

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Caihong Display Devices Co., Ltd.,

Petitioner,

v.

Corning Incorporated,

Patent Owner.

Case No.: IPR2025-01040

U.S. Patent No. 9,512,025

PETITION FOR INTER PARTES REVIEW

OF U.S. PATENT NO. 9,512,025

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PETITIONER’S EXHIBIT LIST

EX1001	U.S. Patent No. 9,512,025 (“the ’025 Patent”) with certified Japanese translation
EX1002	Partial Prosecution History of the ’025 Patent with certified Japanese translation
EX1003	Declaration of Murakami Tsugunobu
EX1004	U.S. 2011/0209502 (“El Kahlout”) with certified Japanese translation
EX1005	CN102765869 (“CN ’869”) with certified English translation and certified Japanese translation
EX1006	U.S. 2012/0111060 (“Tsuda”) with certified Japanese translation
EX1007	<i>Curriculum Vitae</i> of Murakami Tsugunobu

I. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

A. Real Party-in-Interest

Caihong Display Devices Co., Ltd. (“Caihong”) is the Petitioner and a real party-in-interest.

B. Related Matters

U.S. Patent No. 9,512,025 (“the ’025 Patent”) is presently the subject of a patent infringement lawsuit filed against Petitioner in the United States District Court for the Eastern District of Virginia and captioned *Corning Incorporated v. Caihong Display Devices Co., Ltd. et al*, Case No. 1-24-cv-02328. The ’025 Patent is also asserted in the investigation captioned *Certain Glass Substrates for Liquid Crystal Displays, Products Containing the Same, and Methods for Manufacturing the Same II*, Investigation No. 337-TA-1441, at the U.S. International Trade Commission. This is the first case in which the ’025 Patent was litigated. The ’025 Patent has not been subjected to post-grant review by the Patent Trial & Appeal Board.

C. Lead and Back-up Counsel and Service Information

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II. FEE AUTHORIZATION

The PTO is authorized to charge any fees due during this proceeding to Deposit Account No. 132725.

III. GROUNDS FOR STANDING

Petitioner certifies that the '025 Patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting *inter partes* review challenging the patent claims on the grounds identified in this Petition.

IV. REQUESTED RELIEF

Petitioner requests review and cancellation of Claims 1-20 as unpatentable based on the following grounds, supported by a declaration from Murakami Tsugunobu. EX1003.

Ground	Challenged Claims	Asserted Prior Art
1	1-20	El Kahlout in view of CN '869 and Tsuda

V. REASONS FOR THE REQUESTED RELIEF

As set forth in detail below in Ground 1, the asserted prior art renders obvious each of the claims of the '025 Patent.

The '025 Patent is directed to an apparatus and process for manufacturing glass ribbons useful as glass sheets for liquid crystal displays ("LCDs"). The '025 Patent describes an apparatus for use in the known fusion down draw glass manufacturing process which incorporates a heating cartridge that is described as providing reduced devitrification of the glass produced. EX1001, Col. 1-2; EX1003, ¶ 29.

The challenged claims, however, would have been obvious to a person of ordinary skill ("POSITA") in view of the prior art. A POSITA would have found it obvious to combine the teachings of El Kahlout, CN '869, and Tsuda. In particular, all three references are in the same technical field. Thus, El Kahlout, CN '869, and Tsuda are analogous references, and a POSITA would have found combining these references to be one of a finite number of identified means for desired processing of glass applicable to substrates in display technologies, and further, would have had a reasonable expectation of success in combining their teachings, thus rendering all of the challenged claims obvious. EX1003, ¶ 47.

This Petition's showing that the cited art renders the challenged claims unpatentable is fully supported by the Declaration of Murakami Tsugunobu

(EX1003) who is an expert in glass and material science—including knowledge and experience in, for example, glass processing such as down draw processing; glass properties such as density, strength, structure, and devitrification; and apparatus components, operations, methodology, and know how in the operation of systems for producing glass materials, particularly glass for panels in LCD displays. EX1003, ¶ 22.

Accordingly, the Board should institute trial and cancel the challenged claims.

A. Summary of the ‘025 Patent

The ‘025 Patent is directed to an apparatus and process for manufacturing glass ribbons useful as glass sheets for LCD displays that incorporates a heating cartridge into a known process for glass manufacturing. The details of the heating cartridge are described throughout the specification and recited in the claims of the ‘025 Patent. The ‘025 Patent presents a computational model analysis comparing a conventional heater with an inclined angle α of 90° relative to the base of the heater and a replaceable heating cartridge with an inclined angle α of 60°. EX1001, Col. 13, lines 40-56; EX1003, ¶ 30.

The modeling reports increases in surface temperatures with an inclined angle α of 60° relative to that with an inclined angle α of 90°. EX1001, Col. 14, line 12-26; FIG. 7. The ‘025 Patent describes:

The data of FIG. 7 indicates that the replaceable heating cartridges described herein which have heat directing surfaces having an inclined angle α of less than 90° , such as from about 45° to about 75° , are more effective at maintaining the surface of the edge director at an elevated temperature relative to conventional heaters (i.e., heaters with an inclined angle α of 90°) and, as such, are more effective at reducing the devitrification of glass drawn over the edge director. In particular, the inclined angle of the heat directing surface allows heat to be more efficiently radiated towards the edge director. In addition, the inclined angle of the heating surface allows for the removable heating cartridge to be inserted between the pulling rolls and the edge director thereby thermally shielding the edge director from the pulling rolls which act as a heat sink.

EX1001, Col. 14, lines 12-26; EX1003, ¶ 31.

B. Priority Date

The '025 Patent was filed on May 15, 2014. EX1001, cover page. No priority application or claim is identified. *Id.* Accordingly, any patent or printed publication published before May 15, 2014 is prior art under 35 U.S.C. § 102(a)(1) (AIA) and any patent granted on an application filed before May 15, 2014, is prior art under § 102(a)(2) (AIA).

All of the references cited in this Petition qualify as prior art.

C. The Prosecution History of the '025 Patent

El Kahlout (EX1001) and Tsuda (EX1006) were before the USPTO during prosecution of the '025 Patent.

El Kahlout was cited in a rejection by the USPTO. EX1002, 000048.

Tsuda was cited, along with several other publications, in an Information Disclosure Statement after a Notice of Allowance was issued but was not cited in a rejection or otherwise substantively considered. EX1002, 000012¹

CN ‘869 (EX1005) was not cited or identified on any Information Disclosure Statements during the prosecution of the ‘025 Patent. EX1003, ¶ 37.

The USPTO has not previously considered the teachings of El Kahlout and Tsuda, particularly when combined with the disclosure in CN ‘869 (EX1005), which

¹ Although the Examiner initialed Form 1449, it is not clear whether the Examiner actually considered Tsuda. EX1002 at 000012. *See, e.g., Fox Factory, Inc. v. SRAM, LLC*, IPR2016-01876, Paper 8 at 7–9 (PTAB Apr. 3, 2017) (refusing to deny institution for grounds based on a prior art reference that was simply cited in an IDS); *Praxair Distribution, Inc. v. INO Therapeutics LLC*, IPR2015-00893, Paper 14 at 8 (PTAB Sept. 22, 2015) (granting institution even though references were previously cited in an IDS because patent owner failed to identify where those references were considered); *HyperBranch Medical Technology, Inc. v. Confluent Surgical, Inc.*, IPR2018-01099, Paper 14 at 17 (PTAB Nov. 27, 2018) (instituting IPR because, inter alia, “[t]he Examiner does not appear to have considered the combined teachings of [the references] during examination of the [challenged] patent.”).

describes features of the '025 Patent claims that were deemed to be patentable by the USPTO. And, more importantly, the Office has not previously considered any of the combinations of these references that form the grounds for this Petition. Thus, this Petition presents substantially new arguments that were not previously considered during prosecution of the '025 Patent

VI. CLAIM CONSTRUCTION

In *inter partes* review, claims are “construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” 37 C.F.R. § 42.100(b). Claims must therefore be given their ordinary and customary meaning as understood by a POSITA at the time of the invention in light of the specification and the prosecution history pertaining to the patent. *Id.* See also *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-13 (Fed. Cir. 2015 (*en banc*); 83 Fed. Reg. 51340, Vol. 83, No. 197 (Oct. 11, 2018). As such, this Petition and the Murakami declaration construe claim terms consistent with the understanding a POSITA would have in view of the '025 Patent's intrinsic evidence and, where appropriate, extrinsic evidence. *Phillips*, 415 F.3d at 1312. EX1003, ¶¶ 24-27.

Terms for which a specific construction is not provided below have been given their plain and ordinary meaning, as discussed in more detail for particular terms. Petitioner, however, may pursue constructions of additional claim terms in the

related litigations concerning the '025 Patent to help the Administrative Law Judge and/or jury understand the relevant technical terms and expressly reserves the right to assert that certain claim terms are indefinite.

VII. STATUTORY GROUNDS FOR CHALLENGES AND REFERENCES USED

Claims 1-20 would have been obvious over El Kahlout (EX1004), CN '869 (EX1005) and Tsuda (EX1006), which constitutes the sole ground in this Petition.

El Kahlout was filed on February 26, 2010 and published on September 1, 2011. EX1004, cover page.

CN '869 was filed on July 30, 2012 and published on November 7, 2012. EX1005, page 1.

Tsuda was filed on January 13, 2012 as a continuation of PCT/JP2010/061279 filed on July 1, 2010, and published on May 10, 2012. EX1006, cover page.

Accordingly, each piece of prior art relied upon in this Petition qualifies as prior art to the '025 Patent under at least 35 U.S.C. 102(a)(1) (AIA).

VIII. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA is one who is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity. A POSITA would have had knowledge of and experience with the concepts of glass and material science relevant to '025 Patent, including (but not limited to) glass

processing such as down draw processing; glass properties such as density, strength, structure, and devitrification; and apparatus components, operations, methodology, and know how in the operation of systems for producing glass materials, particularly glass for panels in LCD displays. EX1003, ¶ 22.

XI. THE PRIOR ART IN THE APPLIED INVALIDITY GROUNDS

A. El Kahlout

El Kahlout was filed on February 26, 2010 and published on September 1, 2011. EX1004, cover page. Therefore, El Kahlout was published more than one year before the filing date of the ‘025 Patent.

Similar to the ‘025 Patent, El Kahlout relates to “apparatus and methods for making glass sheets, and more particularly, to apparatus and methods for making glass sheets with edge directors.” EX1004, ¶ 0001; EX1003, ¶ 41.

B. CN ‘869

CN ‘869 was filed on July 30, 2012, and published on November 7, 2012. EX1005, page 1. Therefore, CN ‘869 was published more than one year before the filing date of the ‘025 Patent.

Similar to the ‘025 Patent, CN ‘869 describes “an apparatus for manufacturing plate glass by adopting an overflow down draw fusion process, and in particular, to a platinum heating apparatus for manufacture of plate glass.” EX1005, ¶ 0001, FIG. 1; EX1003 ¶ 43.

CN ‘869 describes “forming a glass preform when glass is separated from a bottom of an isopipe, heating the glass preform through platinum heaters in a muffle furnace and a forming zone, and then drawing the glass plate to a set width. The temperature of the glass preform at point 2 shown in FIG. 1 is required to be higher than 1000°C, and is required to be higher than 1050°C in a more preferable solution.” EX1005, ¶ 0006; EX1003, ¶ 44. CN ‘869 also describes the utility of a heating unit included in this apparatus and the method to “greatly improve temperature compensation at two ends of the isopipe.” EX1005, ¶ 0007; EX1003, ¶ 45.

C. Tsuda

Similar to the ‘025 Patent, Tsuda describes “a method and a device for manufacturing a glass sheet.” EX1006, ¶ 0001. Tsuda further describes:

The fusion process is a method in which molten glass is run down along both side surfaces of a molded body with a cross section of a wedge shape converging downward and also the molten glass is joined and integrated just under a lower edge part of the molded body and while cooling an integrated sheet-shaped glass ribbon, the glass ribbon is drawn downward and molded.

EX1006, ¶ 0002; EX1003, ¶ 46.

D. Motivation to Combine

As set forth below in more detail with respect to the specific relevant limitations, a POSITA would have found it obvious to combine the teachings of El Kahlout, CN ‘869, and Tsuda. In particular, all three references are in the same technical field. EX1003, xx. Thus, El Kahlout, CN ‘869, and Tsuda are analogous

references, and a POSITA would have found combining these references to be one of a finite number of identified means for desired processing of glass applicable to substrates in display technologies, and further, would have had a reasonable expectation of success in combining their teachings. EX1003, ¶ 47.

X. CLAIMS 1-20 ARE UNPATENTABLE

A. Ground 1: Claims 1-20 would have been obvious over El Kahlout, CN ‘869, and Tsuda

1. Independent Claim 15

Limitation 15[p]: A method of making a glass ribbon comprising:

Both El Kahlout and CN ‘869 teach a method of making glass ribbons.

See, e.g., El Kahlout (EX1004), ¶ 0001, FIG. 2:

El Kahlout discloses the following:

[0046] As shown in FIG. 2, the method includes the step of flowing molten glass 17 over the pair of downwardly **inclined forming surface portions 66a, 66b of the forming wedge 62.**

* * * * *

[0016] **The downwardly inclined forming surface portions 66a, 66b converge along a downstream direction 68 to form a root 70.**

EX1004, ¶¶ 1016, 0046 (emphasis added). Therefore, limitation 15[a] is disclosed in El Kahlout. EX1003, ¶¶ 52-53.

Limitation 15[b]: flowing the molten glass over an edge director intersecting with at least one of the pair of downwardly inclined forming surface portions;

El Kahlout discloses the following:

[0017] In further examples, **the edge director can intersect with both downwardly inclined forming surface portions 66a, 66b.**

* * * * *

[0046] [T]he method further includes the steps of **flowing molten glass over the edge director** and drawing the molten glass from the root 70 of the forming wedge 62 to form the glass sheet 12.

EX1004, ¶¶ 0017, 0046 (emphasis added). Therefore, limitation 15[b] is described in El Kahlout. EX1003, ¶¶ 54-55.

Limitation 15[c]: drawing the molten glass from the root of the forming wedge to form the glass ribbon;

El Kahlout discloses the following:

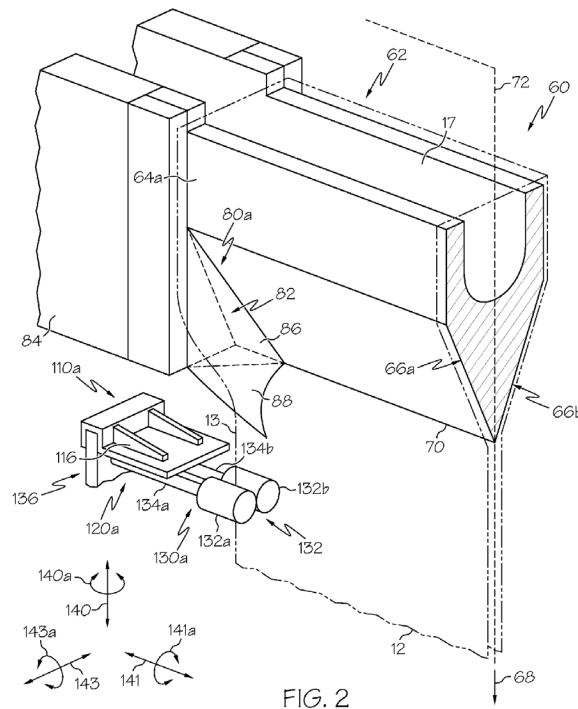
[0046] [T]he method further includes the steps of flowing molten glass over the edge director and **drawing the molten glass from the root 70 of the forming wedge 62 to form the glass sheet 12.**

EX1004, ¶ 0046 (emphasis added). Therefore, limitation 15[c] is described in El Kahlout. EX1003, ¶¶ 56-57.

Limitation 15[d]: engaging an edge portion of the glass ribbon with a plurality of edge rollers positioned downstream from the root and edge director, the plurality of edge rollers extending through a housing; and

El Kahlout's FIG. 2 illustrates edge rollers extending through the seal plate

136:



El Kahlout describes the edge rollers as follows:

[0021] The apparatus 10 for making glass can also include at least one edge roller device including **a pair of edge rollers configured to engage a corresponding edge of the glass ribbon as the ribbon is drawn off the root 70 of the forming wedge 62.**

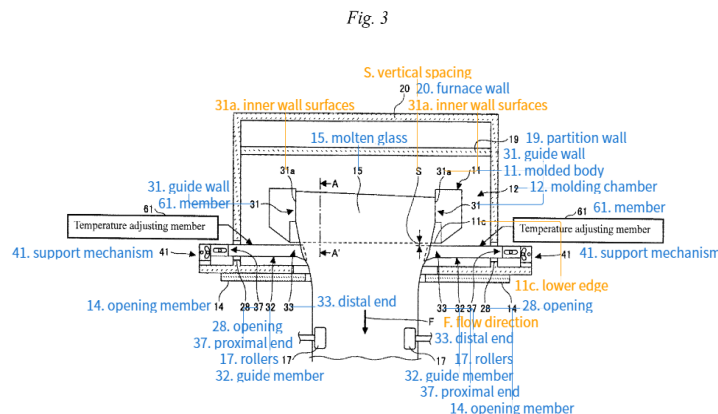
* * * * *

[0023] **The first and second shafts 134a, 134b extend through a seal plate 136 and are configured to be rotatably driven by a motor 138. The seal plate 136 is configured to provide closure to an opening leading to the area housing the motor 138.** The seal plate may comprise a refractory material, steel, or other thermal insulation to protect sensitive components of the motor and/or other mechanisms located within the housing area.

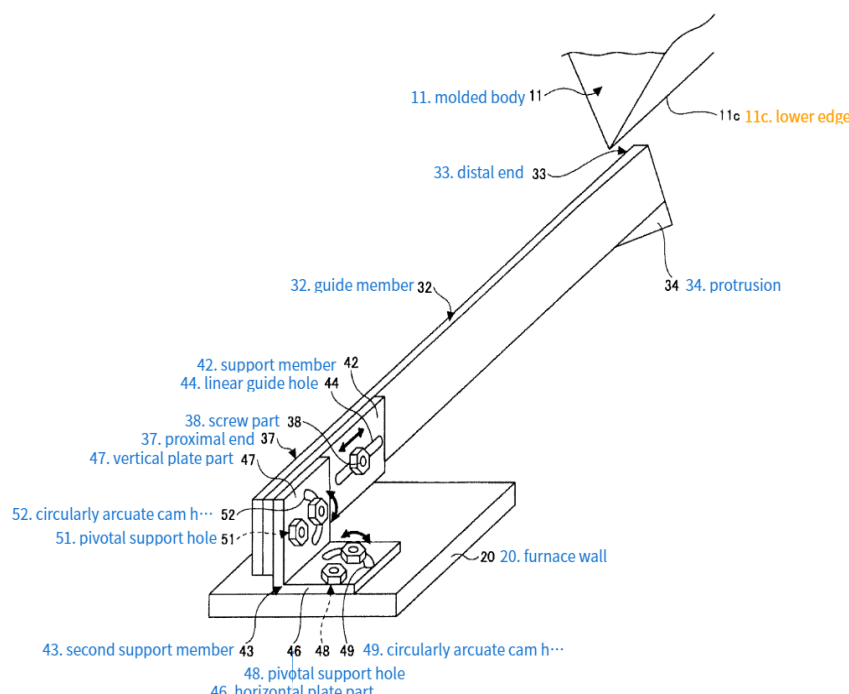
EX1004, ¶¶ 0021, 0023 (emphasis added). Therefore, limitation 15[d] is described in El Kahlout. EX1003, ¶¶ 58-60.

Limitation 15[e]: heating the edge director with a replaceable heating cartridge located in a port in the housing,

Tsuda depicts a glass manufacturing device as shown in Fig. 3 (annotated) below:



In addition, Tsuda depicts a supporting mechanism as shown in FIG. 6 (annotated) below:



Tsuda also discloses a replaceable heater for heating the guide member:

[0056] The guide members 32 are installed one by one in both right and left sides of the molten glass 15 joining just under the lower edge part 11b of the molded body 11. The joined molten glass 15 expands to distal ends 33 of the guide members 32 of both right and left sides and runs down in a state of contacting with the distal ends 33. As the molten glass 15 runs down, the width of flow narrows by surface tension in a natural state. On the other hand, by providing the guide members 32, the joined molten glass 15 contacts with the distal ends 33 of the guide members 32 and wets, so that the width of flow can be inhibited from narrowing.

* * * * *

[0070] **The support mechanism 41 is a mechanism for supporting the guide member 32 so as to be able to adjust a position and/or an angle with respect to the lower edge 11c of the molded body 11. The support mechanism 41 is provided in the vicinity of the opening 28 of the furnace wall 20.**

* * * * *

[0090] A member for heating the guide member 32 includes an internal heater embedded in the distal end 33 of the guide member 32, and an external heater for heating the proximal end 37 of the guide member 32 from the outside. **In the case of using the internal heater, the distal end 33 can be heated efficiently. In the case of using the external heater, replacement and repair are facilitated.** In the case of using the external heater, a material of the guide member 32 desirably has high thermal conductivity.

EX1006, ¶¶ 0056, 0070, and 0090 (emphasis added). Therefore, Tsuda teaches limitation 15[e]. EX1003, ¶¶ 61-64.

A POSITA would have been motivated to combine the teachings of Tsuda with that of El Kahlout so that the heater can be replaced to facilitate equipment maintenance and ensuring the stability of the glass manufacturing process. This conclusion is consistent with El Kahlout's teaching that "a variety of attachment structures may be used to mount the one or more heating devices. . . . Allowing the heating devices to rotate and/or translate with respect to the edge director can help adjust the distance and/or angle with respect to the edge director to direct heat in a desired manner to the edge director." EX1004, ¶ 0037; EX1003, ¶¶ 65-66.

Limitation 15[f]: wherein the replaceable heating cartridge is positioned between the plurality of edge rollers and the edge director;

El Kahlout describes a heating device positioned between a plurality of edge rollers and the edge director:

[0033] **The thermal shield may also be positioned partially or entirely between the first pair of edge rollers and the first edge director.**

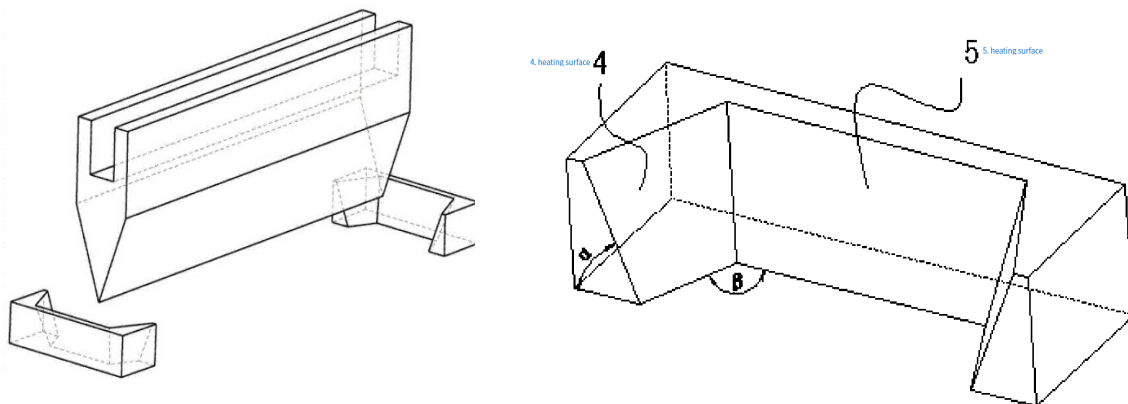
* * * * *

[0035] In addition or alternatively, a second example heating device 170b may be positioned on the first thermal shield 120a and configured to direct heat upwardly toward the first edge director 80a.

EX1004, ¶¶ 0033, 0035 (emphasis added). Therefore, limitation 15[f] is described in El Kahlout. EX1003, ¶¶ 67-68.

Limitation 15[g]: the replaceable heating cartridge comprising an enclosure having a heat directing surface that is inclined at an angle of less than about 90° with respect to a bottom surface of the enclosure,

CN '869 depicts a heating apparatus in FIGS. 2 and 4 (annotated) below:



Further, CN '869 teaches the following:

A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . The heating apparatus is combined with a glass forming body, and two heating

apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

* * * * *

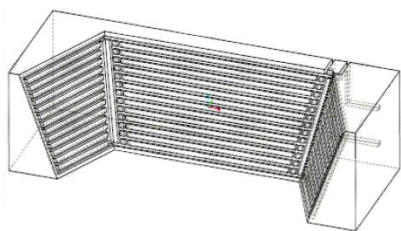
An angle between a heating surface 4 and a horizontal plane is α , and an angle between the heating surface 4 and a heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention **includes the surface 4 and the surface 5 with the angle α and the angle β . Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶¶ 0007, 0016 (emphasis added). As is evident from FIGS. 2 and 4 and the accompanying description, the heating device has a heat directing surface including facets 4 and 5 with facet 4 inclined at an angle of less than 90 degrees with respect to the bottom surface of the heating device. EX1003, ¶ 91. Therefore, CN '869 teaches limitation 15[g]. *Id.* ¶¶ 69-71.

A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout so that the heat directing surface of the heater can be inclined to compensate for the temperature of the edge director. The precise angle is simply optimizing the inclination depicted and described in CN '869. EX1003, ¶ 72.

Limitation 15[h]: the heat directing surface comprising at least one heating element positioned on or adjacent to a face thereof,

CN '869 depicts a hob of a heating apparatus as shown in FIG. 3:



Further, CN '869 teaches the following:

A platinum heating device for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. **The three surfaces are all heating surfaces.**

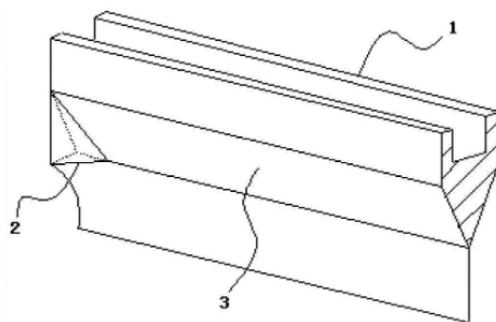
EX1005, ¶ 0007 (emphasis added). Therefore, CN '869 teaches limitation 15[h].

EX1003, ¶¶ 73-75.

A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout as described above and in doing so would achieve the structure of limitation 15[h]. EX1003, ¶ 76.

Limitation 15[i]: wherein the replaceable heating cartridge is oriented such that the heat directing surface faces the edge director, a view factor from the heat directing surface is greater at the edge director than at the plurality of edge rollers,

CN '869 depicts a glass preform in FIG. 1:



Further, CN '869 teaches the following:

An angle between a heating surface 4 and a horizontal plane is α , and an angle between the heating surface 4 and a heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches that when an inclined heating surface is employed, a POSITA would expect that “a view factor from the heat directing surface is greater at the edge director than at the plurality of edge rollers” as recited in limitation 15[i] of the '025 Patent. EX1003, ¶¶ 77-79. Therefore, this limitation is taught by El Kahlout and CN '869.

Limitation 15[j]: and a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge are at least partially positioned between the edge director and the plurality of edge rollers to thermally shield the edge director from the plurality of edge rollers.

CN '869 teaches the following:

A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . **The heating apparatus is combined with a glass forming body,**

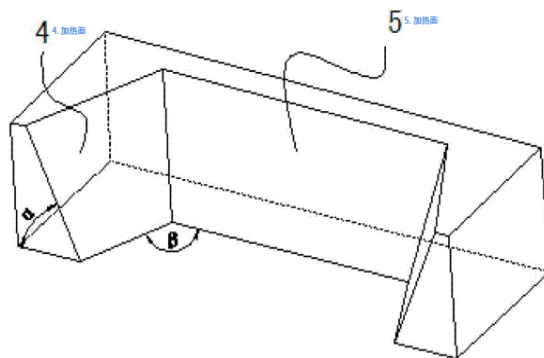
and two heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

EX1005, ¶ 0007 (emphasis added). CN ‘869, when combined in the method of El Kahlout, teaches that when the two heating devices are placed at both ends of the lower part of the glass forming body, they direct heat to the edge director and away from the roller such that the expected result would be “a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge are at least partially positioned between the edge director and the plurality of edge rollers to thermally shield the edge director from the plurality of edge rollers” as recited in limitation 15[j] of the ‘025 Patent. EX1003, ¶¶ 80-81. Therefore, this limitation is disclosed by El Kahlout and CN ‘869.

2. Dependent Claim 16

The method of claim 15, wherein the angle of the heat directing surface is from about 45° to about 75° relative to bottom surface.

CN ‘869 depicts a heating apparatus as shown in FIG. 2 (annotated) below:



Further, CN ‘869 discloses inclined heating surfaces:

A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving effective temperature compensation. The precise angles recited in claim 16 are simply optimizing the angles already described in CN '869. EX1003, ¶¶ 82-84. Therefore, this limitation is disclosed by El Kahlout and CN '869.

3. Dependent Claim 17

The method of claim 15, wherein the heat directing surface comprises a plurality of facets orientated to at least partially surround the edge director.

CN '869 teaches a heating hob with angled surfaces and positioned as follows:

[0016] A heating hob supported by a refractory material adopted in the present invention includes the **surface 4 and the surface 5 with the angle α and the angle β .**

* * * * *

[0007] [T]wo heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

EX1005, ¶¶ 0007, 0016 (emphasis added). A POSITA with the knowledge of CN '869 would have been motivated to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving

effective temperature compensation. Thus, CN '869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to provide a heat directing surface comprising a plurality of facets orientated to at least partially surround the edge director in the method of El Kahlout. EX1003, ¶¶ 85-86. Therefore, this limitation is disclosed by El Kahlout and CN '869.

4. Dependent Claim 18

The method of claim 17, wherein the plurality of facets comprises a center facet and two side facets on opposite ends of the center facet, wherein a largest angle between each of the two side facets relative to the center facet is from about 145° to about 175°.

CN '869 teaches a heating hob with angled surfaces as follows:

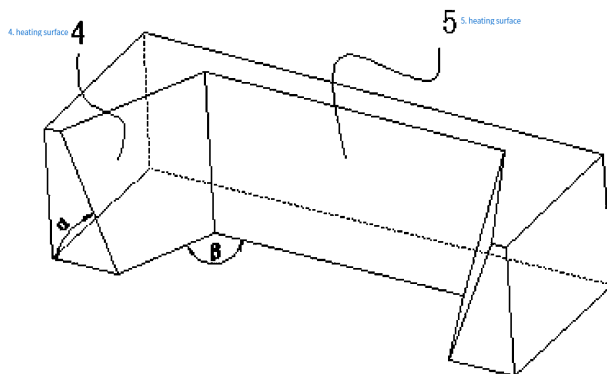
[0016] A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving effective temperature compensation. The precise angles recited in claim 18 are simply optimizing the angles already described in CN '869. EX1003, ¶¶ 87-88. Therefore, this limitation is disclosed by El Kahlout and CN '869.

5. Dependent Claim 19

The method of claim 15, wherein the heat directing surface comprises a curved surface such that the heat directing surface at least partially surrounds the edge director.

CN '869 depicts a heating apparatus as shown in FIG. 4 (annotated) below:



Further, CN '869 teaches using the inclined surfaces of the heating apparatus as follows:

The angle between the heating surface 4 and the horizontal plane is α , and the angle between the heating surface 4 and the heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. **Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage.** A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout such that the heat directing surface of the heater is curved to compensate for the temperature of the edge director

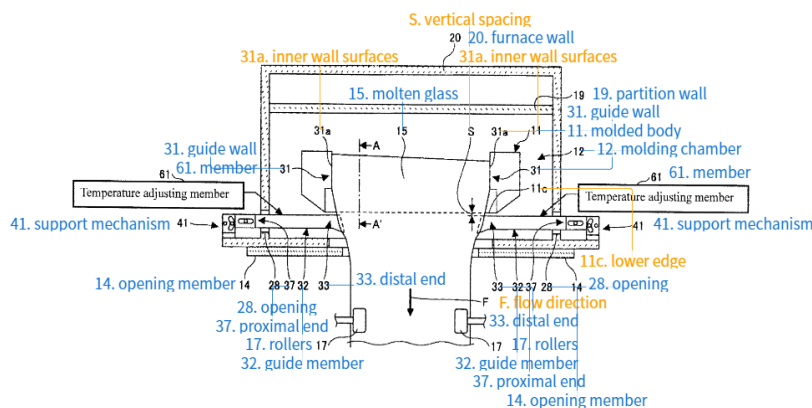
and to improve heating efficiency. EX1003, ¶¶ 90-91. Therefore, this limitation is taught by El Kahlout and CN '869.

6. Dependent Claim 20

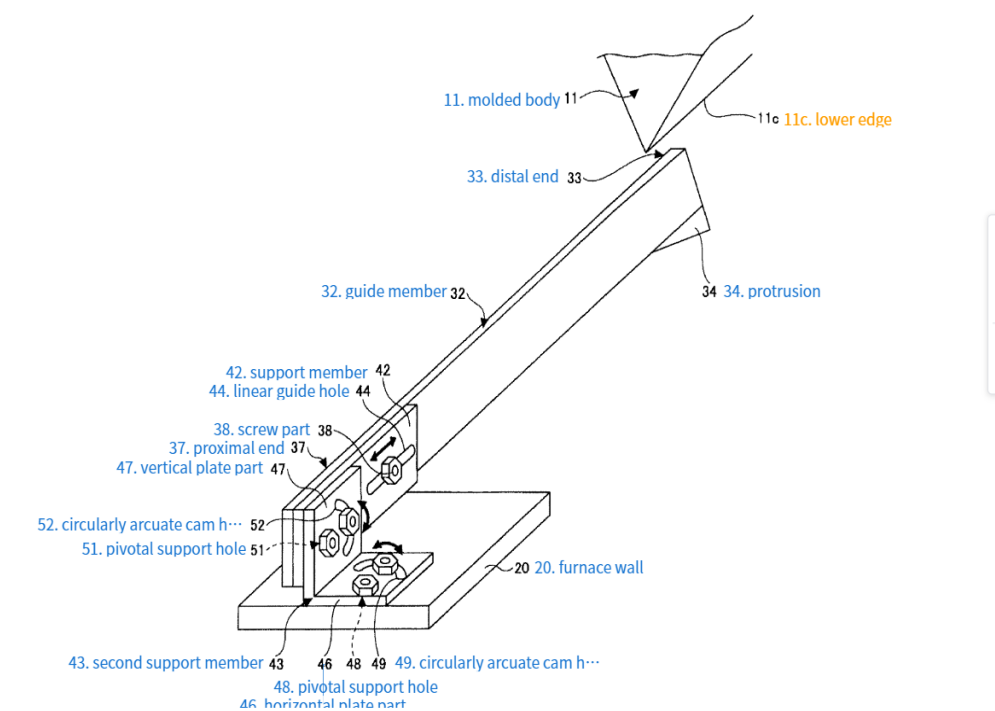
The method of claim 15, wherein the replaceable heating cartridge is replaceable as the glass ribbon is being formed.

Tsuda depicts a glass manufacturing device as shown in Fig. 3 (annotated below):

Fig. 3



In addition, Tsuda depicts a supporting mechanism as shown in FIG. 6 (annotated below):



Tsuda also teaches a replaceable heater for heating the guide member:

[0056] The guide members 32 are installed one by one in both right and left sides of the molten glass 15 joining just under the lower edge part 11b of the molded body 11. The joined molten glass 15 expands to distal ends 33 of the guide members 32 of both right and left sides and runs down in a state of contacting with the distal ends 33. As the molten glass 15 runs down, the width of flow narrows by surface tension in a natural state. On the other hand, by providing the guide members 32, the joined molten glass 15 contacts with the distal ends 33 of the guide members 32 and wets, so that the width of flow can be inhibited from narrowing.

* * * * *

[0070] **The support mechanism 41 is a mechanism for supporting the guide member 32** so as to be able to adjust a position and/or an angle with respect to the lower edge 11c of the molded body 11. **The support mechanism 41 is provided in the vicinity of the opening 28 of the furnace wall 20.**

* * * * *

[0090] A member for heating the guide member 32 includes an internal heater embedded in the distal end 33 of the guide member 32, and an external heater for heating the proximal end 37 of the guide member 32 from the outside. **In the case of using the internal heater, the distal end 33 can be heated efficiently. In the case of using the external heater, replacement and repair are facilitated.** In the case of using the external heater, a material of the guide member 32 desirably has high thermal conductivity.

EX1006, ¶¶ 0056, 0070 and 0090 (emphasis added).

A POSITA would have been motivated to combine the teachings of Tsuda with that of El Kahlout so that the heater can be replaced, during the heating process, to ensure continuous production, to facilitate equipment maintenance and ensuring the stability of the glass manufacturing process. This conclusion is consistent with the teaching in El Kahlout that “a variety of attachment structures may be used to mount the one or more heating devices. . . . Allowing the heating devices to rotate and/or translate with respect to the edge director can help adjust the distance and/or angle with respect to the edge director to direct heat in a desired manner to the edge director.” EX1004, ¶ 0037; EX1003, ¶¶ 92-96. Therefore, this limitation is disclosed by El Kahlout and Tsuda.

7. Independent Claim 1

Likewise, Tsuda discloses that “[t]he present invention relates to a method and a device for manufacturing a glass sheet.” EX1006, ¶ 0001.

Accordingly, this limitation is disclosed by at least El Kahlout. EX1003, ¶¶ 97-100.

Limitation 1[a]: a forming wedge including a pair of downwardly inclined forming surface portions converging along a downstream direction to form a root;

El Kahlout discloses the following:

[0046] As shown in FIG. 2, the method includes the step of flowing molten glass 17 over the pair of downwardly **inclined forming surface portions 66a, 66b of the forming wedge 62.**

* * * * *

[0016] **The downwardly inclined forming surface portions 66a, 66b converge along a downstream direction 68 to form a root 70.**

EX1004, ¶¶ 1016, 0046 (emphasis added). Therefore, limitation 1[a] is described in El Kahlout. EX1003, ¶¶ 101-102.

Limitation 1[b]: an edge director intersecting with the pair of downwardly inclined forming surface portions;

El Kahlout discloses the following:

[0017] In further examples, **the edge director can intersect with both downwardly inclined forming surface portions 66a, 66b.**

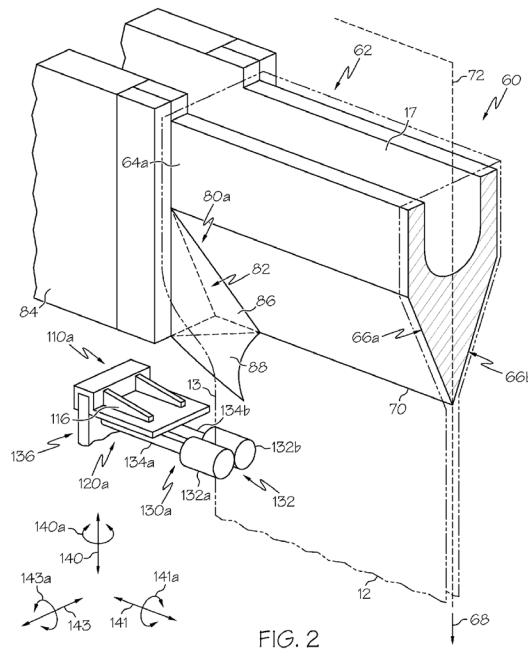
* * * * *

[0046] [T]he method further includes the steps of **flowing molten glass over the edge director** and drawing the molten glass from the root 70 of the forming wedge 62 to form the glass sheet 12.

EX1004, ¶¶ 0017, 0046 (emphasis added). Therefore, limitation 1[b] is described in El Kahlout. EX1003, ¶¶ 103-104.

Limitation 1[c]: a plurality of edge rollers positioned downstream from the root and edge director, wherein the plurality of edge rollers are positioned to engage an edge portion of the glass ribbon;

El Kahlout's FIG. 2 illustrates edge rollers extending through the sealing plate 136:



El Kahlout describes the edge rollers as follows:

[0021] The apparatus 10 for making glass can also include at least one edge roller device including **a pair of edge rollers configured to engage a corresponding edge of the glass ribbon as the ribbon is drawn off the root 70 of the forming wedge 62.**

El Kahlout describes the edge rollers as follows:

[0021] The apparatus 10 for making glass can also include at least one edge roller device including **a pair of edge rollers configured to engage a corresponding edge of the glass ribbon as the ribbon is drawn off the root 70 of the forming wedge 62. The pair of edge rollers facilitates proper finishing of the edges of the glass sheet. Edge roller finishing provides desired edge characteristics and proper fusion of the edge portions of the molten glass being pulled off opposed Surfaces of the edge director associated with the pair of downwardly inclined forming Surface portions 66a, 66b.**

* * * * *

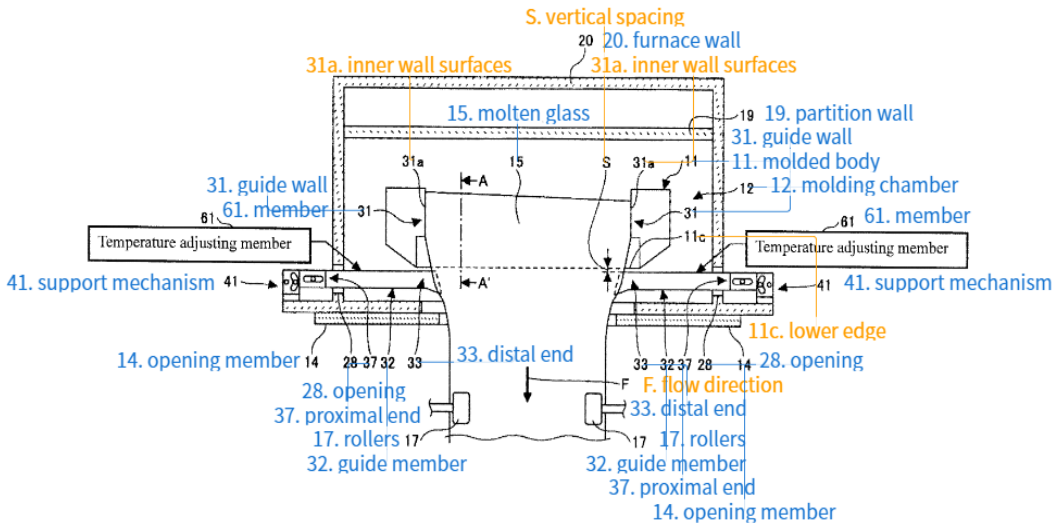
[0023] The first and second shafts 134a, 134b extend through a seal plate 136 and are configured to be rotatably driven by a motor 138. The seal plate 136 is configured to provide closure to an opening leading to the area housing the motor 138. The seal plate may comprise a refractory material, steel, or other thermal insulation to protect sensitive components of the motor and/or other mechanisms located within the housing area.

EX1004, ¶¶ 0021, 0023 (emphasis added). Therefore, limitation 1[d] is described in El Kahlout. EX1003, ¶¶ 108-110.

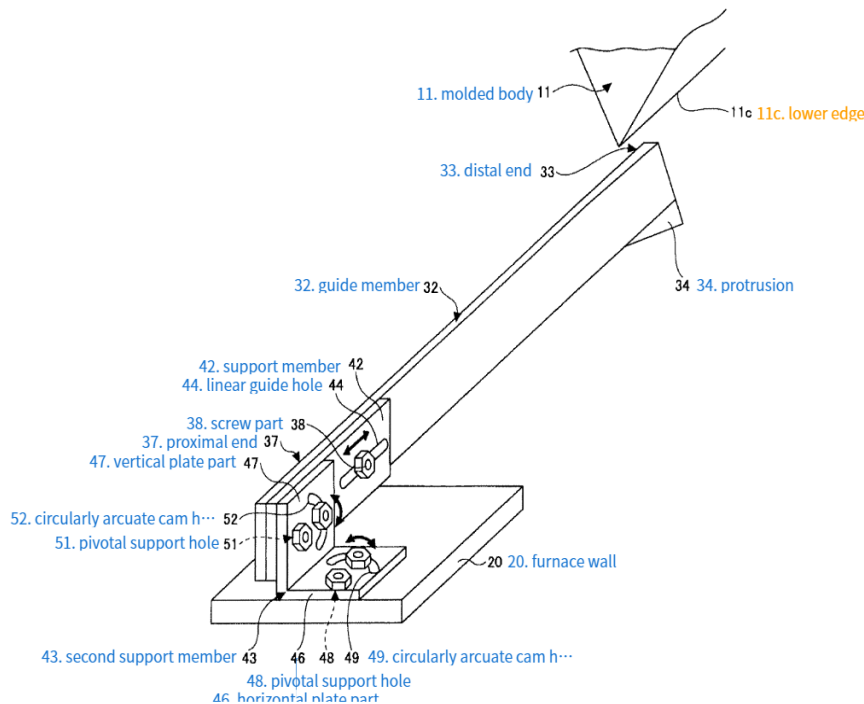
Limitation 1[e]: a heating cartridge removably positioned in a port of the housing below the edge director,

Tsuda depicts a glass manufacturing device as shown in Fig. 3 (annotated) below:

Fig. 3



In addition, Tsuda depicts a supporting mechanism as shown in FIG. 6 (annotated) below:



Tsuda also discloses a replaceable heater for heating the guide member:

[0056] The guide members 32 are installed one by one in both right and left sides of the molten glass 15 joining just under the lower edge part 11b of the molded body 11. The joined molten glass 15 expands to distal ends 33 of the guide members 32 of both right and left sides and runs down in a state of contacting with the distal ends 33. As the molten glass 15 runs down, the width of flow narrows by surface tension in a natural state. On the other hand, by providing the guide members 32, the joined molten glass 15 contacts with the distal ends 33 of the guide members 32 and wets, so that the width of flow can be inhibited from narrowing.

* * * * *

[0070] **The support mechanism 41 is a mechanism for supporting the guide member 32** so as to be able to adjust a position and/or an angle with respect to the lower edge 11c of the molded body 11. **The support mechanism 41 is provided in the vicinity of the opening 28 of the furnace wall 20.**

* * * * *

[0090] A member for heating the guide member 32 includes an internal heater embedded in the distal end 33 of the guide member 32, and an external heater for heating the proximal end 37 of the guide member 32 from the outside. **In the case of using the internal heater, the distal end 33 can be heated efficiently. In the case of using the external heater, replacement and repair are facilitated.** In the case of using the external heater, a material of the guide member 32 desirably has high thermal conductivity.

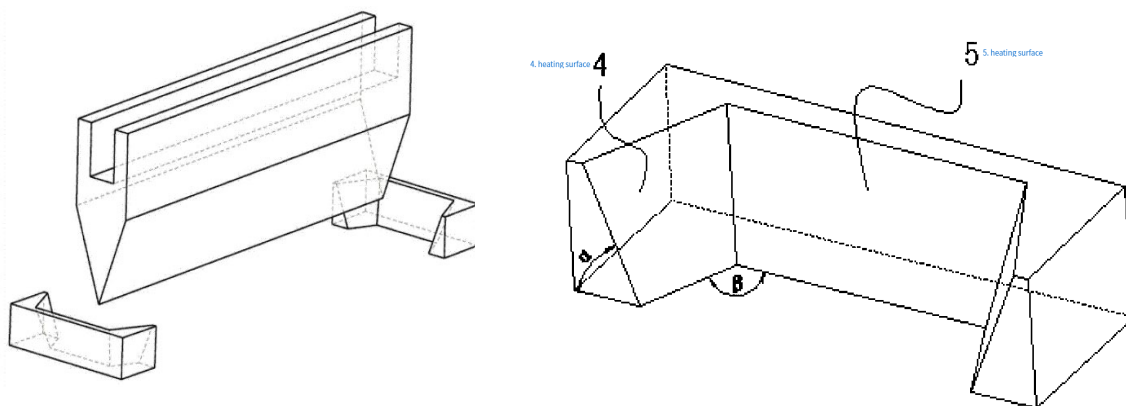
EX1006, ¶¶ 0056, 0070, and 0090 (emphasis added). Therefore, Tsuda teaches limitation 1[e]. EX1003, ¶¶ 111-114.

A POSITA would have been motivated to combine the teachings of Tsuda with that of El Kahlout so that the heater can be replaced to facilitate equipment

maintenance and ensure the stability of the glass manufacturing process. This conclusion is consistent with El Kahlout's teaching that "a variety of attachment structures may be used to mount the one or more heating devices. . . . Allowing the heating devices to rotate and/or translate with respect to the edge director can help adjust the distance and/or angle with respect to the edge director to direct heat in a desired manner to the edge director." EX1004, ¶ 0037; EX1003, ¶¶ 115-116.

Limitation 1[f]: the heating cartridge comprising an enclosure having a heat directing surface that is inclined at an angle of less than about 90° with respect to a bottom surface of the enclosure,

CN '869 depicts a heating apparatus in FIGS. 2 and 4 (annotated) below:



Further, CN '869 teaches the following:

A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . The heating apparatus is combined with a glass forming body, and two heating

apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

* * * * *

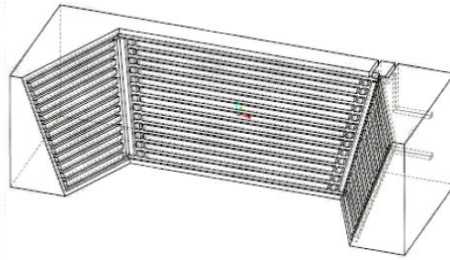
An angle between a heating surface 4 and a horizontal plane is α , and an angle between the heating surface 4 and a heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention **includes the surface 4 and the surface 5 with the angle α and the angle β . Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶¶ 0007, 0016 (emphasis added). As is evident from FIGS. 2 and 4 and the accompanying description, the heating device has a heat directing surface including facets 4 and 5 with facet 4 inclined at an angle of less than 90 degrees with respect to the bottom surface of the heating device. EX1003, ¶ 153. Therefore, CN '869 combined with El Kahlout teaches limitation 1[f]. *Id.* ¶¶ 117-119.

A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout so that the heat directing surface of the heater can be inclined to compensate for the temperature of the edge director. The precise angle is simply optimizing the inclination depicted and described in CN '869. *Id.* ¶ 120.

Limitation 1[g]: the heat directing surface comprising at least one heating element positioned on or adjacent to a face thereof,

CN '869 depicts a hob of a heating apparatus as shown in FIG. 3:



Further, CN '869 teaches the following:

A platinum heating device for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. **The three surfaces are all heating surfaces.**

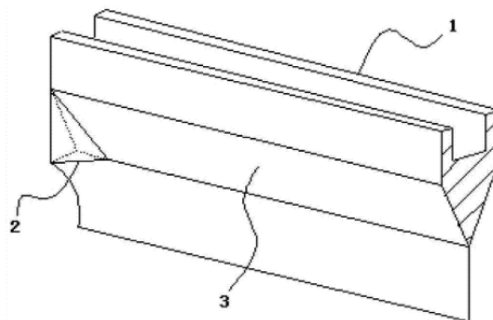
EX1005, ¶ 0007 (emphasis added). Therefore, CN '869 teaches limitation 1[g].

EX1003, ¶¶ 121-123.

As is discussed above in the context of limitation 1[e], a POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout and in doing so would achieve the structure of limitation 1[g]. EX1003, ¶ 124.

Limitation 1[h]: wherein the heating cartridge is oriented such that the heat directing surface faces the edge director, a view factor from the heat directing surface is greater at the edge director than at the plurality of edge rollers,

CN '869 depicts a glass preform in FIG. 1:



Further, CN '869 teaches the following:

An angle between a heating surface 4 and a horizontal plane is α , and an angle between the heating surface 4 and a heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches that when an inclined heating surface is employed, it would be expected that “a view factor from the heat directing surface is greater at the edge director than at the plurality of edge rollers” as recited in limitation 1[h] of the '025 Patent. EX1003, ¶ 127. Therefore, this limitation is disclosed by El Kahlout and CN '869.

Limitation 1[i]: and a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge are at least partially positioned between the edge director and the plurality of edge rollers to thermally shield the edge director from the plurality of edge rollers.

CN '869 teaches the following:

A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . **The heating apparatus is combined with a glass forming body,**

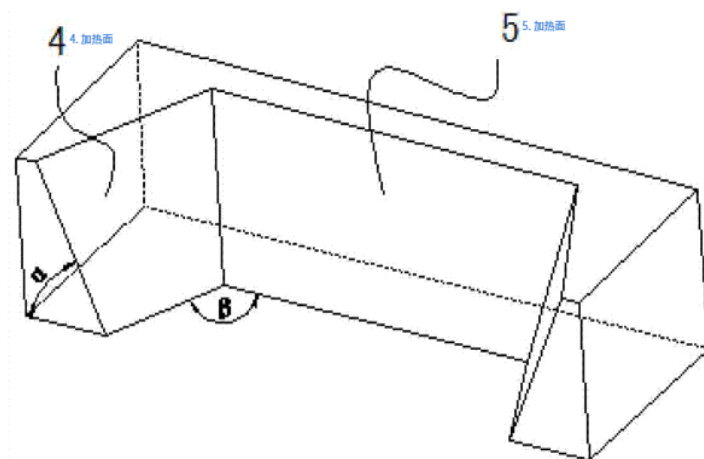
and two heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

EX1005, ¶ 0007 (emphasis added). CN ‘869, when combined in the method of El Kahlout, teaches that when the two heating devices are placed at both ends of the lower part of the glass forming body, they direct heat to the edge director and away from the roller such that the expected result would be “a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge are at least partially positioned between the edge director and the plurality of edge rollers to thermally shield the edge director from the plurality of edge rollers” as recited in limitation 1[i] of the ‘025 Patent. EX1003, ¶ 129. Therefore, this limitation is disclosed by El Kahlout and CN ‘869.

8. Dependent Claim 2

The apparatus of claim 1, wherein the angle of the heat directing surface is from about 45° to about 75° relative to the bottom surface of the enclosure.

CN ‘869 depicts a heating apparatus as shown in FIG. 2 (annotated) below:



Further, CN '869 discloses inclined heating surfaces:

A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving effective temperature compensation. The precise angles recited in claim 2 are simply optimizing the angles already described in CN '869. EX1003, ¶ 132. Therefore, this limitation is disclosed by El Kahlout and CN '869.

9. Dependent Claim 3

The apparatus of claim 1, wherein the heat directing surface comprises a plurality of facets oriented to at least partially surround the edge director.

CN '869 teaches a heating hob with angled surfaces and positioned as follows:

[0016] A heating hob supported by a refractory material adopted in the present invention includes the **surface 4 and the surface 5 with the angle α and the angle β .**

* * * * *

[0007] [T]wo heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

EX1005, ¶¶ 0007, 0016 (emphasis added). A POSITA with the knowledge of CN '869 would have been motivated to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving

effective temperature compensation. EX1003, ¶¶ 133-134. Thus, CN ‘869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to provide a heat directing surface comprising a plurality of facets orientated to at least partially surround the edge director in the method of El Kahlout. *Id.* ¶ 134. Therefore, this limitation is disclosed by El Kahlout and CN ‘869.

10. Dependent Claim 4

The apparatus of claim 3, wherein the plurality of facets comprise a center facet and two side facets on opposite ends of the center facet, wherein a largest angle between each of the two side facets relative to the center facet is from about 145° to about 175°.

CN ‘869 teaches a heating hob with angled surfaces as follows:

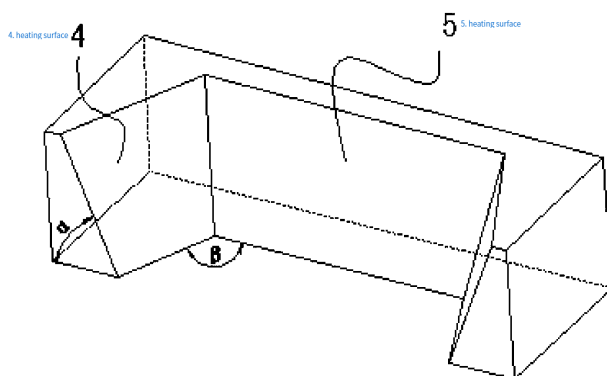
[0016] A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN ‘869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving effective temperature compensation. The precise angles recited in claim 4 are simply optimizing the angles already described in CN ‘869. EX1003, ¶¶ 135-136. Therefore, this limitation is disclosed by El Kahlout and CN ‘869.

11. Dependent Claim 5

The apparatus of claim 1, wherein the heat directing surface is a curved surface such that the heat directing surface at least partially surrounds the edge director.

CN '869 depicts a heating apparatus as shown in FIG. 4 (annotated) below:



Further, CN '869 teaches using the inclined surfaces of the heating apparatus as follows:

An angle between the heating surface 4 and the horizontal plane is α , and the angle between the heating surface 4 and the heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. **Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage.** A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

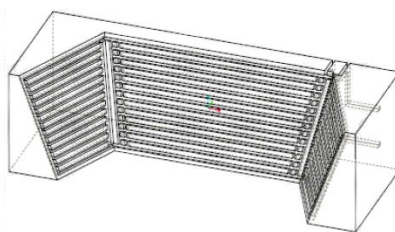
EX1005, ¶ 0016 (emphasis added). A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout so that the heat directing surface of the heater can be curved to compensate for the temperature of the edge

director and to improve heating efficiency. EX1003, ¶¶ 138-139. Therefore, this limitation is disclosed by El Kahlout and CN '869.

12. Dependent Claim 6

The apparatus of claim 1, wherein the at least one heating element comprises a coil having an elongated cross section.

CN '869 depicts a hob of a heating apparatus as shown in FIG. 3:



Further, CN '869 teaches the following:

A platinum heating device for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. **The three surfaces are all heating surfaces.**

EX1005, ¶ 0007 (emphasis added). A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout, and further, the heating element comprising an elongated coil would be an obvious design choice to take advantage of increased heating efficiency. EX1003, ¶¶ 140-142. Therefore, this limitation is disclosed by El Kahlout and CN '869.

13. Dependent Claim 7

The apparatus of claim 6, wherein the at least one heating element is formed from a material selected from the group consisting of molybdenum disilicide, platinum, platinum-rhodium, and iron-chromium-aluminum alloys.

CN '869 teaches a platinum heater:

The implementation of the present invention includes heating a glass body formed in FIG. 1 by adopting **a platinum heater** designed according to FIG. 2.

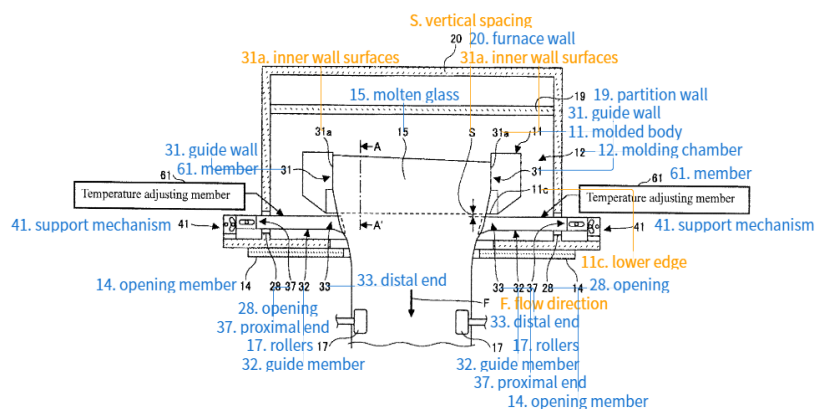
EX1005, ¶ 0016 (emphasis added). Thus, CN '869 discloses a heating element including platinum, and when combined with El Kahlout, teaches the limitation of claim 7. EX1003, ¶¶ 143-44.

14. Independent Claim 8

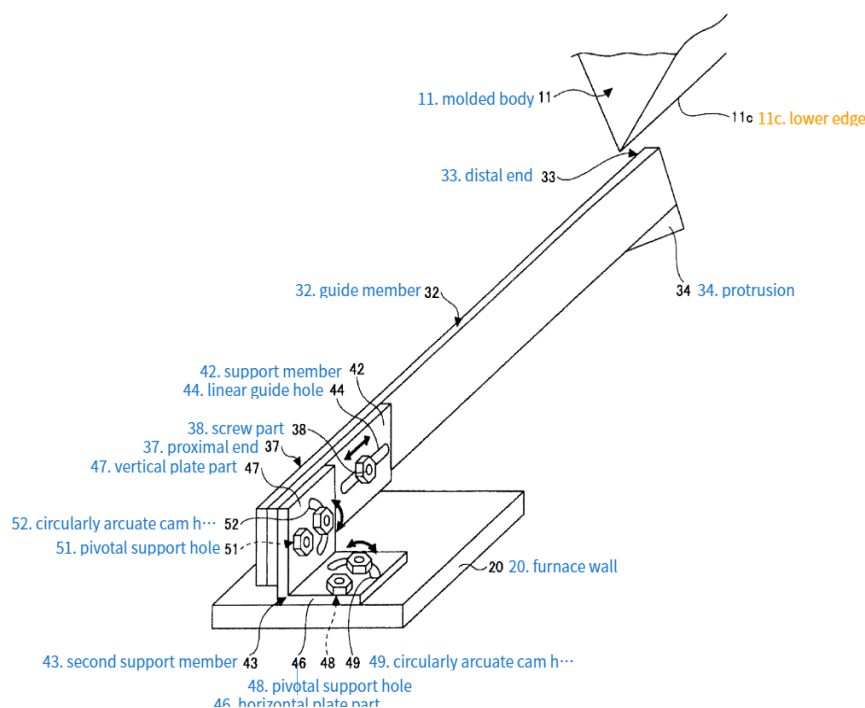
Limitation 8[p]: A replaceable heating cartridge for use in an apparatus for forming a glass ribbon, the replaceable heating cartridge comprising:

El Kahlout discloses that “[t]he present invention relates generally to apparatus and methods for making glass sheets, and more particularly, to apparatus and methods for making glass sheets with edge directors.” EX1004, ¶ 0001. *See also* FIG. 2:

Fig. 3



In addition, Tsuda depicts a supporting mechanism as shown in FIG. 6 (annotated) below:



Tsuda also teaches a replaceable heater for heating the guide member:

[0056] The guide members 32 are installed one by one in both right and left sides of the molten glass 15 joining just under the lower edge part 11b of the molded body 11. The joined molten glass 15 expands to distal ends 33 of the guide members 32 of both right and left sides and runs down in a state of contacting with the distal ends 33. As the molten glass 15 runs down, the width of flow narrows by surface tension in a natural state. On the other hand, by providing the guide members 32, the joined molten glass 15 contacts with the distal ends 33 of the guide members 32 and wets, so that the width of flow can be inhibited from narrowing.

* * * * *

[0070] **The support mechanism 41 is a mechanism for supporting the guide member 32** so as to be able to adjust a position and/or an angle with respect to the lower edge 11c of the molded body 11. **The support mechanism 41 is provided in the vicinity of the opening 28 of the furnace wall 20.**

* * * * *

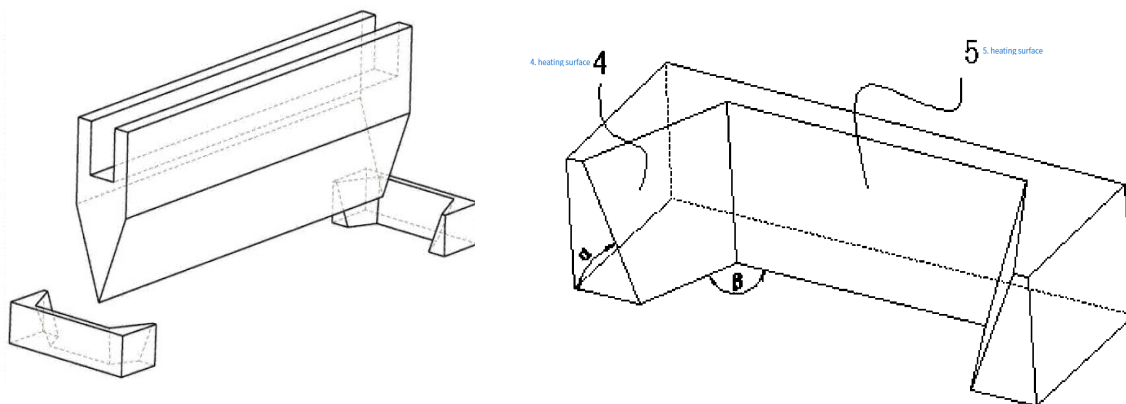
[0090] A member for heating the guide member 32 includes an internal heater embedded in the distal end 33 of the guide member 32, and an external heater for heating the proximal end 37 of the guide member 32 from the outside. **In the case of using the internal heater, the distal end 33 can be heated efficiently. In the case of using the external heater, replacement and repair are facilitated.** In the case of using the external heater, a material of the guide member 32 desirably has high thermal conductivity.

EX1006, ¶¶ 0056, 0070, and 0090 (emphasis added). A POSITA would have been motivated to combine the teachings of Tsuda with that of El Kahlout to incorporate a replaceable heater for facilitating equipment maintenance and ensuring the stability of the glass manufacturing process. This conclusion is consistent with El Kahlout's teaching that "a variety of attachment structures may be used to mount the one or

more heating devices. . . . Allowing the heating devices to rotate and/or translate with respect to the edge director can help adjust the distance and/or angle with respect to the edge director to direct heat in a desired manner to the edge director.” EX1004, ¶ 0037; EX1003, ¶¶ 145-152. Therefore, the combination of at least El Kahlout and Tsuda teaches limitation 8[p]. EX1003, ¶¶ 145-152.

Limitation 8[a]: an enclosure having a heat directing surface that is inclined at an angle of less than about 90° with respect to a bottom surface of the enclosure,

CN ‘869 depicts a heating apparatus in FIGS. 2 and 4 (annotated) below:



Further, CN ‘869 teaches the following:

A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . The heating apparatus is combined with a glass forming body, and two heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

* * * * *

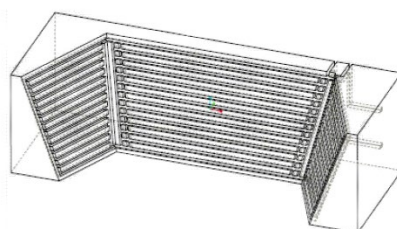
An angle between a heating surface 4 and a horizontal plane is α , and an angle between the heating surface 4 and a heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention **includes the surface 4 and the surface 5 with the angle α and the angle β . Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶¶ 0007, 0016 (emphasis added). As is evident from FIGS. 2 and 4 and the accompanying description, the heating device has a heat directing surface including facets 4 and 5 with facet 4 inclined at an angle of less than 90 degrees with respect to the bottom surface of the heating device. EX1003, ¶¶ 155. Therefore, CN ‘869 teaches limitation 8[a]. *Id.*

A POSITA would have been motivated to combine the teachings of CN ‘869 with that of El Kahlout (as modified by Tsuda) so that the heat directing surface of the heater can be inclined to compensate for the temperature of the edge director. The precise angle is simply optimizing the inclination depicted and described in CN ‘869. EX1003, ¶¶ 153-156.

Limitation 8[b]: the heat directing surface comprising at least one heating element positioned on or adjacent to a face thereof,

CN '869 depicts a hob of a heating apparatus as shown in FIG. 3:



Further, CN '869 teaches the following:

A platinum heating device for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. **The three surfaces are all heating surfaces.**

EX1005, ¶ 0007 (emphasis added). Therefore, CN '869 teaches limitation 8[b].

EX1003, ¶¶ 157-159.

A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout as described above and in doing so would achieve the structure of limitation 8[b]. EX1003, ¶¶ 157-160.

Limitation 8[c]: refractory material positioned within the enclosure behind the heat directing surface,

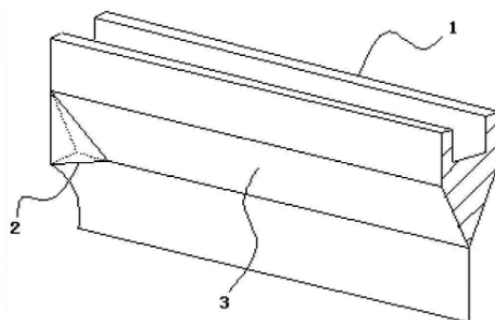
CN '869 teaches a platinum heater:

The implementation of the present invention includes heating a glass body formed in FIG. 1 by adopting **a platinum heater** designed according to FIG. 2.

EX1005, ¶ 0016 (emphasis added). Thus, CN ‘869 teaches a heating element including refractory material. EX1003, ¶¶ 161-162.

Limitation 8[d]: wherein a view factor from the heat directing surface is greater above the bottom surface of the enclosure than below the bottom surface of the enclosure,

CN ‘869 depicts a glass preform in FIG. 1:



Further, CN ‘869 teaches the following:

An angle between a heating surface 4 and a horizontal plane is α , and an angle between the heating surface 4 and a heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. Local temperature control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN ‘869, when combined in the method of El Kahlout, teaches that when an inclined heating surface is employed, it would be expected that “a view factor from the heat directing surface is greater above the bottom surface of the enclosure than below the bottom surface of the enclosure” as

recited in limitation 8[d]. EX1003, ¶¶ 163-165. Therefore, this limitation is disclosed by El Kahlout and CN ‘869.

Limitation 8[e]: and a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge thermally shields an area above the heat directing surface from an area below the heat directing surface.

CN ‘869 teaches the following:

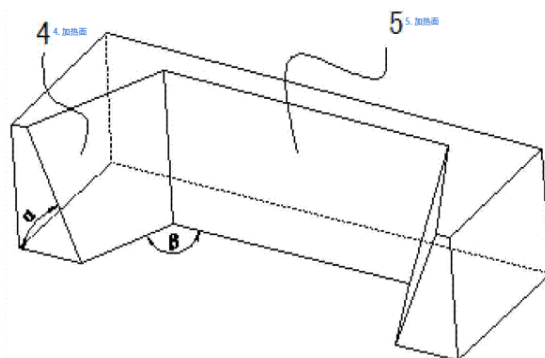
A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . **The heating apparatus is combined with a glass forming body, and two heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.**

EX1005, ¶ 0007 (emphasis added). CN ‘869, when combined in the method of El Kahlout, teaches that when the two heating devices are placed at both ends of the lower part of the glass forming body, they direct heat to the edge director and prevent the roller from the heat such that the expected result would be that “a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge thermally shields an area above the heat directing surface from an area below the heat directing surface” as recited in limitation 8[e]. EX1003, ¶¶ 166-167. Therefore, this limitation is disclosed by El Kahlout and CN ‘869.

15. Dependent Claim 9

The replaceable heating cartridge of claim 8, wherein the angle of the heat directing surface is from about 45° to about 75° relative to the bottom surface.

CN '869 depicts a heating apparatus as shown in FIG. 2 (annotated) below:



Further, CN '869 discloses inclined heating surfaces:

A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches to a POSITA that it would have been obvious to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving effective temperature compensation. The precise angles recited in claim 9 are simply optimizing the angles already described in CN '869. EX1003, ¶¶ 168-170. Therefore, this limitation is disclosed by El Kahlout and CN '869.

16. Dependent Claim 10

The replaceable heating cartridge of claim 8, wherein the heat directing surface comprises a plurality of facets.

CN '869 teaches a heating hob with angled surfaces and positioned as follows:

[0016] A heating hob supported by a refractory material adopted in the present invention includes the **surface 4 and the surface 5 with the angle α and the angle β .**

* * * * *

[0007] [T]wo heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

EX1005, ¶¶ 0007, 0016 (emphasis added). CN '869, when combined with El Kahlout, teaches a POSITA that it would have been obvious to provide a heat directing surface comprising a plurality of facets. EX1003, ¶¶ 171-172. Therefore, this limitation is disclosed by El Kahlout and CN '869.

17. Dependent Claim 11

The replaceable heating cartridge of claim 10, wherein the plurality of facets comprise a center facet and two side facets on opposite ends of the center facet, wherein a largest angle between each of the two side facets relative to the center facet is from about 145° to about 175°.

CN '869 teaches a heating hob with angled surfaces as follows:

[0007] A platinum heating apparatus for manufacture of plate glass is in a recessed shape. A bottom of the recessed shape is perpendicular to a horizontal plane, and two inner side surfaces of the recessed shape are inclined relative to the horizontal plane and symmetrical bilaterally. The three surfaces are all heating surfaces. An angle between the inclined heating surface and the horizontal plane is α , and an angle between the inclined heating surface and the vertical heating surface is β . The heating apparatus is combined with a glass forming body, and

two heating apparatuses are placed at two ends of a lower portion of the glass forming body to heat the glass forming body.

* * * * *

[0016] A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). CN '869, when combined in the method of El Kahlout, teaches a POSITA that it would have been obvious to select between each of the two side facets relative to the center facet based on the equipment structure, thereby achieving effective temperature compensation. The precise angles recited in claim 11 are simply optimizing the angles already described in CN '869. EX1003, ¶¶ 173-174. Therefore, this limitation is disclosed by El Kahlout and CN '869.

18. Dependent Claim 12

The replaceable heating cartridge of claim 11, further comprising a shield member extending from the center facet of the heat directing surface proximate the bottom surface of the enclosure.

El Kahlout describes a thermal shield positioned between a pair of edge rollers and the edge director:

[0033] **The thermal shield may also be positioned partially or entirely between the first pair of edge rollers and the first edge director.**

* * * * *

[0035] In addition or alternatively, a second example **heating device 170b may be positioned on the first thermal shield 120a and**

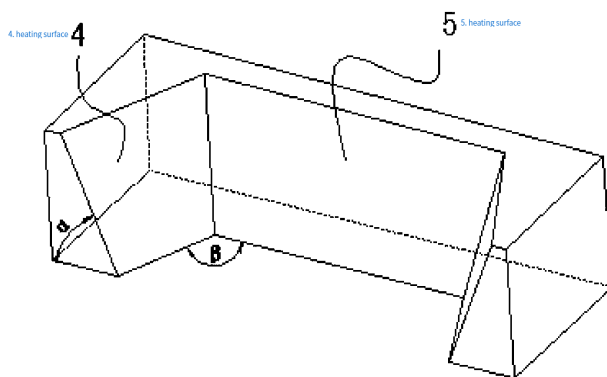
configured to direct heat upwardly toward the first edge director
80a.

EX1004, ¶¶ 0033, 0035 (emphasis added). To provide a better thermal shielding effect for the roller, it would have been obvious to a POSITA to extend the shield to form a physical barrier, as demonstrated by El Kahlout, to isolate the area above the heat directing surface from the area below the heat directing surface through the use of a shield. EX1003, ¶¶ 175-176.

19. Dependent Claim 13

The replaceable heating cartridge of claim 8, wherein the heat directing surface comprises a curved surface.

CN '869 depicts a heating apparatus as shown in FIG. 4 (annotated) below:



Further, CN '869 teaches using the inclined surfaces of the heating apparatus as follows:

The angle between the heating surface 4 and the horizontal plane is α , and the angle between the heating surface 4 and the heating surface 5 is β . During heating, these two angles are used for compensating the temperature of a flow guide plate part 2 in FIG. 1. **Local temperature**

control measures are adopted to optimize the thickened part caused by glass shrinkage. A heating hob supported by a refractory material adopted in the present invention includes the surface 4 and the surface 5 with the angle α and the angle β . **Use of the inclined surfaces with the angle α and the angle β can effectively compensate the temperature at two ends of an isopipe.**

EX1005, ¶ 0016 (emphasis added). A POSITA would have been motivated to combine the teachings of CN '869 with that of El Kahlout so that the heat directing surface of the heater can be curved to compensate for the temperature of the edge director and to improve heating efficiency. EX1003, ¶¶ 177-179. Therefore, this limitation is disclosed by El Kahlout and CN '869.

20. Dependent Claim 14

The replaceable heating cartridge of claim 8, wherein the at least one heating element is formed from a material selected from the group consisting of molybdenum disilicide, platinum, platinum-rhodium, and iron-chromium aluminum alloys.

CN '869 teaches a platinum heater:

The implementation of the present invention includes heating a glass body formed in FIG. 1 by adopting **a platinum heater** designed according to FIG. 2.

EX1005, ¶ 0016 (emphasis added). Thus, CN '869 discloses a heating element including platinum, and when combined with El Kahlout, teaches the limitation of claim 14. EX1003, ¶¶ 180-181.

XI. CONCLUSION

Petitioner respectfully requests that a trial be instituted. Claims 1-20 should be cancelled.

Respectfully Submitted,

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. §42.24(d), Petitioner certifies that this Petition includes 11,656 words, as measured by Microsoft Word®, exclusive of the table of contents, mandatory notices under §42.8, certificates of service, word count, and exhibits.

CERTIFICATE OF SERVICE (37 C.F.R. § 42.6(e)(1))

The undersigned hereby certifies that the above document was served on 2025, by filing this document through the Patent Trial and Appeal Board P-TACTS System, as well as delivering a copy via express mail upon the following attorneys of record for the Patent Owner and Petitioner:

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Dated: May 22, 2025

Respectfully submitted,

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APPENDIX A – CLAIM LISTING

U.S. Patent No. 9,512,025

Claim/Claim Element	Limitation(s)
1[p]	An apparatus for making a glass ribbon comprising:
1[a]	a forming wedge including a pair of downwardly inclined forming surface portions converging along a downstream direction to form a root;
1[b]	an edge director intersecting with the pair of downwardly inclined forming surface portions;
1[c]	a plurality of edge rollers positioned downstream from the root and edge director, wherein the plurality of edge rollers are positioned to engage an edge portion of the glass ribbon;
1[d]	a housing enclosing the forming wedge, edge director and the plurality of edge rollers; and
1[e]	a heating cartridge removably positioned in a port of the housing below the edge director,

Claim/Claim Element	Limitation(s)
1[f]	the heating cartridge comprising an enclosure having a heat directing surface that is inclined at an angle of less than about 90° with respect to a bottom surface of the enclosure,
1[g]	the heat directing surface comprising at least one heating element positioned on or adjacent to a face thereof,
1[h]	wherein the heating cartridge is oriented such that the heat directing surface faces the edge director, a view factor from the heat directing surface is greater at the edge director than at the plurality of edge rollers,
1[i]	and a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge are at least partially positioned between the edge director and the plurality of edge rollers to thermally shield the edge director from the plurality of edge rollers.
2	The apparatus of claim 1, wherein the angle of the heat directing surface is from about 45° to about 75° relative to the bottom surface of the enclosure.

Claim/Claim Element	Limitation(s)
3	The apparatus of claim 1, wherein the heat directing surface comprises a plurality of facets oriented to at least partially surround the edge director.
4	The apparatus of claim 3, wherein the plurality of facets comprise a center facet and two side facets on opposite ends of the center facet, wherein a largest angle between each of the two side facets relative to the center facet is from about 145° to about 175°.
5	The apparatus of claim 1, wherein the heat directing surface is a curved surface such that the heat directing surface at least partially surrounds the edge director.
6	The apparatus of claim 1, wherein the at least one heating element comprises a coil having an elongated cross section.
7	The apparatus of claim 6, wherein the at least one heating element is formed from a material selected from the group consisting of molybdenum disilicide, platinum, platinum-rhodium, and iron-chromium-aluminum alloys.

Claim/Claim Element	Limitation(s)
8[p]	A replaceable heating cartridge for use in an apparatus for forming a glass ribbon, the replaceable heating cartridge comprising:
8[a]	an enclosure having a heat directing surface that is inclined at an angle of less than about 90° with respect to a bottom surface of the enclosure,
8[b]	the heat directing surface comprising at least one heating element positioned on or adjacent to a face thereof,
8[c]	refractory material positioned within the enclosure behind the heat directing surface,
8[d]	wherein a view factor from the heat directing surface is greater above the bottom surface of the enclosure than below the bottom surface of the enclosure,
8[e]	and a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge thermally shields an area above the heat directing surface from an area below the heat directing surface.
9	The replaceable heating cartridge of claim 8, wherein the angle of the heat directing surface is from about 45° to about 75° relative to the bottom surface.

Claim/Claim Element	Limitation(s)
10	10. The replaceable heating cartridge of claim 8, wherein the heat directing surface comprises a plurality of facets.
11	11. The replaceable heating cartridge of claim 10, wherein the plurality of facets comprise a center facet and two side facets on opposite ends of the center facet, wherein a largest angle between each of the two side facets relative to the center facet is from about 145° to about 175°.
12	The replaceable heating cartridge of claim 11, further comprising shield member extending from the center facet of the heat directing surface proximate the bottom surface of the enclosure.
13	The replaceable heating cartridge of claim 8, wherein the heat directing surface comprises a curved surface.
14	The replaceable heating cartridge of claim 8, wherein the at least one heating element is formed from a material selected from the group consisting of molybdenum disilicide, platinum, platinum-rhodium, and iron-chromium-aluminum alloys.

Claim/Claim Element	Limitation(s)
15[p]	A method of making a glass ribbon comprising:
15[a]	flowing molten glass over a pair of downwardly inclined forming surface portions of a forming wedge, the pair of downwardly inclined forming surface portions converging along a downstream direction to form a root;
15[b]	flowing the molten glass over an edge director intersecting with at least one of the pair of downwardly inclined forming surface portions;
15[c]	drawing the molten glass from the root of the forming wedge to form the glass ribbon;

Claim/Claim Element	Limitation(s)
15[d]	engaging an edge portion of the glass ribbon with a plurality of edge rollers positioned downstream from the root and edge director, the plurality of edge rollers extending through a housing; and
15[e]	heating the edge director with a replaceable heating cartridge located in a port in the housing,
15[f]	wherein the replaceable heating cartridge is positioned between the plurality of edge rollers and the edge director,

Claim/Claim Element	Limitation(s)
15[g]	the replaceable heating cartridge comprising an enclosure having a heat directing surface that is inclined at an angle of less than about 90° with respect to a bottom surface of the enclosure,
15[h]	the heat directing surface comprising at least one heating element positioned on or adjacent to a face thereof,

Claim/Claim Element	Limitation(s)
15[i]	wherein the replaceable heating cartridge is oriented such that the heat directing surface faces the edge director, a view factor from the heat directing surface is greater at the edge director than at the plurality of edge rollers,
15[j]	and a lower edge of the heat directing surface and the bottom surface of the replaceable heating cartridge are at least partially positioned between the edge director and the plurality of edge rollers to thermally shield the edge director from the plurality of edge rollers.

Claim/Claim Element	Limitation(s)
16	The method of claim 15, wherein the angle of the heat directing surface is from about 45° to about 75° relative to bottom surface.
17	The method of claim 15, wherein the heat directing surface comprises a plurality of facets orientated to at least partially surround the edge director.
18	The method of claim 17, wherein the plurality of facets comprises a center facet and two side facets on opposite ends of the center facet, wherein a largest angle between each of the two side facets relative to the center facet is from about 145° to about 175°.

Claim/Claim Element	Limitation(s)
19	The method of claim 15, wherein the heat directing surface comprises a curved surface such that the heat directing surface at least partially surrounds the edge director.
20	The method of claim 15, wherein the replaceable heating cartridge is replaceable as the glass ribbon is being formed.