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APPARATUS FOR THE MANUFACTURE OF FLAT GLASS ON A MOLTEN METAL BATH

Filed Oct. 11, 1963

Fig. 1

Fig. 2

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This invention relates to the manufacture of flat glass, and in particular to apparatus for use in the manufacture of flat glass during which the glass is advanced in ribbon form along a bath of molten metal.

In apparatus of this kind as described in United States of America Patents Nos. 2,911,759 and 3,083,551 the bath of molten metal, for example tin, or a tin alloy in which tin predominates, is contained in a tank structure having an inlet to and an outlet from the bath for the glass. The metal bath is so constituted as to have all the characteristics fully described in United States of America Patent No. 2,911,759.

It is a main object of the invention to provide an improved apparatus for use in the manufacture of flat glass in ribbon form during which the glass is advanced along a bath of molten metal.

From its broadest aspect apparatus according to the invention for use in the manufacture of flat glass during which the glass is advanced along a bath of molten metal comprises a tank structure containing a bath of molten metal, temperature regulators for maintaining thermal conditions along the bath which ensure that the ribbon of glass is sufficiently stiff to permit it to be taken unharmed through an outlet from the bath, ribbon supporting means at the outlet from the bath so as to take up the ribbon from the bath and discharge the ribbon through the outlet, a roof structure extending over the tank structure to define a headspace over the bath and the ribbon supporting means, and means for maintaining a plenum of protective atmosphere in the headspace.

In a preferred embodiment of the invention said ribbon supporting means includes means for sealing the outlet against ingress of external atmosphere under the ribbon into the headspace.

Preferably the roof structure is extended in the direction of the outlet to form a pit, the ribbon supporting means includes a take-up roll mounted in the pit so as to take up the ribbon from the bath for discharge through said outlet, and the roof structure extends over the extension of the tank structure so that a plenum of protective atmosphere is maintained in the pit. Preferably the take-up roll is a carbon roll.

In another embodiment of the invention the ribbon supporting means includes at least one conveying roll mounted in the extension of the tank structure so as to be spaced from the take-up roll in the direction of advance of the glass, said conveying roll being arranged to be in sealing engagement with the underface of the ribbon after the ribbon leaves the take-up roll, and sealing means mounted on said tank extension and bearing on the conveying roll in sealing engagement with the roll along the length of the roll, whereby the outlet is sealed against the ingress of external atmosphere under the ribbon into the headspace.

Preferably the conveying roll is a steel roll and the sealing means includes a laterally extending carbon blade mounted under the roll so as to contact the roll along its length, and a housing for said blade, which housing is fixed to said tank extension and includes resilient means operable to urge the blade into sealing engagement with the roll.

Preferably the roof structure includes a partition arranged transversely of the roof structure and extending downwardly therefrom to define with said extension of the tank structure a slot-shaped opening through which the ribbon of glass is advanced from the take-up roll to said conveying roll.

Still further according to the invention the roof structure extends over said conveying roll and includes an end wall extending downwardly to define with said extension of the tank structure a slot-shaped outlet through which the ribbon of glass is discharged from said conveying roll.

Since a plenum of protective atmosphere is maintained in the headspace over the bath there will be an outward flow of atmosphere through the slot-shaped openings defined between the extension of the tank structure and the partition and end wall respectively.

In order that the invention may be more clearly understood, some embodiments thereof will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a sectional elevation of apparatus according to the invention showing the outlet end of a tank structure containing a bath of molten metal and a roof structure over the tank structure, and

FIGURE 2 is a view similar to FIGURE 1, showing a modified construction of the outlet end of the tank structure.

In the drawings like references indicate the same or similar parts.

Referring to the drawings, FIGURE 1 shows the outlet end of a tank structure which contains a bath 1 of molten metal, for example molten tin, or a tin alloy in which tin predominates. The tank structure comprises a floor 2, side walls 3 and an end wall 4 at the outlet end of the tank. The side walls 3 and the end wall 4 are integral with each other and with the floor 2. The level of the surface of the bath of molten metal is indicated at 5.

The tank structure supports a roof structure bridging the bath 1 and including a roof 6, side walls 7 and an outlet end wall 8. The roof 6 and side walls 7 provide a tunnel over the bath 1 and define with the end wall 8 and a corresponding end wall at the inlet end of the tank a headspace over the bath.

The headspace is charged with a protective atmosphere maintained at a plenum, the protective atmosphere being a nonoxidising or reducing gas. The protective atmosphere is supplied to the headspace through vertical ducts, not shown, arranged at intervals in the roof 6. The ducts are connected to headers by transversely arranged branches of the headers.

Glass may be delivered to the bath as a formed ribbon of glass and is delivered by casting rolls, not shown, on to the surface 5 of the bath at a controlled rate. The ribbon of glass is advanced through the tunnel defined by the bath 1, the roof 6 and the side walls 7 and in this tunnel temperature regulators, shown as heaters, such as heaters 9, mounted in the roof structure, and heaters 10 immersed in the bath, regulate the temperature of the bath by creating thermal conditions such that the cooled ribbon of glass 11 which is advanced along the bath towards the outlet end, is sufficiently stiff to permit it to be taken unharmed through the outlet 12 from the bath on to lehr rollers 13. By treatment on the bath the glass taken from the bath may have flat parallel faces and a surface brightness at least equal to “fire-finish” quality.

The tank structure is extended in the direction of the outlet to define a pit 14 formed in the end wall 4 of the tank structure so that a part 15 of the end wall 4 acts as a partition between the bath 1 and the pit 14. A take-up
roll 16 is mounted in the pit 14 and, in the embodiment illustrated the roll 16 is exposed above the upper surface of the end wall, lifts the stiffened ribbon of glass 11 from the bath surface 5 and facilitates the removal of the ribbon from the bath by delivering the ribbon through the outlet 12 from the bath. The take-up roll 16 is a carbon roll, along with a graphite roll having end walls and means for introducing protective gas into the interior of the roll so that the gas is forced through the roll wall and forms a gas cushion between the roll and the underside of the ribbon of glass.

Alternative forms of the take-up roll 16 may be used for the take-up roll may comprise a hollow steel core on which are threaded carbon rings. The carbon rings on the steel core provide a carbon surface to the take-up roll, which surface is non-wetting to the molten metal of the bath.

Another alternative form of take-up roll comprises a steel roll with a chromium surface. The chromium surface on the take-up roll is obtained by spraying pure chromium onto the steel roll with a plasma torch to a depth of about 7 thou. The chromium surface on the take-up roll is also non-wetting to the tin which usually constitutes the main constituent of the molten metal bath.

In an alternative the take-up roll may comprise a stainless steel roller which has been heat-treated in air to induce the formation of some oxide on its surface. The presence of oxide on the stainless steel roller inhibits the adhesion on the roll of any oxide from the bath.

The take-up roll 16 is so positioned with respect to the first Lehr roll 13 that the stiff ribbon 11 is horizontally disposed as it is delivered through the outlet 12 from the bath, which outlet is defined between the bottom face of the end wall 8 of the roof structure, and the top face of the tank end wall 4.

In an alternative embodiment illustrated in FIGURE 2, the tank structure is further extended beyond the pit 14 to form a second pit 17 in which a conveying roll 18 is mounted. The pits 14 and 17 are separated by a wall 19, the conveying roll 18 is, as shown in FIGURE 2, spaced from the take-up roll 16, and the conveying roll 18 is arranged to be in sealing engagement with the underside of the ribbon of glass 11 after the ribbon leaves the take-up roll. The conveying roll 18 is a steel roll and the ends of the rolls are sealed in the side walls of the pit 17, and the end of the ribbon of glass 11 by glands of known kind, not shown.

In order to complete the sealing of the outlet from the bath against the ingress of external atmosphere under the ribbon 11 into the headspace, sealing means is mounted in the bottom of the pit 17, and bears on the roll in sealing engagement with the roll along the length of the roll. The sealing means includes a laterally extending carbon blade or brush 21 mounted in a housing 22 fixed to the floor of the pit 17. Resilient means 23 extend between the bottom surface of the carbon blade 21 and the floor of the housing 22 to urge the top surface of the carbon blade 21 into sealing engagement with the surface of the conveying roll 18.

By the action of the carbon blade 21 against the steel roll a carbon coating 20 is given to the roller. This coating 20 substantially prevents any oxide from the bath sticking to the roller, and the blade 21 rubs off any oxide which may adhere during a revolution of the roller. As an alternative to the carbon blade 21 a silicon carbide blade may be used.

The final part 12 of the outlet from the bath is defined between the bottom surface 23 of the end wall 8 of the roof structure and the top surface 24 of that part 25 of the end wall of the tank structure which extends the extension of the tank structure.

The roof structure includes a partition 26 arranged transversely of the roof structure and extending downwardly therefrom to define with the dividing wall 19 a slot-shaped opening 27 through which the cooled ribbon of glass 11 passes from the take-up roll 16 to the conveying roll 18.

The lower edge of the partition 26 is formed with a groove 28 in which is seated a slotted pipe 29. The pipe 29 is connected to the means for supplying the protective atmosphere, and is so located in the groove that the slot is exposed towards the upper face of the ribbon of glass in a manner to cause protective gas to flow outwardly in the direction of the arrow 30 through the slot-shaped opening 27. This assists in maintaining the protective atmosphere at a plenum in the chamber 31 defined between the partition 26 and the end wall 8 and in minimizing gas flow from the chamber 31 into the headspace over the bath. The maintenance of a plenum of protective atmosphere in the chamber 31 ensures that there is an outward flow of protective atmosphere through the channel 12 for the glass to minimise the ingress of ambient atmosphere.

If desired the lower surface of the partition 26, the upper surface of the wall 19, the lower surface of the wall 8, and the upper surface of the wall part 25 may be constructed in the manner described and claimed in pending application No. 315,616, so that outward laminar flow of protective gas is maintained through the 12 slot-shaped openings 27 and 13 to further the outward flow of the outlet against ingress of external atmosphere into the headspace over the bath. Additionally the seal under the partition 26 may be helped by providing a draped curtain of asbestos cloth or silica cloth hanging from the partition, as described in pending application No. 315,616. Furthermore, sealing means including a blade 21 may be provided beneath the take-up roll 16 as well as beneath the conveyer roll 18.

Instead of regulating the delivery of glass to the bath by feeding a ribbon of glass of predetermined dimensions to the bath at a controlled rate, glass in molten form may be supplied to and advanced along the bath to form a stiffened ribbon of glass for discharge through the outlet from the bath.

I claim:

1. Apparatus for use in the manufacture of flat glass during which the glass is advanced along a bath of molten metal, comprising a tank structure containing a bath of molten metal, temperature regulators for maintaining thermal conditions along the bath which ensure that the ribbon of glass is sufficiently stiff to permit it to be taken unharmed through an outlet from the bath, ribbon supporting means arranged within the tank structure near the outlet from the bath and having an operative surface portion above the level of the bath for taking up the ribbon from the bath surface and then discharging the ribbon through the outlet, a roof structure extending over the tank structure to define a headspace over the bath and the ribbon supporting means, and means for maintaining a plenum of protective atmosphere in the headspace.

2. Apparatus for use in the manufacture of flat glass during which the glass is advanced in ribbon form along a bath of molten metal, comprising a tank structure containing a bath of molten metal, a roof structure extending over the tank structure to define a headspace over the bath, means for maintaining a plenum of protective atmosphere in the headspace, temperature regulators for maintaining thermal conditions along the bath which ensure that the ribbon of glass is sufficiently stiff to permit it to be taken unharmed through an outlet from the bath, and ribbon supporting means mounted within the tank structure near the outlet from the bath and having an operative surface portion above the level of the bath for taking up the ribbon from the bath surface and then discharging the ribbon through the outlet, said ribbon supporting means including means for sealing the outlet against ingress of external atmosphere under the ribbon into the headspace.

3. Apparatus for use in the manufacture of flat glass
during which the glass is advanced in ribbon form along a bath of molten metal, comprising a tank structure containing a bath of molten metal, an extension of the tank structure in the direction of the outlet to form a pit, a roof structure extending over the tank structure and its extension to define a headspace over the bath and over said pit, means for maintaining a plenum of protective atmosphere in the headspace and in the pit, temperature regulators for maintaining thermal conditions along the bath which ensure that the ribbon of glass is sufficiently stiff to permit it to be taken unharmed through an outlet from the bath defined between the roof structure and said extension of the tank structure, a take-up roll mounted in the pit so as to take up the ribbon from the bath surface and discharge the ribbon through said outlet, and means for sealing the outlet against ingress of external atmosphere under the ribbon into the headspace.

5. Apparatus according to claim 3, wherein the take-up roll is a carbon roll.

6. Apparatus according to claim 5, wherein the conveying roll is a steel roll and the sealing means includes a laterally extending carbon blade mounted under the roll so as to contact the roll along its length, and a housing for said blade, which housing is fixed to said tank extension and includes resilient means operable to urge the blade into sealing engagement with the roll.

7. Apparatus according to claim 5, wherein the roof structure includes a partition arranged transversely of the roof structure and extending downwardly therefrom to define with said extension of the tank structure a slot-shaped opening through which the ribbon of glass is advanced from the take-up roll to said conveying roll.

8. Apparatus according to claim 7, wherein the roof structure extends over said conveying roll and includes an end wall extending downwardly to define with said extension of the tank structure a slot-shaped outlet through which the ribbon of glass is discharged from said conveying roll.

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