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Device for supplying glass melt via a spout lip during production of float glass

The invention relates to a device for supplying glass melt via a spout lip during production of float glass, said glass melt being supplied from a glass melt bath via an adjustable feeding channel to the spout lip and, directed across its surface which is coated with a metal layer, proceeding to the tin surface of a float bath.

It is normal in the production of float glass according to the float glass method that the glass is melted in a glass melt bath, is "refined" in a refining part in a bubble-free manner, is homogenised in a feeding channel between the glass melt bath and the float bath and conditioned (setting of a viscosity necessary for the shaping). The conditioned glass melt flows at the end of the feeding channel over a spout lip onto the liquid tin in the float bath. The shaping of the glass melt into a glass ribbon is effected in the float bath.

The spacing of the lower edge of the spout lip to the surface of the tin and also the surface properties of the spout lip are thereby crucial for the shaping process in the float bath and hence for the quality of the floated glass.

If the surface of the spout lip coming into contact with the glass melt has cracks, holes or corrosion profiles, this leads to surface defects in the floated glass (cross distortion).

If the spacing of the lower edge of the spout lip to the surface of the tin in the float bath is too big due to increasing corrosion of the spout lip, the supply conditions of the glass melt into the float bath change, such as for example the ratio back flow : front flow. Wet back bubbles are then produced.



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In the case of known devices, the spout lip comprises fire-resistant ceramic material. Normally slip-cast and sintered fused silica ceramic or molten-cast Al_2O_3 is used as material for the spout lip. This material is completely adequate for production of soda-lime glass and offers a service life of 2 to 3 years for the spout lip.

During production of high melting point corrosive glasses such as borosilicate glasses (low in alkali and free of alkali) and aluminosilicate glasses, the service life of a spout lip made of this material is however at most only 6 months. Attempts have been made therefore already to increase the service life of the spout lip by using other materials for said spout lip. It has thus already been proposed to use molten-cast material with 85 to 97% by weight ZrO_2 and to use spout lips of this type in the production of borosilicate glasses, in particular low-alkaline borosilicate glasses. The service life of the spout lip was able thus to be increased to approximately 1 year (JP 06-345467 A).

The disadvantage of the materials known to date for a spout lip is the service life which is limited due to corrosion by the glass melt with the known consequences for the glass quality (distortion etc.). In addition, any corrosion of a ceramic material involves bubble formation and the detachment of corrosion products which likewise impair the glass quality.

The materials cited in JP 06-345467 A for a spout lip in fact have a relatively good corrosion resistance but they are sensitive relative to temperature changes. With temperature changes the result is very readily chips in the surface and in extreme cases even cracks with the known quality defects of the float glass. In addition, these materials are extremely expensive.

In the configuration of the spout lip with a metal layer, the protection of the metal layer in particular against the corrosion of reducing forming gases from the float bath must also be taken into account. Furthermore,

it must be ensured in the choice of material for the spout lip that the heat expansion coefficients of the material of the spout lip and of the metal layer are similar.

If normal materials are used for the spout lip, such as fused silica, Al_2O_3 or zirconium, then the spout lip has a significantly lower heat expansion coefficient than the metal layer. In the case of usage temperatures of 1200 to 1400°C, this leads to the formation of folds and to cracks in the metal layer, in extreme cases to failure of the spout lip.

It is the object of the invention to produce a device of the initially mentioned type in which the spout lip has a high temperature resistance up to 1400°C, a high corrosion resistance relative to various glass melts, no undesired interaction with the glass melt, is not sensitive relative to temperature changes and releases no corrosion products into the glass melt.

This object is achieved according to the invention in that at least the surface of the spout lip, which comes into contact with the glass melt, is covered with a noble, refractory, metal layer.

The metal layer made of noble refractory metal offers excellent corrosion resistance for the surface of the spout lip which comes into contact with the glass melt and hence offers a longer service life for the spout lip. In addition introduction of corrosion products into the glass melt is impeded and a more favourable adaptation of the heat expansion coefficients is offered for the choice of material for the spout lip. Thus platinum or a platinum alloy can be chosen for the metal layer and for the spout lip magnesium aluminate spinel and thus a similar thermal expansion behaviour can be achieved. The formation of folds and cracks in the metal layer is therefore easily avoided. The heat expansion coefficients are in the range of 10 to $14 \times 10^{-6}\text{K}^{-1}$.

Alloys with platinum and 10% by weight rhodium and alloys with platinum and 5% by weight gold have proved very suitable as metal layer.

In order to protect the platinum against the reducing atmosphere from the float bath, gaseous nitrogen at a temperature of 800 to 1200°C is fed below the spout lip via a nozzle.

The device is particularly suitable for a float plant for producing substrate glass for a flat panel display according to the float method.

Particularly platinum and its alloys have excellent corrosion resistance relative to borosilicate and aluminosilicate glasses.

A composition with

55-65% by weight	SiO ₂
12-20% by weight	Al ₂ O ₃
≥ 5% by weight	B ₂ O ₃
0-5% by weight	BaO
3-9% by weight	CaO
1-5% by weight	MgO
1-5% by weight	SrO

is particularly suitable for borosilicate glasses and the spout lip constructed according to the invention has a long service life with a surface which is free of folds and cracks, said surface being of decisive importance for improved surface quality of the floated glass ribbon.

The invention is explained in more detail with reference to an embodiment illustrated in the drawing, which shows:

Fig. 1 a float plant for producing float glass in the transition region from the glass melt bath to the float bath which has a spout lip, and

Fig. 2 the transition region with the spout lip in the case of a float plant with only one stopper in detail.

As the skeleton diagram according to Fig. 1 shows, the glass is melted in a glass melt bath 10 and supplied to a feeding channel 11 in which the quantity of refined glass melt 12 is adjustable with a glass quantity adjustment device 14 (front twee) which is assigned to the spout lip 20 at the end of the feeding channel 11.

A blocking device 13 (back twee) is assigned to the feeding channel 11, by means of which blocking device the supply of glass melt 12 to the spout lip 20 can be completely interrupted.

As Fig. 2 shows more clearly, the quantity of glass melt 12.1 supplied via the upper side of the spout lip 20 is metered by adjustment of the glass quantity adjustment device 14 (front twee). The upper side of the spout lip 20 is covered with a metal layer 22. This comprises in the present case platinum or a platinum alloy. It is secured by means of platinum or platinum alloy pins in the side blocks laterally delimiting the spout lip 20. The attachment points can be placed thereby such that they do not come in contact with the glass melt 12.1 flowing over the lined spout lip 20. It may be mentioned expressly at this point that, in the scope of the invention, the metal layer 22 can either comprise as above a separate component or that this metal layer is configured in one part with the spout lip 20. It is conceivable that the metal layer 22 is vapour-deposited onto the spout lip 20 or is coated in another manner.

The glass melt 12.1 proceeds into the float bath which is indicated with the initial wall 15 and the base elements 17 and receives liquid tin 18. The inflowing glass melt 12.1 forms a glass ribbon 12.1 above the liquid tin 18, which glass ribbon is drawn out via extraction rollers from the float bath.

The lower edge of the spout lip 20 must assume the correct spacing to the surface of the liquid tin 18 in the float bath. The spout lip 20 can thereby be disposed on the initial wall 15 of the float bath. A nozzle 21, via which gaseous nitrogen at a temperature of 800 to 1200°C can be supplied to the transition between the spout lip 20 and the float bath, is disposed underneath the spout lip 20. Consequently, the parts of the platinum coating not covered by the glass melt are protected from the reducing float bath atmosphere.

The transition region between the spout lip 20 and the float bath is covered towards the feeding channel 11 by means of a front cover 19. The liquid tin 18 forms a liquid carrier for the floated glass ribbon 12.2 in the float bath which is made of the initial wall 15 and the base elements 17, said glass ribbon being separated from the initial wall 15 of the float bath by a tile 16.

The spout lip 20 comprises magnesium aluminate spinel which like the metal layer made of platinum and 10% by weight rhodium or made of platinum and 5% by weight gold has a similar heat exchange coefficient of $10\text{--}14 \cdot 10^{-6} \text{K}^{-1}$. These adapted heat exchange coefficients ensure that, at temperatures of 1200 to 1400°C, the metal layer has no formation of folds or cracks and thus forms an excellent surface for improved surface quality of the floated glass ribbon 12.2. On the underside of the spout lip 20, gaseous nitrogen at a temperature of 800 to 1200°C is fed via a nozzle 21 in order to protect the platinum from the reducing atmosphere from the float bath.

The lower side of the metal layer can also bear a gas-impermeable diffusion barrier layer in order to protect the metal layer from tin vapours escaping from the float bath and from the reducing forming gas.

The device according to the invention is particularly suitable for producing glass substrates for flat panel display according to the float method. The borosilicate glass used for this has preferably the following composition:

55-65% by weight	SiO_2
12-20% by weight	Al_2O_3
$\geq 5\%$ by weight	B_2O_3
0-5% by weight	BaO
3-9% by weight	CaO
1-5% by weight	MgO
1-5% by weight	SrO .

Claims

1. Device for supplying glass melt via a spout lip during production of float glass,
characterised in that
at least the surface of the spout lip (20), which comes into contact with the glass melt (12.1), is covered with a noble, refractory, metal layer (22).
2. Device according to claim 1,
characterised in that
the underside of the metal layer (22), which does not come into contact with the glass melt (12.1), is provided with a gas-impermeable diffusion barrier layer.
3. Device according to claim 1 or 2,
characterised in that
the metal layer (22) comprises platinum or a platinum alloy.
4. Device according to one of the claims 1 to 3,
characterised in that
the spout lip (20) comprises a material with a heat expansion coefficient (HEC) of 10 to $14 \times 10^{-6} \text{K}^{-1}$.
5. Device according to claim 4,
characterised in that
the spout lip (20) comprises magnesium aluminate spinel which has a thermal expansion behaviour which is adapted to the thermal expansion behaviour of the metal layer (22) made of platinum and its alloys.
6. Device according to one of the claims 3 to 5,
characterised in that

the metal layer (22) comprises an alloy with platinum and 10% by weight rhodium or with platinum and 5% by weight gold.

7. Device according to one of the claims 1 to 6,
characterised in that
nitrogen can be introduced preferably at a temperature of 800 to 1200°C via a nozzle (21) underneath the spout lip (20).
8. Device according to one of the claims 1 to 7,
characterised in that
it is used in the production of substrate glass for flat panel display according to the float method.
9. Device according to claim 8,
characterised in that
it concerns borosilicate glass with the following composition:

55-65% by weight	SiO ₂
12-20% by weight	Al ₂ O ₃
≥ 5% by weight	B ₂ O ₃
0-5% by weight	BaO
3-9% by weight	CaO
1-5% by weight	MgO
1-5% by weight	SrO.