

Description

Glass that is used for glazing vision openings such as windows in buildings and automobiles has high standards for optical uniformity. This type of glass, generally characterized as "flat glass" even though the product may be somewhat curved, is required to transmit images free from distortion that would be displeasing to the human eye. Therefore, it is desired to provide flat glass with a high degree of compositional uniformity so as to avoid any localized differences in the index of refraction that would cause distortion in a transmitted image. The standards for flat glass are considerably higher than for other types of glass, such as pressed and blown ware (e.g., bottles) or fibers, for which the transmitted image quality is not a major consideration in their normal applications.

It is known that a major cause of compositional inhomogeneity in glass is contamination of the molten glass by the refractories that contact the glass during the melting process. The slow but constant erosion of the ceramic refractory materials by the molten glass creates streaks of differing composition within the molten glass. In order to minimize the amount of these inhomogeneities in the product glass stream withdrawn from a melting furnace, a flat glass making operation usually provides a large volume of molten glass within the melting furnace and withdraws the product stream from a surface portion that has had little or no refractory contact immediately before withdrawal, and the bulk of the glass is recirculated to disperse the refractory contamination. This technique has only limited success, and is costly due to the large size of melting vessels required and the energy required to maintain the recirculating mass of molten glass. It would be desirable to reduce these costs and to improve the homogeneity of flat glass.

Stirring has long been employed to improve homogeneity in glass melting operations. In making bottle glass or the like, it is common to stir the molten glass in a forehearth immediately prior to forming the glassware, but stirring at a similar stage in a flat glass making operation has been found in the past to worsen rather than improve the distortion quality of the product glass. This difference is due not only to greater tolerance of distortion in bottle glass or the like, but is also due to the fact that flat glass is generally formed at lower temperatures than bottle glass, and stirring is apparently ineffective at these lower temperatures: Flat glass is sometimes stirred, such as shown in U.S. Patent No. US-A-1, 872,664. An improved apparatus is disclosed, including a melting tank, an agitating compartment and a refining chamber.

Stirring is also disclosed in U.S. Patent Nos. US-A-4, 046,546 and 4,047,918, but the stirring is generally in hotter regions of the melting furnace considerably upstream from the region where forming of the flat product is initiated. Therefore, in such cases, a substantial distance between the stirring and the flat forming region must be provided for molten glass to cool to the forming temperature, and as a result, refractory contact occurs subsequent to the stirring operation. It would be desirable to stir flat glass immediately prior to forming, so as to improve homogeneity of the glass without otherwise worsening the distortion quality of the glass.

The ability to stir container glass immediately prior to forming affords the opportunity to add coloring agents to the glass at that point. This is advantageous in that it enables the glass color to be changed quickly and inexpensively because only a small volume of residual glass is involved during the color change. Because of the difficulties with stirring flat glass at a downstream location, as described above, that method of changing the glass color has not generally been available to flat glass manufacturers. Instead, the coloring agents for flat glass are usually fed to the melting furnace mixed with the other raw ingredients. As a result, all of the molten glass contained in the melting furnace has a given color, and changing the color requires substantially the entire contents to be flushed from the furnace. This method of changing colors is time-consuming and costly, and it would be desirable to provide a more effective way of changing colors in a flat glass melting operation.

It is the object of the invention to provide a method and an apparatus to produce glass which is substantially free from optical distortions.

This object is attained by a method of making glass by melting, stirring in a stirring chamber, homogenizing and forming glass, characterized by feeding a stream of molten glass onto a molten metal support, stirring the molten glass while supported on the molten metal, so as to substantially homogenize the glass and thereafter passing the homogenized glass to a forming operation.

The invention also includes an apparatus for processing glass comprising a melting furnace, means for feeding molten glass from the melting furnace into a stirring chamber comprising means for stirring the molten glass and which is adapted to pass the homogenized glass to a forming operation, characterized in that the stirring chamber contains a pool of molten metal on which the glass is supported during stirring.

The invention is preferably used in a float glass process to form the glass into a high optical quality flat glass product.

Inhomogeneities present in the molten glass, such as those due to contact with refractory surfaces, are thus alleviated by the stirring at a location where there is little or no opportunity for subsequent introduction of additional inhomogeneities before the glass is formed into a sheet. The optical quality of flat glass is improved by stirring the molten glass before its temperature has fallen to its forming temperature from the refining temperature. For a typical soda-lime-silica flat glass composition, it has been found desirable to perform the stirring while the glass temperature is at least 1200° C (2200° F). Because this temperature occurs significantly upstream from the location where forming begins in a typical commercial flat glass operation, measures are required to avoid reintroducing distortion-producing contamination between the stirring location and the beginning of the forming operation. These measures include two options: beginning the forming operation at exceptionally high temperatures, or preventing contaminating refractory contact while the glass cools to a more conventional forming temperature.

Initiating the forming of the glass into a flat glass sheet at or near the temperatures employed for stirring the glass in the present invention is problematic with a conventional float forming process because the viscosity of the glass at such temperatures is too low for effective use of mechanical attenuating means. The relatively high temperatures involved would also negatively affect the erosion rate of the delivery structures employed with conventional float forming operations, to which the molten glass is usually introduced at temperatures below about 1100° C (2000° F). But it has now been found that homogenization without degrading the product quality below flat glass standards can be achieved if the molten glass is stirred at relatively high temperatures and immediately transferred to a forming operation that can accommodate glass at such temperatures. An example of a suitable flat glass forming process is that disclosed in U.S. -A-4,395,272 (Kunkle et al.), wherein a pressurized chamber is employed to attenuate the glass to the desired thickness. Because such a forming process can accommodate glass at or slightly below the stirring temperature, forming of the glass into a flat ribbon can be initiated a short distance downstream from the stirring operation, thus obviating the need for an intermediate passageway of significant length in which the uniformity of the glass might become degraded. In the preferred embodiments of the present invention, the molten metal support used for forming the flat glass may begin upstream from the forming chamber, most preferably extending through the stirring zone, where the glass is anyhow supported on a pool of molten metal, into the forming chamber, thereby eliminating a major refractory contact area. Such an arrangement also advantageously permits the elimination of a lip or threshold at the point of entry into the forming chamber, thereby eliminating an element that is subjected to a relatively high rate of wear in a conventional float forming operation.

In preferred embodiments contaminating refractory contact with the glass downstream from the stirring zone as it is cooling to an appropriate forming temperature while advancing toward the forming chamber is avoided. Thus, the channel between the stirring zone and the forming chamber may be lined with a noncontaminating material such as platinum, molybdenum, or fused quartz. Alternatively, the bottom of the channel may be provided with a layer of molten metal such as tin, which may be separate from or an extension of the molten metal in the forming chamber. The protective layer is of course also provided within the stirring zone by which friction of the vessel on the molten glass is reduced. This results in a faster average throughput speed through the stirring zone and enables product changes or color changes to be effected more rapidly.

The present invention is in principle independent of the particular flat glass forming technique employed, but it can be employed with particular advantage in connection with the float forming process, wherein a continuous ribbon of flat glass is formed by casting molten glass onto the surface of a pool of molten metal. Other examples of flat glass forming methods include the well known sheet drawing and plate rolling processes.

The molten glass being fed to the stirring chamber of the present invention may be melted and refined by any technique suitable for producing flat glass, but because the stirring and preferably the forming operations are initiated at exceptionally high temperatures, the temperature conditioning section of the melting furnace may be shorter than usual. It is an advantage that in the present invention the stirring is applied to the forwardly flowing stream of glass being delivered to the forming chamber rather than to a recirculating mass of glass. For this reason, it is preferred to provide means to prevent return flow of glass from the stirring zone toward the melter. In this regard, a most advantageous arrangement whereby return flow of glass is precluded is to provide a vertical pouring of molten glass into the stirring zone. A vertical entry into the stirring zone avoids the materials problem inherent in providing a barrier to prevent return flow that would be entailed in a horizontally entering mode. Additionally, vertical entry is compatible with unit refining techniques, such as that disclosed in U.S. -A- 4,600,426 (Schwenninger). In that arrangement, glass progresses downwardly through a vertically elongated refining vessel and drains from a bottom portion. Such an arrangement can advantageously drain refined glass directly into the stirring chamber of the

present invention.

The stirring arrangement of the present invention can not only improve the optical quality of flat glass, but can also be employed to homogenize colorants or other additives to the glass after the glass has been refined. As a result, the glass color or composition can be changed rapidly and inexpensively because of the small volume of residual glass affected during a product change.

The invention relates to stirring on a molten metal support and has advantages that are not tied to production of higher quality glass products such as flat glass. The low frictional resistance to the flow of glass and the resulting ease of product changes would be advantageous as well to the manufacture of other types of glasses such as containerware and tableware.

Addition details of these and other advantages of the present invention will become apparent from the drawings and detailed description which follows.

The Drawings

Figure 1 is a longitudinal, cross-sectional view of a preferred embodiment of the present invention wherein a pool of molten metal provides a support surface for the molten glass extending continuously through the stirring chamber and into a high temperature flat glass forming chamber.

Figure 2 is a longitudinal, cross-sectional view showing a variation of the Figure 1 arrangement, wherein the molten metal support in the stirring chamber is separated from that in the forming chamber by a threshold member.

Figure 3 is a longitudinal, cross-sectional view of an embodiment of the present invention that includes a molten metal support surface in the stirring chamber and the forming chamber, and provides a cooling zone therebetween for the molten glass temperature to be reduced to a conventional flat glass forming temperature.

Figure 4 is a longitudinal, cross-sectional view of an alternative arrangement for feeding refined molten glass to the stirring chamber of the present invention, wherein a conventional tank type melting and refining furnace may supply molten glass to the stirring chamber by way of vertical pouring.

Figure 5 is a longitudinal, cross-sectional view of another alternative molten glass feeding arrangement similar to Figure 6, but with a bottom drain opening controlled by a plunger.

Figure 6 is a longitudinal, cross-sectional view of another arrangement for feeding molten glass to the stirring chamber of the present invention, wherein refined molten glass is fed horizontally to the stirring chamber over a threshold member.

Detailed Description

In Figure 1 there is shown an embodiment of the present invention that includes a stirring chamber 10 holding a volume of refined molten glass 11 that is continuously flowing into the chamber from a melting and refining furnace of any suitable type known in the art. As shown, the preferred arrangement provides for the incoming stream of glass to flow vertical into the stirring chamber 10 so as to preclude return flow. In the particular example depicted, the vertical flow is from a bottom drain of a refining vessel 12 or other upstream container. The flow from the vessel 12 in the arrangement shown may be regulated by means of a valve member 13 which may be of the type disclosed in U.S. -A- 4,804,121 (Schwenninger). A useful concept shown in the figure, which is not part of the present invention, is the provision of a rod 14 extending downwardly from the valve member 13, which assures a regular streamlined path for the vertically flowing glass so as to avoid entrapment of air into the glass as it enters the body of glass 11 contained within the stirring chamber.

As in all embodiments of the present invention, the glass is preferably above 1200° C (2000° F) during stirring. Therefore, the stream of glass 15 entering the stirring chamber is at least that temperature. Preferably, no significant amount of heating is employed in the stirring chamber, and therefore, the incoming stream of glass 15 would typically have a temperature somewhat greater than the minimum stirring temperature, with the glass cooling slightly as it passes from the refiner 12 to the forming chamber 16. There is no essential upper limit on the temperature of the glass entering the stirring chamber, but as a practical matter, it is most likely that the glass would be somewhat below the peak refining temperature imparted to the glass in the upstream refining process, which would typically be no greater than about 1500° C (2800° F). As a further practical matter, permitting the glass to cool substantially before entering the stirring chamber, for example to about 1300° C (2400° F) or less, might be preferred in some cases to

extend the life of elements such as stirrers that come into contact with the molten glass.

The present invention is not limited to any particular structure of stirrer, any of the various mechanical devices that have been proposed for stirring molten glass in the prior art being usable. Some arrangements may be more effective than others in homogenizing the glass, but the number of stirrers and their speed or rotation can be selected to compensate for variations in efficiency. The particular stirrer structure shown in each of the drawings here is a preferred example in that it provides a strong mixing action and is a type that is readily available commercially. Another embodiment that may be suitable is that disclosed in U.S. -A- 4,493,557 (Nayak et al.). Each of the stirrers 20 as depicted in Figure 1 is comprised of a helical stirring portion at the bottom of a shaft, both of which may be cast from a ceramic refractory material. In order to avoid drawing air into the melt, it is preferred to rotate the helical stirrers in such a direction that they draw the molten glass upwardly toward the surface. This also serves to prevent additives that may be deposited onto the surface of the melt in the stirring chamber from being swept prematurely, and in concentrated streaks, into the zone of active stirring. Drive means, (not shown), for rotating the stirrers may be of any suitable type employed in the art for this purpose, and the stirrers may be driven separately or in groups. For the sake of convenience, the stirrers in a transverse row, for example, may be rotated in the same direction, and to enhance shearing forces imparted to the glass it is preferred to rotate the adjacent transverse row in the opposite direction as shown in the drawings. It should be understood, however, that any pattern of rotation could be employed for the present invention as long as adequate homogenization is achieved. In order to achieve good homogeneity, it is considered desirable to stir substantially the entire transverse cross-sectional area of the molten glass in the stirring chamber, and the number and size of stirrers may be selected accordingly. Thus, in the embodiment shown in Figure 1, the helical portion of each stirrer corresponds to virtually the depth of the molten glass, and an array of closely spaced stirrers is provided that actively affects substantially the full width of molten material in the stirring chamber. The degree of homogenization is also influenced by the amount of agitation experienced by each increment of the melt and by the throughput rate of the melt. Thus, a plurality of rows of a plurality of stirrers is preferred so that each increment of glass is repeatedly subjected to mixing forces as it passes along the length of the stirring chamber. The number of rows of stirrers will depend upon the degree of homogenization desired, and the throughput rate of glass. As a general guideline, one stirrer may be provided for each 10 tons per day of glass produced for average quality flat glass. Obviously, for some applications lower quality requirements may permit the use of fewer stirrers. On the other hand, the use of a larger number of stirrers will usually produce improved results. Implying a larger number of stirrers than required has no significant drawback other than the cost of the stirrers.

The walls of the stirring chamber 10 in the Figure 1 embodiment may be made of fusion cast ceramic refractory material, contact with which can contaminate the molten glass to an extent that perceptible optical distortion can be produced in the flat glass product. Accordingly, in this embodiment the molten glass is delivered to a forming chamber 16 immediately after being stirred so as to minimize the area of refractory contacted by the glass after being stirred. In Figure 1, a vertically adjustable wheel 21 regulates the flow of molten glass from the stirring chamber onto a pool of molten metal 23, which is usually comprised chiefly of molten tin. The glass forms a ribbon 24, which is reduced in thickness and cools as it is drawn along molten metal pool until it cools to a temperature sufficient to be withdrawn from the molten metal without marring the surface of the glass ribbon. Because the molten glass is stirred at relatively high temperatures, and is immediately thereafter delivered to the forming chamber, the glass enters the forming chamber at a temperature higher than is conventional for a float type forming process. The temperature of the glass may fall somewhat from the stirring temperature, which is above 1200° C (2200° F), but will typically enter the forming chamber before the glass has cooled to a conventional float process delivery temperature of 1040° C to 1090° C (1900° F to 2000° F). Typically the glass entering the forming chamber in the Figure 1 embodiment of the present invention, will be at a temperature of at least about 1150° C (2100° F), at which temperature the viscosity of the glass does not lend itself to engagement by mechanical means for attenuating the glass ribbon to the desired thickness in the forming chamber. Therefore, a forming process that employs elevated pressure within the forming chamber, preferably the process disclosed in U.S. -A- 4,395,272 (Kunkle et al.), lends itself to use with those embodiments of the present invention in which the stirred glass is delivered at relatively high temperature to the forming chamber. Although not as advantageous, other pressurized glass forming processes may be used, such as those disclosed in U.S. -A- 3,241,937 (Michalik et al.), or U.S. -A- 3,432,283 (Galey).

A threshold may be present, which is preferably made of a noncontaminating material such as fused quartz, and its length in the transverse direction across the direction of flow of glass may be substantially the full width of the ribbon being formed in accordance with the teachings of U.S. -A- 3,843,346 (Edge et al.). Additional details of the structure of a threshold suitable for use in such a process may be found in U.S.

-A- 4,062,666 (Tilton).

For adding coloring agents or other additives to the molten glass in the stirring chamber, a screw feeder 29 may be provided, which may, for example, extend horizontally from the side wall near the location at which the stream of glass 15 enters the stirring chamber. Coloring agents are readily available commercially and are usually in the form of concentrates, which may include a coloring compound such as a metal oxide mixed with a fluxing powder and bound with sodium silicate or some other binder. Additives for purposes other than changing the color may be introduced into the molten glass at the stirring chamber. Thus, a different glass composition could be produced without having to change the composition in the melting and refining stages.

The embodiment of Figure 1 without a threshold member separates the stirring chamber from the forming chamber, and the molten metal 30 extends throughout the stirring chamber 10 as well as forming chamber 16. This arrangement is preferred because refractory contact with the stirring chamber bottom and with the threshold is eliminated, thereby providing additional assurance that inhomogeneities are not reintroduced into the stirred glass. Furthermore, eliminating the threshold eliminates an element that is subject to maintenance and occasional replacement, particularly at high temperatures such as are involved in the preferred embodiments here. It should be understood that the molten metal layer 30 need not extend throughout the entire stirring chamber in order to achieve the advantages of avoiding refractory contact, but that only portions of the stirring chamber may be covered, in particular the portion downstream from the stirrers 20.

Apart from providing a noncontaminating surface for the major area contacted by the molten glass, the use of molten metal as the support surface in the stirring chamber has other advantages. It has been found that the molten metal surface provides very little frictional drag on the molten glass moving thereover. As a result, the glass moves downstream through the stirring chamber relatively uniformly throughout its cross-section, so that any change in color or composition can be carried out relatively quickly with little waste glass during the transition.

Figure 2 shows a slight variation of the Figure 1 embodiment, wherein a refractory threshold 31 separates the molten metal support into a stirring chamber portion 32 and a forming chamber portion 33. Although in most cases it would be desired to avoid a threshold member, the arrangement shown in Figure 2 may be useful in situations where it is desired to isolate the molten metal in the stirring chamber from the molten metal in the forming chamber so as to provide different conditions in the two zones. The life of the threshold 31 may be extended by providing cooling conduits 34 therein.

Delivering stirred glass to a forming chamber at elevated temperatures is considered to be an advantageous feature of the preferred embodiments of the present invention, but some of the advantages of the invention can be obtained when the glass is delivered to a forming chamber at more conventional forming temperatures if undue contamination from refractory contact can be avoided after stirring while the glass is cooling to a conventional forming temperature. An example of such an arrangement is shown in Figure 3, where a cooling zone 40 is provided between the stirring zone 10 and the forming chamber 16. Bottom refractory contact is avoided by providing a molten metal layer 41 (e.g., molten tin), which may extend continuously from the stirring chamber through the cooling zone and into the forming chamber as shown in Figure 3. The continuous molten metal layer 41 is advantageous for the sake of avoiding threshold members, but it should be understood that two or more separate molten metal zones could be maintained by providing a separating member such as a threshold.

Because maintaining flat glass optical quality standards entails stirring the glass at relatively high temperatures in accordance with the present invention, the function of the cooling zone 40 in the Figure 3 embodiment is to permit the glass temperature to fall from the stirring temperature to a forming temperature. As previously mentioned, for a typical soda-lime-silica flat glass composition the stirring temperature is preferably above 1200°C (2200°F) and the forming temperature is typically below 1100°C (2000°F). Therefore, the length of the cooling zone is selected so as to provide sufficient residence time for the glass temperature to fall the requisite amount. Unaided cooling through the refractory walls of the cooling zone may be sufficient, but in some cases it may be desired to shorten the length of the cooling zone by providing cooling means, such as the cooling pipes 42 depicted in Figure 3, in the space above the molten glass in the cooling zone 40. Alternatively, forced air currents may be employed to cool the glass to the forming temperature. In this example, the process for forming the molten glass into a flat ribbon need not involve elevated pressure, but can be any conventional flat glass forming technique such as a conventional float forming technique employing mechanical attenuating means that grip marginal edge portions of the ribbon. Entry to the forming chamber 16 in Figure 3, may advantageously involve merely a tweel 21 that regulates glass flow over the molten metal support surface 41.

The arrangement for vertically feeding molten glass to the stirring chamber described in connection

with Figure 1 may be applied to each of the embodiments described herein, and in Figures 4, 5, and 6 there are shown examples of alternative arrangements for feeding glass to the stirring chamber which could be used in association with any of the disclosed embodiments. In Figure 4, the molten glass feeding arrangement retains the preferred characteristic of passing the molten glass stream 50 vertically into the stirring chamber 10. Unlike Figure 1, however, the vertical stream is not exiting from a bottom drain of a refining vessel, but rather is passing from an exit 51 at an end of more conventional horizontally configured tank type refining vessel 52. A gate valve 53 may regulate the flow of molten glass from the refining vessel 52.

Figure 5 depicts a similar vertical transfer of molten glass from a conventional refining vessel 55 to a stirring chamber 10. In the embodiment glass flow is regulated by means of a plunger 56 coacting with a drain tube 57 extending through the bottom of the vessel 55. The drain tube may be fabricated of a refractory metal such as platinum.

An example of an arrangement that provides horizontal entry of molten glass into the stirring chamber 10 is shown in Figure 6. In this arrangement the stirring chamber 10 is horizontally aligned with an end of a conventional tank type refining vessel 60, with a submerged partition 61 separating the chambers and retarding return flow of molten glass out of the stirring chamber. The integrity of the partition 61 may be reinforced by cooling conduits 62. The Figure 6 embodiment is, otherwise, the same as that shown in Figure 1.

Soda-lime-silica glass as referred to herein may generally be characterized by the following compositional ranges:

		<u>Weight %</u>
25	SiO_2	70-74
	Na_2O	12-16
	CaO	8-12
30	MgO	0- 5
	Al_2O_3	0- 3
35	K_2O	0- 3
	BaO	0- 1
40	Fe_2O_3	0- 1

Small amounts of colorants, refining aids, or impurities may also be present. Most float glass falls within the following ranges:

		<u>Weight %</u>
45	SiO_2	72-74
	Na_2O	12-14
50	CaO	8-10
	MgO	3- 5

55

	Al_2O_3	0- 2
	K_2O	0- 1
5	Fe_2O_3	0- 1

10 The operating temperatures disclosed for the present invention relate to the float glass composition set forth above. For other compositions the appropriate temperatures for stirring and forming will vary in accordance with the temperature/viscosity relationship of the particular glass composition. In order to extrapolate the temperatures disclosed herein to other glass compositions, the relationship between temperature and viscosity of a specific example of soda-lime-silica float glass is set forth below:

15	$\text{Pa}\cdot\text{s}$ <u>Viscosity (poise)</u>	<u>Temperature</u>
	10 (100)	(2630°F) 1443°C ↓
20	100 (1,000)	(2164°F) 1184°C ↓
	1000 (10,000)	(1876°F) 1024°C ↓
25	10000 (10,000)	(1663°F) 906°C ↓

30 Claims

1. A method of making glass by melting, stirring in a stirring chamber (10), homogenizing and forming glass,
characterized by
35 feeding a stream of molten glass onto a molten metal support, stirring the molten glass, while supported on the molten metal, so as to substantially homogenize the glass and thereafter passing the homogenized glass to a forming operation.
2. The method of claim 1,
40 characterized by forming the glass in the forming operation into a flat sheet of glass.
3. The method of claims 1 and 2,
characterized in that
45 the glass is supported by a layer of molten metal during the forming operation.
4. The method of claims 1 to 3,
characterized in that
50 the glass is stirred at a temperature greater than 1200°C and the forming operation is initiated while the glass temperature is at least 1150°C.
5. The method of claims 1 to 4,
characterized in that
55 the glass during the forming operation is subjected to pressure above atmospheric so as to reduce its thickness.
6. The method of claims 1 to 5,
characterized in that



	Al_2O_3	0- 2
	K_2O	0- 1
5	Fe_2O_3	0- 1

10 The operating temperatures disclosed for the present invention relate to the float glass composition set forth above. For other compositions the appropriate temperatures for stirring and forming will vary in accordance with the temperature/viscosity relationship of the particular glass composition. In order to extrapolate the temperatures disclosed herein to other glass compositions, the relationship between temperature and viscosity of a specific example of soda-lime-silica float glass is set forth below:

15	$\text{Pa}\cdot\text{s}$ <u>Viscosity (poise)</u>	<u>Temperature</u>
	10 (100)	(2630°F) 1443°C ↓
20	100 (1,000)	(2164°F) 1184°C ↓
	1000 (10,000)	(1876°F) 1024°C ↓
25	10000 (100,000)	(1663°F) 906°C ↓

30 Claims

1. A method of making glass by melting, stirring in a stirring chamber (10), homogenizing and forming glass,
characterized by
35 feeding a stream of molten glass onto a molten metal support, stirring the molten glass, while supported on the molten metal, so as to substantially homogenize the glass and thereafter passing the homogenized glass to a forming operation.
2. The method of claim 1,
40 characterized by forming the glass in the forming operation into a flat sheet of glass.
3. The method of claims 1 and 2,
characterized in that
45 the glass is supported by a layer of molten metal during the forming operation.
4. The method of claims 1 to 3,
characterized in that
50 the glass is stirred at a temperature greater than 1200°C and the forming operation is initiated while the glass temperature is at least 1150°C.
5. The method of claims 1 to 4,
characterized in that
55 the glass during the forming operation is subjected to pressure above atmospheric so as to reduce its thickness.
6. The method of claims 1 to 5,
characterized in that



the glass is continuously supported on molten metal from the initiation of stirring until the glass has been formed into a flat glass ribbon.

- 5 7. The method of claims 1 to 6,
characterized in that
the molten metal comprises tin.
- 10 8. The method of claims 1 to 7,
characterized in that
immediately prior to stirring a substance is added to the molten glass to modify the characteristics of the glass.
- 15 9. The method of claims 1 to 8,
characterized in that
the substance added to the glass is a coloring additive.
- 20 10. The method of claims 1 to 9,
characterized in that
the glass is a soda-lime-silica composition.
- 25 11. Apparatus for processing glass comprising a melting furnace, means for feeding molten glass from the melting furnace into a stirring chamber (10) comprising means (20) for stirring the molten glass and which is adapted to pass the homogenized glass to a forming operation,
characterized in
that the stirring chamber (10) contains a pool of molten metal (30), on which the glass is supported during stirring.
- 30 12. The apparatus of claim 11,
characterized in that
the molten metal pool communicates with an adjacent chamber adapted to form molten glass into a flat ribbon.
- 35 13. The apparatus of claims 10 and 11,
characterized in that
it includes a vertically adjustable barrier (21) between the stirring vessel and the forming chamber adapted to regulate flow of molten glass from the stirring vessel to the forming chamber.
- 40 14. The apparatus of claims 11 to 13,
characterized in that
the means for stirring includes a plurality of the stirrers in each of a plurality of rows.
- 45 15. The apparatus of claims 11 to 14,
characterized in that
the stirrers have a helical blade configuration.
- 50 16. The apparatus of claims 11 to 15,
characterized in that
it includes a means (29) for feeding additive materials to the molten glass in the stirring vessel.
- 55 17. The apparatus of claims 11 to 16,
characterized in that
it includes forming chamber for receiving molten glass from the stirring vessel and adapted to contain a pool of molten metal (32), the molten metal in the stirring vessel being separated from the molten metal (33) in the forming chamber by threshold member (31).
18. The apparatus of claims 11 to 17,
characterized in that
the stirring vessel includes means (42) for cooling the glass.



19. The apparatus of claims 11 to 18,
characterized in that
a flow pass for molten glass from the stirring chamber into the forming chamber is provided that is substantially horizontal.

5

Revendications

- 10 1. Procédé de fabrication de verre par fusion, brassage dans une chambre de brassage (10), homogénéisation et formage du verre,
caractérisé en ce que
on amène un courant de verre fondu sur un support constitué d'un métal fondu, on brasse le verre fondu, cependant que le métal fondu le supporte, de manière à sensiblement homogénéiser le verre et on envoie ensuite le verre homogénéisé à une opération de formage.
- 15 2. Procédé suivant la revendication 1,
caractérisé en ce que
on forme le verre en une feuille de verre plate au cours de l'opération de formage.
- 20 3. Procédé suivant les revendications 1 et 2,
caractérisé en ce que
une couche de métal fondu supporte le verre au cours de l'opération de formage.
- 25 4. Procédé suivant les revendications 1 à 3,
caractérisé en ce que
on brasse le verre à une température supérieure à 1200° C et on amorce l'opération de formage cependant que le verre se trouve à une température d'au moins 1150° C.
- 30 5. Procédé suivant les revendications 1 à 4,
caractérisé en ce que
on soumet le verre à une pression supérieure à la pression atmosphérique au cours de l'opération de formage, de manière à réduire son épaisseur.
- 35 6. Procédé suivant les revendications 1 à 5,
caractérisé en ce que
le métal fondu supporte le verre en continu depuis l'amorce du brassage jusqu'à ce que le verre ait été façonné en un ruban de verre plat.
- 40 7. Procédé suivant les revendications 1 à 6,
caractérisé en ce que
le métal fondu est constitué d'étain.
- 45 8. Procédé suivant les revendications 1 à 7,
caractérisé en ce que
on ajoute une substance au verre fondu, immédiatement avant le brassage, afin de modifier les caractéristiques du verre.
- 50 9. Procédé suivant les revendications 1 à 8,
caractérisé en ce que
la substance que l'on ajoute au verre est un additif colorant.
- 55 10. Procédé suivant les revendications 1 à 9,
caractérisé en ce que
le verre est de composition sodo-silico-calciue.
11. Appareil pour traiter du verre, comprenant un four de fusion, un dispositif pour amener du verre fondu depuis le four de fusion jusque dans une chambre de brassage (10) qui comprend un dispositif (20) pour brasser le verre fondu et qui convient pour envoyer le verre homogénéisé à une opération de



formage ,
caractérisé en ce que
la chambre de brassage (10) contient un bain ou bassin de métal fondu (30) qui supporte le verre au
cours du brassage.

5

12. Appareil suivant la revendication 11,
caractérisé en ce que
le bain ou bassin de métal fondu communique avec une chambre voisine qui convient pour façonner le
verre fondu en un ruban plat.

10

13. Appareil suivant les revendications 10 et 11,
caractérisé en ce que
il comprend une barrière (21) verticalement ajustable entre le récipient de brassage et la chambre de
formage, barrière qui est adaptée à la régulation de l'écoulement de verre fondu depuis le récipient de
brassage jusque dans la chambre de formage.

15

14. Appareil suivant les revendications 11 à 13,
caractérisé en ce que
le dispositif de brassage comprend une multiplicité de malaxeurs dans chacune d'une multiplicité de
rangées.

20

15. Appareil suivant les revendications 11 à 14,
caractérisé en ce que
les malaxeurs ont une configuration d'ailette hélicoïdale .

25

16. Appareil suivant les revendications 11 à 15,
caractérisé en ce que
il comprend un dispositif (29) pour amener des additifs au verre fondu dans le récipient de brassage.

30

17. Appareil suivant les revendications 11 à 16,
caractérisé en ce que
il comprend une chambre de formage destinée à recevoir le verre fondu en provenance du récipient de
brassage et adaptée à contenir un bain ou bassin de métal fondu (32), le métal fondu dans le récipient
de brassage étant séparé du métal fondu (33) dans la chambre de formage par un seuil (31).

35

18. Appareil suivant les revendications 11 à 17,
caractérisé en ce que
le récipient de brassage comprend un dispositif (42) pour refroidir le verre.

40

19. Appareil suivant les revendications 11 à 18,
caractérisé en ce que
il comporte un passage d'écoulement pour le verre fondu depuis la chambre de brassage dans la
chambre de formage, qui est sensiblement horizontal.

45

Ansprüche

1. Verfahren zum Herstellen von Glas durch Schmelzen, Rühren in einem Rührgefäß (10), Homogenisie-
ren und Ausformen des Glases,
gekennzeichnet durch
Zuführen eines Stromes geschmolzenen Glases auf einen Träger aus geschmolzenem Metall, Rühren
des geschmolzenen Glases, während es von dem geschmolzenen Metall getragen wird, um das Glas
im wesentlichen zu homogenisieren, und anschließendes Weiterleiten des homogenisierten Glases zu
einer Formgebung.
2. Verfahren nach Anspruch 1,
gekennzeichnet durch
Formen des Glases beim Formgeben zu einer flachen Glasscheibe.

55



3. Verfahren nach Ansprüchen 1 und 2,
dadurch gekennzeichnet,
daß das Glas während des Formgebens von einer Schicht geschmolzenen Metalles getragen wird.
- 5 4. Verfahren nach Ansprüchen 1 bis 3,
dadurch gekennzeichnet,
daß das Glas bei einer Temperatur von mehr als 1200° C gerührt wird und die Formgebung eingeleitet
wird, während die Glastemperatur mindestens 1150° C beträgt.
- 10 5. Verfahren nach Ansprüchen 1 bis 4,
dadurch gekennzeichnet,
daß das Glas während der Formgebung einem Druck über Atmosphärendruck ausgesetzt wird, um
seine Dicke zu verringern.
- 15 6. Verfahren nach Ansprüchen 1 bis 5,
dadurch gekennzeichnet,
daß das Glas kontinuierlich vom geschmolzenen Metall getragen wird, vom Beginn des Rührens, bis
das Glas zu einem Flachglasband geformt wurde.
- 20 7. Verfahren nach Ansprüchen 1 bis 6,
dadurch gekennzeichnet,
daß das geschmolzene Metall Zinn enthält.
- 25 8. Verfahren nach Ansprüchen 1 bis 7,
dadurch gekennzeichnet,
daß unmittelbar vor dem Rühren dem geschmolzenen Glas ein Stoff zugesetzt wird, um die Eigen-
schaften des Glases zu verändern.
- 30 9. Verfahren nach Ansprüchen 1 bis 8,
dadurch gekennzeichnet,
daß der dem Glas zugesetzte Stoff ein färbender Zusatz ist.
- 35 10. Verfahren nach Ansprüchen 1 bis 9,
dadurch gekennzeichnet,
daß das Glas eine Soda-Kalk-Silikatzusammensetzung hat.
- 40 11. Vorrichtung zum Herstellen von Glas, enthaltend einen Schmelzofen, Einrichtungen zum Überführen
geschmolzenen Glases aus dem Schmelzofen in ein Rührgefäß (10), mit Einrichtungen (20) zum
Rühren des geschmolzenen Glases, und das ausgebildet ist, um das homogenisierte Glas einer
Formgebung zuzuführen,
dadurch gekennzeichnet,
daß das Rührgefäß (10) ein Bad aus geschmolzenem Metall (30) aufweist, von dem das Glas während
des Rührens getragen wird.
- 45 12. Vorrichtung nach Anspruch 11,
dadurch gekennzeichnet,
daß das Bad aus geschmolzenem Metall in Verbindung mit einer benachbarten Kammer steht, die zur
Formgebung geschmolzenen Glases zu einem Flachglasband ausgebildet ist.
- 50 13. Vorrichtung nach Ansprüchen 10 und 11,
dadurch gekennzeichnet,
daß sie eine senkrecht einstellbare Sperre (21) zwischen dem Rührgefäß und der Formgebungskammer
aufweist, um den Fluß geschmolzenen Glases vom Rührbehälter zur Formgebungskammer zu regeln.
- 55 14. Vorrichtung nach Ansprüchen 11 bis 13,
dadurch gekennzeichnet,
daß die Einrichtung zum Rühren eine Vielzahl von Rührern, jeweils in einer Vielzahl von Reihen,
aufweist.



15. Vorrichtung nach Ansprüchen 11 bis 14,
dadurch gekennzeichnet,
daß die Rührer ein spiralförmiges Blatt aufweisen.
- 5 16. Vorrichtung nach Ansprüchen 11 bis 15,
dadurch gekennzeichnet,
daß sie Einrichtungen (29) zum Zuführen von Zusatzstoffen zum geschmolzenen Glas im Rührgefäß
aufweist.
- 10 17. Vorrichtung nach Ansprüchen 11 bis 16,
dadurch gekennzeichnet,
daß sie eine Formgebungskammer zur Aufnahme von geschmolzenem Glas aus dem Rührgefäß
aufweist, die ausgebildet ist, um ein Bad aus geschmolzenem Metall (32) aufzunehmen, wobei das
geschmolzene Metall im Rührgefäß vom geschmolzenen Metall (33) in der Formgebungskammer durch
15 ein Schwellenteil (31) getrennt ist.
18. Vorrichtung nach Ansprüchen 11 bis 17,
dadurch gekennzeichnet,
daß das Rührgefäß Einrichtungen (42) zum Kühlen des Glases aufweist.
- 20 19. Vorrichtung nach Ansprüchen 11 bis 18,
dadurch gekennzeichnet,
daß ein im wesentlichen horizontal er Fließübergang des geschmolzenen Glases aus dem Rührbehälter
in die Formgebungskammer ausgebildet ist.

25

30

35

40

45

50

55