anthony L.   | Reg. No.: 44,936 |
| Grimaldi, Alan    | Reg. No.: 26,599 | Stimson, Michael J. | Reg. No.: 45,429 |
| Jardieu, Derek J. | Reg. No.: 44,483 |                     |                  |

de HOWREY SIMON ARNOLD & WHITE, LLP., Casilla No. 34, 1299 Pennsylvania Ave., N.W., Washington, D.C. 20004-2402, poder para Insertar en esta cesión cualquier identificación adicional que pueda ser necesaria o deseable con el fin de cumplir con las reglas de la Oficina de Marcas y Patentes de Estados Unidos para el registro de este documento.

EN TESTIMONIO DE LO CUAL, ejecutado por los suscritos en las fechas opuestas a sus nombres:

Inventor: POSTUPACK, Dennis

Firma: \_\_\_\_\_ (Firma) \_\_\_\_\_

Fecha: \_\_\_\_\_ junio 3 de 2004 \_\_\_\_\_

Inventor: LaCOURSE, William

Firma: \_\_\_\_\_ (Firma) \_\_\_\_\_

Fecha: \_\_\_\_\_ junio 3 de 2004 \_\_\_\_\_

**GEORGIA SUPERIOR COURT  
CLERKS' COOPERATIVE AUTHORITY**

**Notary Division**

**1875 Century Boulevard, Suite 100**

**Atlanta, Georgia 30345**

262 259

**APOSTILLE  
(Convention de La Haye du 5 Octobre 1961)**

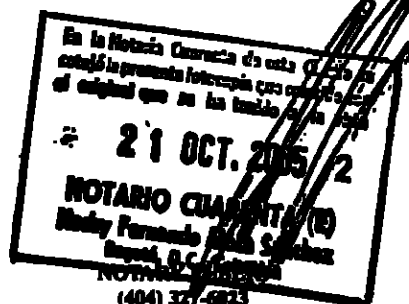
1. Country: **UNITED STATES OF AMERICA**
2. This public document  
has been signed by **TERESA MORRIS**
3. acting in the capacity of **NOTARY PUBLIC, STATE OF GEORGIA**
4. bears the seal/stamp of **TERESA MORRIS  
NOTARY PUBLIC  
FAYETTE COUNTY, GEORGIA**
5. at **ATLANTA, GEORGIA**
6. the **30TH DAY OF AUGUST, 2005**
7. by **GEORGIA SUPERIOR COURT CLERKS' COOPERATIVE AUTHORITY**
8. No. **I-132797**

**CERTIFIED**

9. Seal/Stamp

10. Signature:

  
**DAVID R. WILLIAMS  
EXECUTIVE DIRECTOR**



Brigard & Castro  
BOGOTÁ - COLOMBIA

PODER

Otergado

y

Firmado

El

Suscribo

Hoy... de... de... 20  
0...

Firma

Nombre

Cargo

En

calidad

de

De

POWER OF ATTORNEY

Sociedad constituida de acuerdo con las leyes  
de

The undersigned.....Steve Whaley,

Acting as Legal Representative

OF THE COCA-COLA COMPANY

Company incorporated as per the laws of STATE OF DELAWARE  
domiciled in One Coca-Cola Plaza, Atlanta, Georgia 30313,  
Estados Unidos de América

With principal offices in ATLANTA, GEORGIA

don

domicilio

Oficinas

principales

Nombre(amos) a JUAN PABLO CADENA SARMIENTO y/o CARLOS H. PALACIO EASTMAN y/o HECTOR GOMEZ MEJIA, de Bogotá, Colombia, apoderados verdaderos y legales con poder especial, amplio y suficiente, para recabar de las oficinas y autoridades colombianas administrativas, judiciales y de policía, en cualquier instancia o recurso, la obtención de patentes de invención, registros de marcas, diseños industriales, modelos de utilidad, depósitos de nombres comerciales, lemas comerciales y enseñas, registros de derechos de autor y contratos sobre los mismos, obtención de certificados de obtentor de variedades vegetales, así como sus prórrogas, renovaciones, anotaciones de traspaso, cambios de nombre y/o domicilio; elaborar, tramitar y registrar contratos de licencia y licencias de cualesquiera clases; intervenir como demandante o como demandado en cualquier instancia y recurso ante cualquier juez, corporación, funcionario público o autoridad en acciones judiciales, administrativas y de policía tales como: oposiciones al registro de marcas; acciones de caducidad, cancelación y nulidad; acciones reivindicatorias, acciones derivadas de la obtención o explotación de licencias; acciones de competencia desleal; demandas penales; acciones de indemnización de perjuicios, reclamos y observaciones a solicitudes de patentes, diseños industriales, modelos de utilidad, en el ejercicio de medidas cautelares y otras acciones o medidas similares.

A este efecto, lo(s) faculto(amos) para elevar solicitudes, formular descripciones, enmiendas, protestas, declaraciones de oposición, cancelaciones, nulidades, apelaciones, reclamos; pagar impuestos, cuotas y gravámenes prescritos por la ley; renunciar o desistír a derechos concedidos en curso de concesión; recibir toda clase de documentos y valores, dando el descargo respectivo, y, en general, practicar ante dichas autoridades todos los pasos necesarios al efecto indicado y tomar todas las medidas que creyeran conducentes al resguardo de mis (nuestros) intereses, con todas las demás facultades legales necesarias.

Este poder comprende la facultad de ratificar o confirmar en mi (nuestro) nombre lo actuado así como la facultad de desistír, transigir, comprometer, y la de sustituirlo en todo o en parte y revocar sustituciones. Asimismo nombro(amos) a JUAN PABLO CADENA SARMIENTO y/o CARLOS H. PALACIO EASTMAN y/o HECTOR GOMEZ MEJIA, domiciliado(s) en la Carrera 7 No. 16-56 Piso 9, mis (nuestros) apoderados en Colombia, con facultades para recibir notificaciones y designar apoderados judiciales o extrajudiciales.

Hereby appoints JUAN PABLO CADENA SARMIENTO and/or CARLOS H. PALACIO and/or HECTOR GOMEZ MEJIA, of Bogotá, Colombia, my (our) true and lawful attorneys with special, ample and sufficient power to obtain from the Colombian administrative, judicial and police offices and authorities, in any instance, privileges of patents of invention, registration of trademarks, industrial designs and utility models; registration of commercial names, slogans and emblems, registration of copyright and contracts related thereto, certificates of obtainers of vegetable varieties, as well as extensions, renewals and recordal of assignments and changes of name and domicile related to the above; to prepare, prosecute and register licenses of any kind; to act as plaintiff or defendant in any instance or recourse, and before any judge, corporation, public official or authority in judicial, administrative and police actions, such as: oppositions to the registration of trademarks; caducity, cancellation and nullity actions; claim actions derived from the obtaining or exploitation of licenses, action of unfair competition; criminal proceedings, actions for payment of damages; claims or objections on patent applications, models, industrial designs and utility models; in the exercise of preventive measures and in other actions or similar proceedings.

To that effect they hereby empowered to file applications, formulate descriptions, amendments, protests, declarations, oppositions, cancellations, nullities, appeals and claims; to pay taxes, quotas and assessments prescribed by law, renounce or waive the rights granted or in the process of granting; to receive all kinds of documents and valuables, giving the respective release of receipt, and, in general, to take before said authorities the necessary steps to such effect, and any measures that they may deem pertinent to the safeguard of my (our) interest(s) with all the other necessary legal powers.

This power includes the faculty to ratify or confirm desist, settle and compromise on my (our) behalf, and to substitute this power in whole or in part and to revoke substitutions. At the same time I (We) hereby appoints JUAN PABLO CADENA SARMIENTO and/or CARLOS H. PALACIO EASTMAN and/or HECTOR GOMEZ MEJIA, domiciled in Carrera 7 No. 16-56, Piso 9, my (our) attorney(s) in fact, with powers to receive notifications and to designate judicial and extrajudicial attorneys.

NOTARIAL CERTIFICATE  
NATURAL PERSON

261

On August of 2005 this 25<sup>th</sup> day  
personally appeared before  
me Steve Whaley

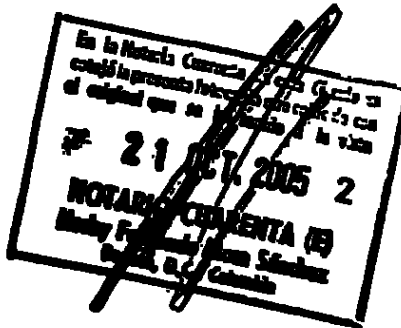
who is(are) known to me and who I attest executed the  
foregoing document and he (they) declared he (they)  
grant(s) the document for the uses and purposes  
therein expressed.

*Teresa Morris*

Notary Public (Seal)



LEGALIZATION BY APOSTILLE IS REQUIRED.



Granted and signed in ATLANTA, GA

Hoy.....de.....de.....

This of AUGUST 25th day of 2005

comparació(eron) ante mí.....

Signature.....

Document Approved By

Name STEVE WHALEY

SBU TM Counsel

Title VICE PRESIDENT

a quien (es) conozco y me consta que es(son) la(s) persona(s) firmante(s) del documento que precede y quien(es) declara(n) que otorgan el mismo para los fines y propósitos que en él se expresan.

CERTIFICADO NOTARIAL (SOCIEDAD)

Hoy.....de.....de.....

Notario Público (sello)

personalmente comparació ante mí.....

LEGALIZACION POR APOSTILLA ES REQUERIDA.

a quien conozco, y de quien me consta que firmó el anterior documento, debidamente juramentado declaró y dijo que él (ella) es.....

NOTARIAL CERTIFICATE (CORPORATION)

On this...25th.....day of August of...2005...

personally appeared before me Steve Whaley, Vice President, General Tax Counsel and Assistant Treasurer.....

to me known, and known to me to be the person who signed the foregoing instrument who being by me duly sworn did depose and say that he (she) is the.....

of...The Coca-Cola Company.....

Sociedad legalmente constituida para un período de duración que aún no ha terminado; que el declarante está autorizado por dicha compañía para conferir este poder; que el sello estampado por él al pie de tal poder, en nombre y representación de la expresada compañía, es el sello oficial de ella; y que el objeto para el cual se confiere este instrumento está comprendido dentro del objeto social de la sociedad.

El suscrito Notario hace constar que tuvo a la vista las pruebas de la existencia de la sociedad.

Estado de.....

Which is legally constituted for a term not yet expired, that deponent is authorized by said Company to confer this Power of Attorney: that the seal affixed hereunto by the deponent in the name and on behalf of said Corporation is the corporate seal thereof; and that the purpose for which this instrument is granted is included within the corporate purpose of company.

con

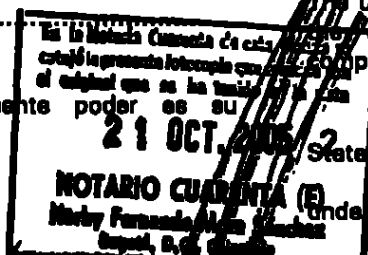
fecha.....

y que quien confiere el presente poder es su representante.

The undersigned Notary Public attests that he has seen the foregoing documents that prove the existence of the Company.

State of.....Georgia.....

Under date of 8/25/05



Notario Público (sello)

and that he (she) who grants the present power of attorney is its Representative.

CERTIFICADO NOTARIAL PERSONA NATURAL



Public Notary (Seal)