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January 07, 2018

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APPLICATION NUMBER: 62/566,380
FILING DATE: *September 30, 2017*

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US62/566,380



Certified by

Nichelle K. Lee

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

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Add

Title of Invention

Aparatus and Method for Strengthening Glass Substrates

Attorney Docket Number (if applicable)

1511.23300

Correspondence Address

Direct all correspondence to (select one):

☒ The address corresponding to Customer Number

☐ Firm or Individual Name

Customer Number

130961

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:

Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

Entity Status

Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29

- ☐ Applicant asserts small entity status under 37 CFR 1.27
- ☐ Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ☒ No

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Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	Joseph L. Morales/			Date (YYYY-MM-DD)	2017-09-30
First Name	Joseph	Last Name	Morales	Registration Number (If appropriate)	58835

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23300
		Application Number	
Title of Invention	Apparatus and Method for Strengthening Glass Substrates		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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Inventor Information:

Inventor	1				Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
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Residence Information (Select One) US Residency ● Non US Residency Active US Military Service					
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	ván		Cornejo		
Residence Information (Select One) US Residency ● Non US Residency Active US Military Service					
City	Lima	Country of Residence ⁱ	PE		

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Address 2	Cercado de Lima				
City	Lima	State/Province			
Postal Code		Country ⁱ	PE		

Inventor	3				Remove
Legal Name					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23300
		Application Number	
Title of Invention	Apparatus and Method for Strengthening Glass Substrates		

Prefix	Given Name	Middle Name	Family Name	Suffix
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Residence Information (Select One) US Residency ☒ Non US Residency Active US Military Service				
City	Lima	Country of Residence ⁱ	PE	

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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add				

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Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	130961		
Email Address	morales@moralesq.com	Add Email	Remove Email

Application Information:

Title of the Invention	Apparatus and Method for Strengthening Glass Substrates		
Attorney Docket Number	1511.23300	Small Entity Status Claimed	☐
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country ⁱ

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23300
		Application Number	
Title of Invention	Apparatus and Method for Strengthening Glass Substrates		

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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When referring to the current application, please leave the application number blank.

Prior Application Status		Remove
Application Number	Continuity Type	Prior Application Number
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Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Remove
			Access Code ⁱ (if applicable)

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23300
		Application Number	
Title of Invention	Apparatus and Method for Strengthening Glass Substrates		

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Applicant Information:

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23300
		Application Number	
Title of Invention	Apparatus and Method for Strengthening Glass Substrates		

Applicant	1 Remove		
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear			
☒ Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor	
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor :			
If the Applicant is an Organization check here. ☒			
Organization Name	AGP AMERICA S.A.		
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City	Panamá	State/Province	
Country	PA	Postal Code	
Phone Number		Fax Number	
Email Address			
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Assignee Information including Non-Applicant Assignee Information:

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Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.	
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23300
		Application Number	
Title of Invention	Apparatus and Method for Strengthening Glass Substrates		

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1				
Address 2				
City		State/Province		
Country ⁱ		Postal Code		
Phone Number		Fax Number		
Email Address				

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Signature:

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Signature	/Joseph L. Morales/		Date (YYYY-MM-DD)	2017-09-30
First Name	Joseph	Last Name	Morales	Registration Number
			58835	

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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APPARATUS AND METHOD FOR STRENGTHENING GLASS SUBSTRATES

Field of the invention

- 5 The present invention relates generally to apparatus and methods for chemically strengthening large pieces and complex shapes of glass substrates.

Abstract of the invention

The present invention relates to an apparatus and a method for manufacturing and chemically strengthening glass substrates. The apparatus comprises a chemical treatment chamber on which the glass substrate is placed, an upper chamber disposed over said chemical treatment chamber and drain means between both chambers. Additionally, the chemical treatment chamber has pour means and is placed over a bottom chamber. The method is carried out by means of the apparatus described above.

10

The present invention reduces the amount of chemical treatment material, which is preferably ionic salt, between 70% and 99%, used to the chemical treatment of the glass substrate. Additionally, the present invention advantageously facilitates and improves the chemical treatment material usage by reducing the ionic salt used in big tanks or chambers for ion exchange processes. As a consequence, the present invention reduces the amount of chemical treatment material used, reducing also the cooling and heating time which fuses and solidify the glass substrates. The present invention lowers the consumption of energy of the operation of the system and costs.

15

20 Inventors

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13518v1

Background of the Invention

In the vehicular field, savings in energy consumption is a function of vehicle weight. It is desirable, therefore, to reduce the weight of glazings without compromising strength other properties. Accordingly, it is necessary to increase the strength and related properties, e.g., impact resistance, breaking stress, penetration resistance, etc., are secured in glass articles, particularly lime-soda-silica flat glass articles such as spandrels, windshields, and other glass sheets suitable for use as viewing or like glass closures or partitions for buildings or transportation compartments, by first creating a compressive stress in a thickness zone extending inwardly from the surface of the glass. Since ordinary glasses (e.g., silicate glasses) are considerably weaker than sintered ceramics, the glass substrates used in the present invention may be strengthened by processes such as thermal or chemical tempering (e.g., ion exchange strengthening). Chemically tempered glass is made by submerging the glass in a bath of molten salt. Chemical tempering is an ion exchange process. Ions in the surface of the glass are exchanged for larger ions from the molten salt bath. The larger ions place the glass surface in compression. The resulting strength is a function of the glass composition, the bath, the temperature of the bath, and the time that the glass is treated. Compressive strengths as high as 1000 GPa can be achieved in this manner.

The high compressive stresses imposed by chemical tempering increase the fracture strength by a factor of about 5 to about 20 depending upon the processing conditions and glass compositions. Treated glass substrates shows improved resistance to strength degradation from surface damage, and often exceeds the strength of most commonly available poly crystalline monolithic ceramics. Additionally, said chemical tempering can delay fracture propagation processes.

Special glasses, chemically treated by an ion exchange process have been developed for different armor applications (especially those directed to military or transportation applications). Additionally, architectural, photovoltaic, optical, electronic and civil applications such as trains, airplanes and even for space shuttles. In the last years interest on applying ionic exchange in conventional glasses has increased due to the high demand of glasses with better mechanical and optical behaviour.

The advantages of a glass that has been subject to an ion exchange process compared to thermal tempered glass are:

- 5 – absence of optical distortions, which implies applications such as optical glass in both vehicles and sensitive instruments.
- glasses with a thickness of 0.5mm to 3 mm can be treated.
- glasses of different shapes, thicknesses and colours can be treated in the same bath.
- glass can be machining after the treatment (cutting, polishing, curving).
- 10 – higher flexural strength and impact resistance are achieved.

Ion exchange is a process that strengthens the surface of a glass by substituting smaller ions in the glass composition (e.g. sodium ions) with larger ions in a molten salt (e.g. potassium ions). The ion exchange process creates a thin layer of high compression on the surface which results in a layer of tension in the center. Conventional ion exchange technique is performed by
15 submerging the glass into an ionic bath for several hours at temperatures usually below the strain point of the glass. In order to make this process manufacturable, large quantities of salt are melted in large stainless-steel vessels following a temperature/time recipe. Very high purity salts are used that needs to be changed frequently as the ion exchange process occurs and the
20 bath salt starts to get contaminated.

Currently, several glass compositions exist in the market that requires different ionic bath compositions, which will have different temperature/time recipes. Thus, if a company uses different type of glasses, each type of glass requiring different ion exchange baths, and different
25 ion exchange recipes.

Usual ion exchange method is performed by submerging the glass substrate directly into a bath wherein the salt or the chemical treatment material is already in liquid state, as illustrated in document US 8,773,848 B2 and US 20110019123 A1. Such documents disclose how the glass
30 substrates are disposed in elements as racks, which support them during the immersion.

Accordingly, it is desirable to have an apparatus and a method that performs a chemical treatment of glasses where the glass substrate remains in a single place throughout the chemical

treatment process. There is still the need to provide a method and apparatus for lowering the consumption of the chemical treatment material (salt bath) and energy consumed when doing a chemical strengthening process. The prior art discloses processes wherein the salt bath is primary melted and then the glass piece is inserted into the device for performing the chemical strengthening. There is no evidence of methods or products that takes advantage of the energy used in the furnace for treating glass (e.g. bending) wherein the glass can also be treated chemically by, for instance, an ion exchange process. The prior art also fails to disclose an apparatus and a method for the manufacture of glass wherein the chemical treatment material (salt bath) can be reused or easily changed, using the same chamber for performing the ion exchange process.

Brief summary of the invention

The present invention relates to an apparatus and a method for manufacturing glass substrates that are chemically treated or strengthened. The apparatus of the present invention comprises a chemical treatment chamber in which the glass substrate is placed, an upper chamber disposed over said chemical treatment chamber and drain means between both chambers. Furthermore, the chemical treatment chamber has pour means that can be placed over a bottom chamber.

The present invention discloses a method comprising the following steps: placing a glass substrate in a chemical treatment chamber; placing a solid chemical treatment material over drain means which is over the chemical treatment chamber and under an upper chamber; and heating the solid chemical treatment material to the melting point, so as to said chemical treatment material crosses from the upper chamber to the chemical treatment chamber covering the glass substrate.

The method and apparatus of the present invention reduces between 70% and 99% the amount of chemical treatment material used for the chemical treatment of the glass substrate. Additionally, the chemical treatment material re-use, carry and disposal are facilitated. Meanwhile, the amount of chemical treatment material used, required cooling and heating times for fusion and solidification are reduced, resulting in energy savings in the overall operation of the system, lowering costs.

Brief description of the drawings

FIG.1 is the isometric view of an embodiment of the apparatus of the invention, showing the
5 upper chamber, the chemical treatment chamber, drain means and pour means.

FIG.2 is the isometric view of another embodiment of the apparatus of the invention, showing
the upper chamber, the chemical treatment chamber, the bottom chamber, the drain means and
the pour means.

10

FIG.3 is an exploded view of the apparatus shown in FIG.2, showing the drain and pour means.

15

FIG.4 is a cross-section view of the apparatus of FIG.2, showing drain means, the pour means,
the glass substrate and the chemical treatment material in solid state.

FIG.5 is an example of the glass substrate shapes.

FIG.6 shows the steps of the method.

Reference numerals of drawings

- 1: Upper chamber
- 2: Drain means
- 3: Chemical treatment chamber
- 25 4: Pour means
- 5: Bottom chamber
- 6: Glass substrate
- 7: Chemical treatment material

Detailed description of the invention

The present invention relates to an apparatus and a method for strengthening glass substrates
(6). In one embodiment of the apparatus of the present invention comprises at least two

chambers placed one above the other and drain means (2) between the chambers. A chemical treatment material (7), in solid state, is placed in the upper chamber (1) and at the same time a glass substrate (6) is located in the chamber (3). It should be understood that a glass substrate can be any piece of glass of any composition that can be strengthened. The glass substrate (6) is for example a windshield that needs to be subjected to an ion exchange process.

By heating the chemical treatment material (7) to its melting point, it then passes through the drain means (2) so that it falls onto the glass substrate (6) and fills the chamber (1) where the product is located, in order to carry out a chemical treatment. The chamber (1) wherein the chemical treatment is performed, has means for pouring out the chemical treatment material (7) in liquid state, optionally the liquid is poured into a third chamber that can be located below the chemical treatment chamber (3), where it can cool getting back to its solidified state again.

The present invention allows the reuse of chemical treatment material (7) originating energy and time savings along the chemical treatment process. In automotive applications where there is the need to bend the glazing, a bending process can be performed at the same time while the glazing is subjected to a chemical strengthening process. As noted before, in the automotive industry, the process to bend and the ion exchange process occur in different times of the process. In first place, the glass is chemically tempered and then bended in a bending furnace. For large pieces of glass, the salt bath wherein the glass piece is placed, requires a lot of energy in order to melt the salt, wherein the glass piece is then introduced within the salt bath for several hours. After this process, the large piece is taken out to the bending furnace in order to the glass piece to be bent. This process is energy and time consuming. On the contrary, the present invention allows the large piece of glass to be introduced in the chemical treatment chamber (3), and then the complete device with the upper chamber (1) and bottom chamber (5) can be introduced in the bending furnace in order to take advantage of the energy for two things: (i) melt the ionic salt; and (ii) bending the piece of glass at the same time. This process is time and energy saving.

The present invention discloses an apparatus and a method for manufacturing a chemically treated glass substrate (6). The apparatus comprises a chemical treatment chamber on which the glass substrate (6) is placed, an upper chamber (1) disposed over said chemical treatment

chamber and drain means (2) between both chambers. Furthermore, the chemical treatment chamber (3) has pour means (4) and its placed over a bottom chamber (5).

Referring to FIG. 1, the present invention relates to an apparatus for manufacturing chemically treated glass substrates (6), the apparatus comprising: a chemical treatment chamber (3) on which the glass substrate (6) is placed, an upper chamber (1) placed over said chemical treatment chamber (3) and drain means (2) between the chemical treatment chamber (3) and the upper chamber (1) that allows the passage of the melt chemical treatment material (7) to pass throw the drain means (2) into the chemical treatment chamber (3) when the chemical treatment material (7) melts to a liquid state. After the chemical treatment has been carried out (e.g. the ion exchange process), the chemical treatment material (7) (e.g. an ionic salt) is then poured throw pour means (4) to the bottom chamber (5).

As noted before, the glass substrates (6) of the present invention can be made of Soda-Lime, Glass-Ceramics, Borosilicate glass, alkali aluminosilicate, lithium aluminosilicate, Aluminum Oxynitride (ALON), Single Crystal Aluminum Oxide (Sapphire), Spinel ($MgAl_2O_4$), polymers as: polycarbonate (PC), poliurethane (PU), ethylene vinyl acetate (EVA), ionomers, polyvinyl butyrate (PVB), polyacrylates, polyethylene, polyureas, rigid polyurethanes, polyesters and equivalent elements known by a person versed in the art or combinations thereof.

Said glass substrates (6) can be made for electronic devices (e.g. mobile phones, smartphones, tablets, video players, data terminals, laptops, etc.), architectural structures (e.g. counter tops or walls) refrigerator doors and dishwashers, etc.), information screens (e.g., whiteboards) and automotive components (e.g. instrument panels, windshields, window components, etc.) and equivalent elements known by a person versed in the art. The present invention is also directed to large pieces of glass substrates (6), for instance, glass pieces for up to $4m^2$, with complex curvatures, for instance, such as those exemplified in FIG.5.

The chemical treatment chamber (3) corresponds to an enclosure where the glass substrate (6) and a liquid chemical treatment material (7) are disposed. For the present invention a “chemical treatment” shall be understood as any of the following procedures: leaching, chemical matting and ion exchange, which is divided into: cementation, desalination, chemical and

electrochemical quenching. Particularly the ionic exchange is a chemical process by means of which ions of a certain size are extracted from regions of the glass substrate (6) and larger ions are introduced in the same regions. Incorporating larger ions to the molecular structure of the glass substrate (6) generates compressive stresses on the surface of said product. The thickness of said compressive stresses is known as “case depth” and is given by the depth reached by the larger ions on the surface of the glass substrate (6). The ionic exchange increases the mechanical strength of the glass substrate (6) in higher percentage than 200%, making it more resistant to breakage.

The chemical treatment material (7) is a substance or a mixture of substances that attach to the glass substrate (6) physical and / or chemical properties such as strength, toughness, hardness, ductility, elastic stiffness, plasticity, strain, strength, toughness, and other properties as reflectance, colour, transparency, translucency, etc. The chemical treatment material (7) is selected from the group comprises by ionic exchangers as ionic salts, chemical additives, liquid solvents and combinations thereof.

Particularly the ionic exchangers comprises elements from the group of the alkali metals which is a group (column) in the periodic table consisting of the chemical elements lithium (Li), sodium (Na), potassium (K), rubidium (Rb), caesium (Cs), and francium (Fr). Typical ion exchangers are ion exchange resins (functionalized porous or gel polymer), zeolites, montmorillonite, clay, and soil humus. Ion exchangers are either cation exchangers that exchange positively charged ions (cations) or anion exchangers that exchange negatively charged ions (anions). There are also amphoteric exchangers that are able to exchange both cations and anions simultaneously. However, the simultaneous exchange of cations and anions can be more efficiently performed in mixed beds that contain a mixture of anion and cation exchange resins, or passing the treated solution through several different ion exchange materials. In the present invention the ionic salt can be a salt with the generic formula ANO_3 , or a mixed ionic salt (A, B) NO_3 , or a mixture thereof; wherein A and B are an alkali metal (e.g. $NaNO_3$, KNO_3 , $LiNO_3$, etc.). Furthermore, the liquid solvent is deionized water, distilled water, potable water, or another suitable solvent.

The chemical treatment chamber (3) is made of a heat-resistant and corrosive-resistant material because the apparatus of the present invention could operate inside an oven up to 20hr and

500°C or to the stain point of the glass substrate and be in contact with corrosive elements like strong bases, particularly alkalis, and not to acids, oxidizers, or other non-alkaline corrosives.

The chemical treatment chamber (3) material is selected from the group consisting of stainless steel, ceramics and equivalent materials known by a person versed in the art or combinations thereof. Furthermore, the chemical treatment chamber (3) comprises pour means (4) through which the liquid substances in said chamber are drained out of it. The pour means (4) are selected from the group consisting of valves, holes, ducts, pores, membranes and equivalent elements known by a person versed in the art or combinations thereof.

The upper chamber (1) corresponds to an enclosure where a solid chemical treatment material (7) is disposed, said chamber is made of a heat-resistant and corrosive-resistant material because the apparatus of the present invention could operate inside an oven up to 20hr and 500°C or to the stain point of the glass substrate and be in contact with corrosive elements like strong bases, particularly alkalis, and not to acids, oxidizers, or other non-alkaline corrosives. The chemical treatment chamber (3) material is selected from the group consisting of stainless steel, ceramics and equivalent materials known by a person versed in the art or combinations thereof.

The drain means (2) corresponds to one or more elements that allow the passage of the liquid chemical treatment material (7) from the upper chamber (1) to the chemical treatment chamber (3). Said drain means (2) are selected from the group consisting of sieve, mesh, perforations, valves and equivalent elements known by a person versed in the art or combinations thereof.

Referring to FIG.2 to FIG.4, the apparatus of the present invention comprises a bottom chamber (5) connected to the drain means (2), said bottom chamber (5) receives the liquid chemical treatment material (7). As the same way as the upper chamber (1) and chemical treatment chambers (3), the bottom chamber (5) is made of a heat-resistant and corrosive-resistant material because the apparatus of the present invention could operate inside an oven up to 20hr and 500°C or to the stain point of the glass substrate and be in contact with corrosive elements like strong bases, particularly alkalis, and not to acids, oxidizers, or other non-alkaline corrosives. The chemical treatment chamber (3) material is selected from the group consisting

of stainless steel, ceramics, and equivalent materials known by a person versed in the art or combinations thereof.

Both the upper chamber (1), the chemical treatment chamber (3) and the bottom chamber (5)
5 may be connected to vibration means, in order to avoid bubbles and areas of low impregnation in the glass substrate (6), in order to homogenize the substances in the chambers, among other technical effects.

As can be noted, the present invention is not limited to a particular shape, geometry or size of
10 the chemical treatment chamber (3), the upper chamber (1), and the bottom chamber (5). Furthermore, the invention can be used independently of the glass type and or composition used.

The present invention additionally comprises a method for manufacturing chemically treated glass substrates (6), comprising the steps of: placing a glass substrate (6) in a chemical treatment chamber (3); placing a solid chemical treatment material (7) over drain means (2) which is over the chemical treatment chamber (3) and under a upper chamber (1); and heating the solid chemical treatment material (7) to the melting point, so as to said chemical treatment material (7) crosses from the upper chamber (1) to the chemical treatment chamber (3) and covers the glass substrate (6).

15 Each one of the steps in the above method are illustrated in FIG.6a, FIG.6b y FIG.6c. In FIG.6a is shown the location of the glass substrate (6) and the solid chemical treatment material (7) respect to the elements of the apparatus. FIG. 6b shows that by heating the solid chemical treatment material (7) to its melting point it becomes liquid and begins to move from the upper chamber (1) to the chemical treatment chamber (3) through the drain means (2). FIG. 6c shows
20 that the chemical treatment material (7) has become completely liquid, has crossed the drain means (2) and is covering the glass substrate (6) located in the chemical treatment chamber (3).

In the embodiment illustrated in FIG.6c, once the fusion of the chemical treatment material (7) is completely and its covering the glass substrate (6) totally it is possible to carry out an
25 additional step d) in which the glass substrate (6) is heated to a certain temperature of chemical treatment, which is maintained for an equally pre-set time. Subsequently and in reference to

FIG.6d, the chemical treatment material (7) in liquid state is drained from the chemical treatment chamber (3) through the pour means (4) and stored in the bottom chamber (5) in which it is cooled, solidified and arranged to be reused later, if desired.

- 5 Referring to FIG.6 the pour means (4) are gate valves, which are opened to allow the liquid chemical treatment material (7) pass to the bottom chamber (5). It should be understood that additional pouring means (4) can be implemented, such as pumps or any other means.

Example 1

10

It has been built an apparatus for production of chemically treated glass substrates in order to be subjected to an ion exchange process. The traditional ionic exchange follows the next steps: a salt bath is heated up until it reaches a temperature where the salt goes from solid to liquid. Once the salt is liquefied, a glass piece is inserted in the salt bath, allowing the exchange of ion
15 molecules. Once the process is finished, the glass is extracted from the bath and left to be cooled. Traditional ionic exchange machines move the glass from a preheating chamber, to the ionic exchange chamber, and taking the glass back from the liquid salt to the heating/colding chamber again. This sequence of movements is dangerous for the glass. Expensive, and need large space in a plant to accommodate all the furniture.

20

The example of the present invention consisted in an apparatus using three chambers. The first chamber stored the solid salt. Once the salt was liquefied, the salt passed from upper chamber to the middle through the drain means. Once the second chamber is filled with liquid salt the ionic exchange process starts automatically. Whenever the process ends, pour means, in this
25 example, valves let the liquid flow to the bottom chamber.

The present invention allows the preheating in the same ion exchange chamber without the need of an additional chamber. Glass heating and ion exchange is performed simultaneously. The chamber moves the liquefied salt instead of the glass. In addition, the chamber allows the
30 change of salt faster for different kind of glazing compositions.

The chambers of the present invention retain the chemical treatment material (e.g. ionic salt) by providing three chambers where the top has open sites small enough to allow the salt to

remain in it as the system is heated. When the melting point of the salt was reached, the salt was transferred through the drain means to the intermediate chamber or chemical treatment chamber where the piece or pieces of glass are located. The temperature is then adjusted to the desired ion exchange temperature. After the process of ion exchange is done, a valve is open
5 in the second chamber allowing the salt to be stored in the bottom chamber. Then the temperature of the system is reduced allowing the glass to cool and at the same time the salt to solidify in the bottom chamber.

In different embodiments of the present invention, the bottom chamber can be eliminated and
10 interchanged by a mechanism to rotate the chamber in order to separate salt from the glass piece.

Additional embodiments of the present invention can include a heating system avoiding the need of an external furnace. The present invention can include any heating system that allow
15 the process of the present invention to be carried on by itself. This embodiment would increase the efficiency of the heating process of the chemical treatment material and the glass piece.

In additional embodiments the chambers of the present invention can have isolation means in order to control the temperature individually in each chamber. This embodiment can have
20 electronic control means in order to separately control the temperature by any means in each of the chambers. The present invention has shown advantages in terms of less usage or change of the chemical treatment material. A person versed in the art understands that in the automotive industry, bath salts for ion exchange treatment are expensive. The exemplified embodiment was constructed with the following dimensions:

- 25
- **Upper chamber dimension:** 2,9m in length, 3,2m in width, 0,1m in height. Volume 0.92m³
 - **Drain means:** Sheet with perforations
 - **Chemical treatment chamber:** 1,65m in length, 1,85m in width, 0,3m in height.
30 Volume 0.93m³
 - **Pour means:** Valve
 - **Bottom chamber:** 2,9m in length, 3,2m in width, 0,1m in height. Volume 0.92m³
 - **Material:** Stainless steel

The apparatus described above was placed into a furnace, with the following provisions:

- A Gorilla Glass® piece of sheet was disposed in the chemical treatment chamber
 - 5 – 1000kg of NaNO₃ (with a density of 1100Kg/m³) was disposed in the upper chamber;
 - The heating temperature ranged to around 420°C during 4 hours;
 - The CS resulted in 851;
 - The Deep of Layer (DOL) resulted in 30 um.
- 10 It is to be understood that both the foregoing general description and detailed description are merely exemplary, and are intended to provide an overview or framework to understanding the nature and character of the claims. The accompanying drawings are included to provide a further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate one or more embodiment(s), and together with the description serve to
- 15 explain principles and operation of the various embodiments.

CLAIMS

1. An apparatus for strengthening glass substrates with a chemical treatment material,
5 comprising:
 - a) a chemical treatment chamber on which the glass substrate is placed;
 - b) an upper chamber over said chemical treatment chamber wherein the chemical treatment material is placed; and
 - c) drain means between the chemical treatment chamber and the upper chamber
10 wherein the chemical treatment material melts from the upper chamber to the chemical treatment chamber when the chemical treatment material is heated;
wherein optionally the chemical treatment chamber has pour means in order to recycle the chemical treatment material.
- 15 2. The apparatus of Claim 1, comprising a bottom chamber (5) connected to the chemical treatment chamber with drain means (2).
3. The apparatus of Claim 1, wherein either the chemical treatment chamber (3) or the upper chamber are independently connected to vibrations means.
20
4. The apparatus of Claim 2, wherein the bottom chamber (5) is connected to vibrations means.
5. A method for strengthening glass substrates, comprising the steps of:
25
 - a) placing a glass substrate in a chemical treatment chamber;
 - b) placing a solid chemical treatment material over drain means which is located over the chemical treatment chamber and under an upper chamber; and
 - c) heating the solid chemical treatment material to the melting point, so as to said chemical treatment material crosses from the upper chamber to the chemical
30 treatment chamber and covers the glass substrate.
6. The method of Claim 5, wherein after step c.) there is a step d.) on which the glass substrate (6) is heated to a chemical treatment temperature.

7. The method of Claim 5, wherein the chemical treatment material (7) in liquid phase is poured from the chemical treatment chamber (3) to a bottom chamber (5) by pour means (4).

5

FIGURES

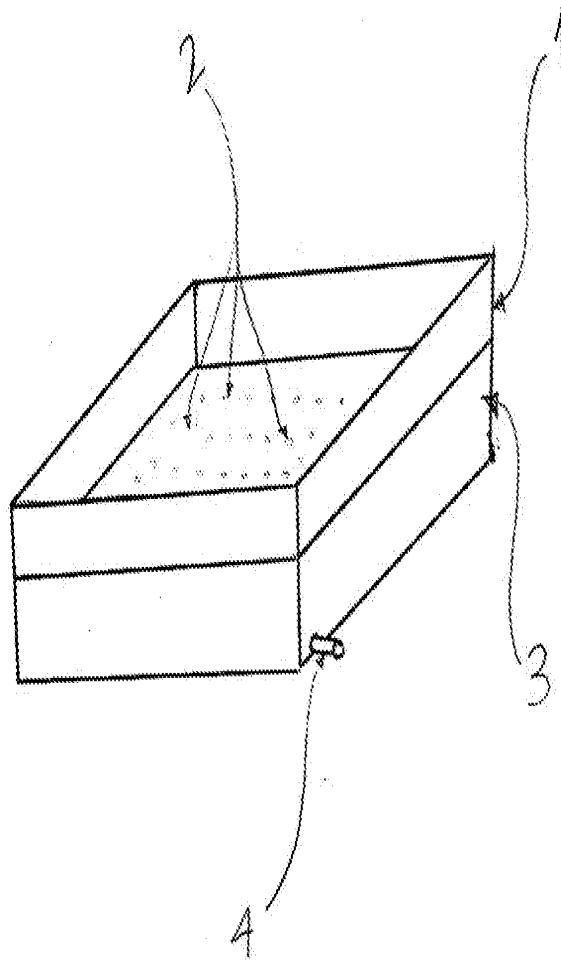


FIG. 1

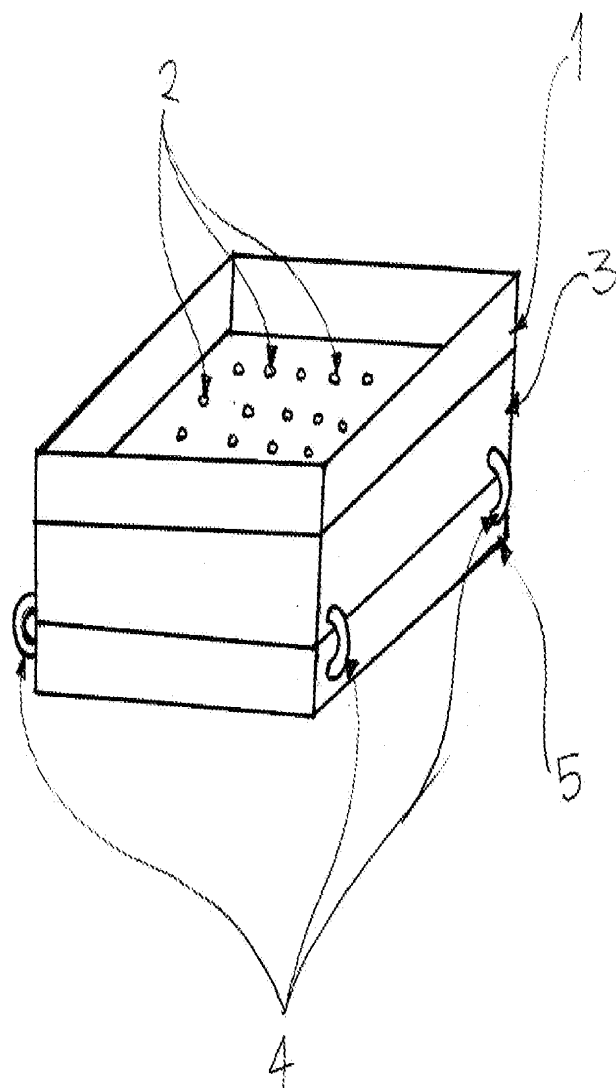


FIG. 2

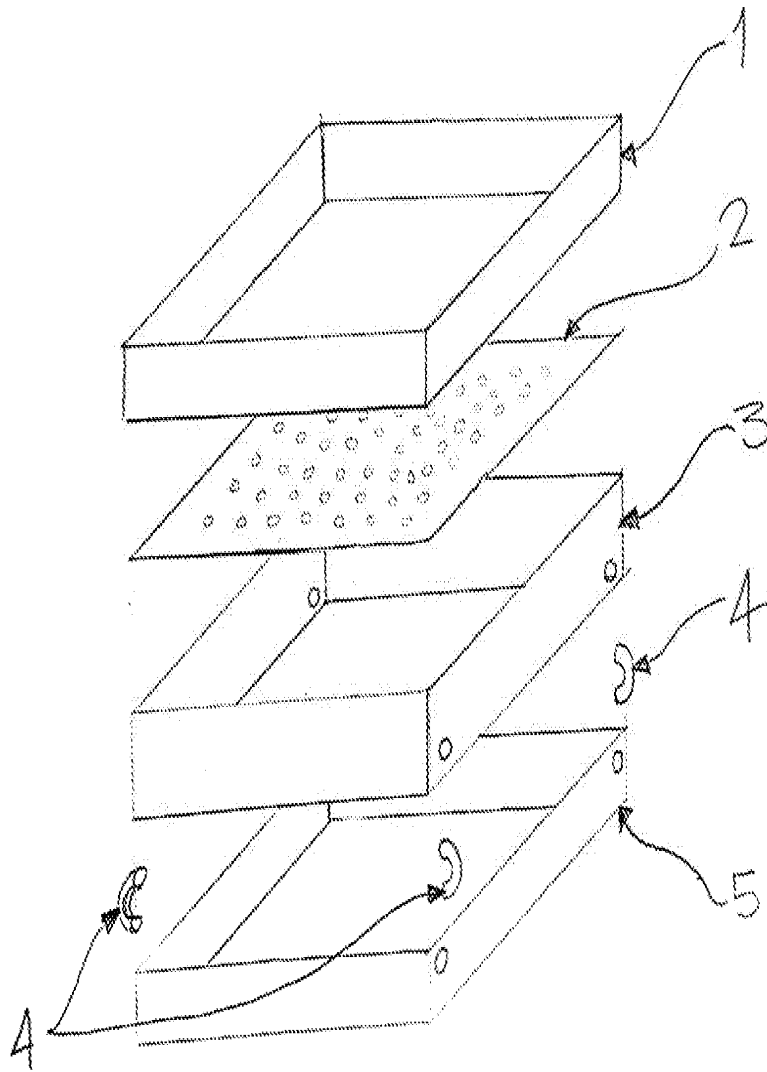


FIG. 3

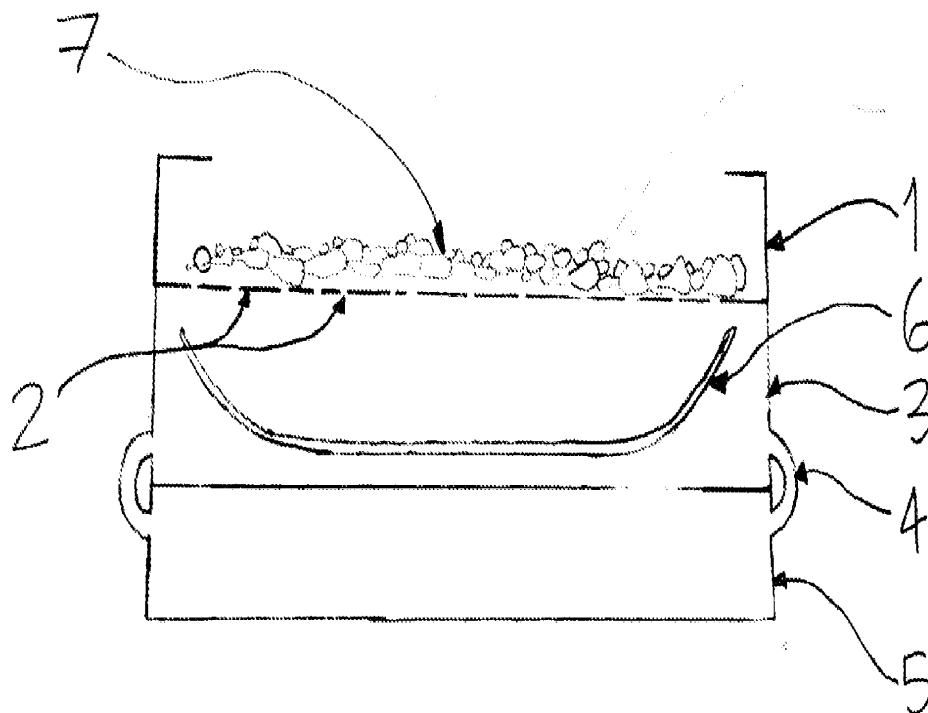


FIG. 4

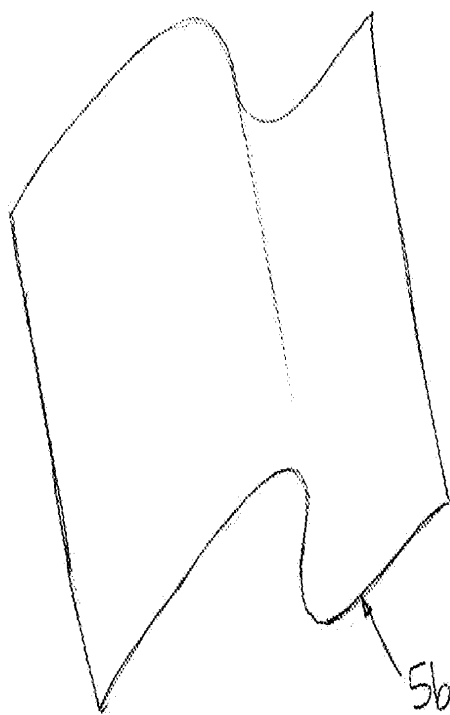
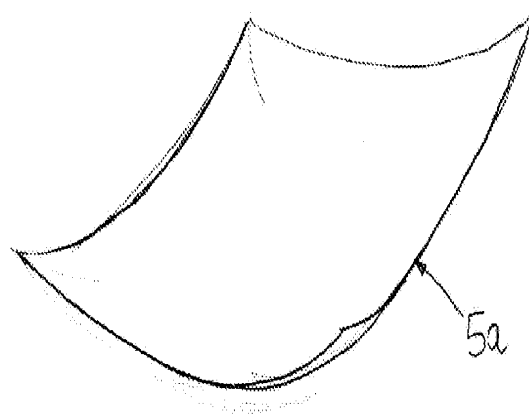
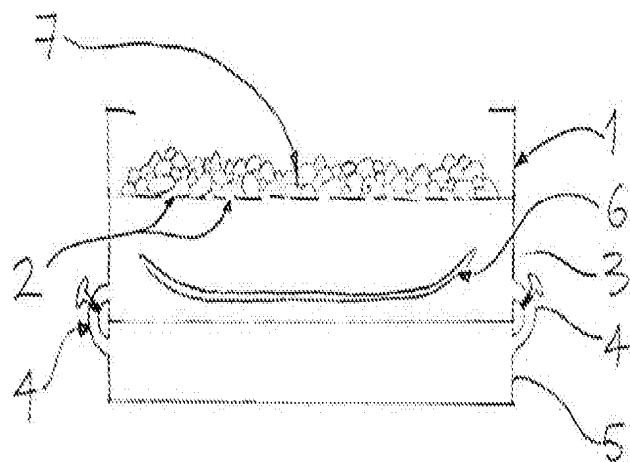
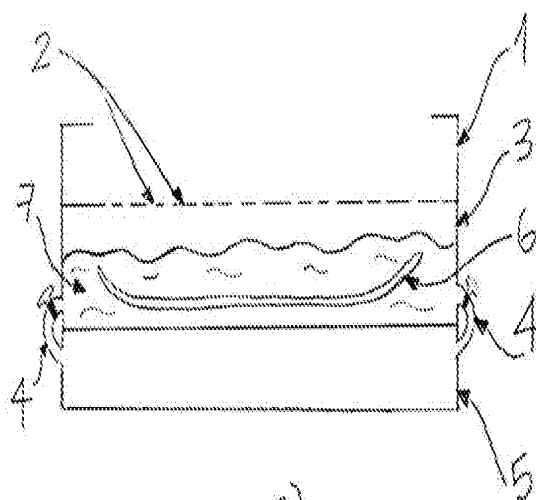


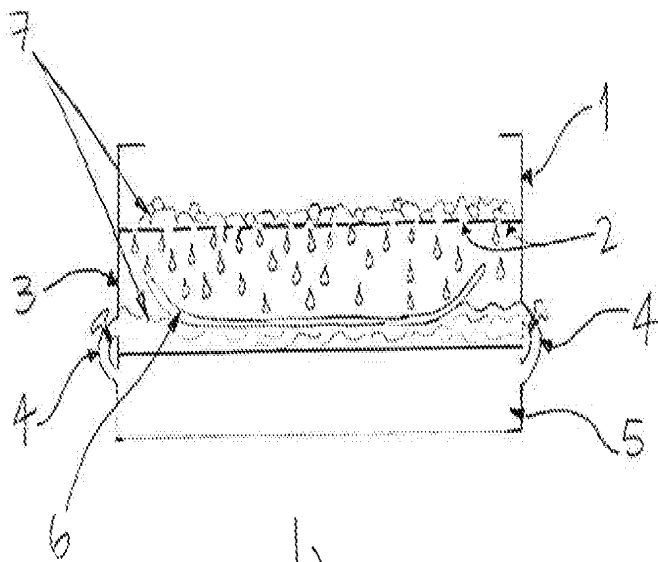
FIG.5



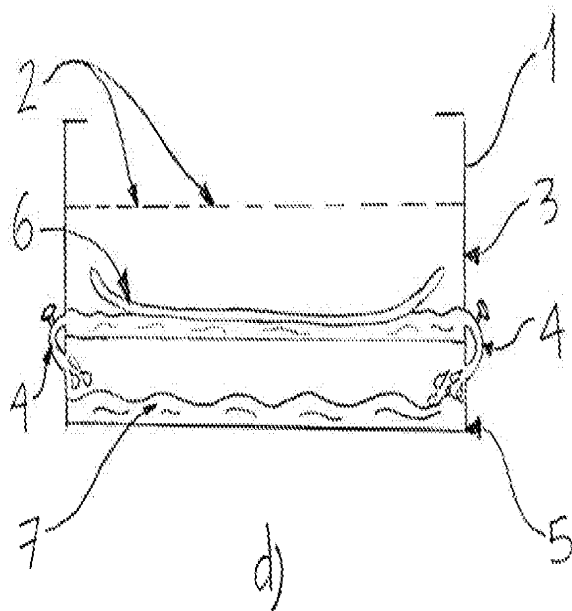
a)



c)



b)



d)

FIG. 6

Electronic Acknowledgement Receipt

EFS ID:	30530577
Application Number:	62566380
International Application Number:	
Confirmation Number:	3824
Title of Invention:	Apparatus and Method for Strengthening Glass Substrates
First Named Inventor/Applicant Name:	Mario Arturo Mannheim Astete
Customer Number:	130961
Filer:	Joseph L. Morales
Filer Authorized By:	
Attorney Docket Number:	1511.23300
Receipt Date:	30-SEP-2017
Filing Date:	
Time Stamp:	16:24:47
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 260
RAM confirmation Number	100217INTEFSW16253600
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Warnings:					
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