ABSTRACT OF THE DISCLOSURE

Apparatus for tempering curved glass sheets moving along a substantially horizontal path including a plenum chamber, an elongated nozzle arranged transversely of said path and communicating with said chamber, said nozzle and chamber having interfering surfaces to secure said nozzle to said chamber while enabling sliding of the nozzle endwise transversely of said path onto and off of said chamber.

This invention relates generally to apparatus for tempering curved sheets of glass. More particularly, the invention is concerned with tempering apparatus including blast heads having nozzles shaped to conform with the curvature of the glass sheets and operable to direct streams of cooling fluid from a plenum chamber against the surfaces of the sheet.

The general aim of the invention is to provide blast heads of the above-character having interchangeable nozzles to facilitate tempering glass sheets bent to different curvatures.

Another object is to provide an improved means for mounting the nozzles on the plenum chamber permitting the changing of the nozzles to be quickly and easily accomplished.

Another object is to provide a mounting means in which a substantially air tight seal is formed between the nozzle and the plenum without interfering in any way with the attachment or detachment of the nozzles.

Still another object is to utilize the pressure of the air flowing through the nozzles to aid in effecting the seal between the nozzles and the chamber.

Other objects and advantages of the invention will become more apparent during the course of the following description when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals are employed to designate like parts throughout the same:

FIG. 1 is a transverse sectional view of a tempering apparatus embodying the novel features of the invention;

FIG. 2 is a fragmentary sectional view of a portion of the nozzles or fins constructed in accordance with the present invention;

FIG. 3 is a fragmentary plan view of two of the nozzles or fins;

FIG. 4 is a perspective view showing a portion of the mounting and sealing means for the fins;

FIG. 5 is a sectional view of a modification of the fin mounting means; and

FIG. 6 is a sectional view of another modification of the fin mounting means.

It should be appreciated at the outset that the present invention is concerned with the tempering of curved glass sheets and that, within the spirit of the invention, the sheets may be bent to the desired curvatures by any one of many well-known bending procedures. In other words, the invention, in its broadest aspect, relates to an apparatus operable to support an already bent glass sheet which has been heated to an elevated temperature and to quench or rapidly chill this sheet by directing cooling fluid against its surfaces. For purposes of illustration only, the invention is shown in the drawings and is hereinafter described in detail in connection with apparatus for producing curved tempered sheets of glass in accordance with one well-known process.

In this process, the sheets to be treated are moved one by one along a predetermined path through a heating area wherein the sheets are heated to the softening point of glass enabling them to be bent to the desired curvature and thereafter are immediately moved into a tempering area wherein the sheet is chilled to produce the desired temper in the glass. With this process, the heat imparted to the sheet to soften the glass is utilized in the tempering phase of the operation and thus the entire procedure is carried out in a continuous manner conducive to the commercial production of bent and tempered sheets in relatively large quantities.

With the process described above, the bending of the sheets may be accomplished by supporting a sheet 10 in bending relation to curved shaping surfaces on a gravity-type bending mold 11 (FIG. 1). In order to avoid marring the major areas of the sheet, a skeleton-type mold is commonly used, which mold has shaping surfaces adapted to engage only the marginal portions of the sheet. The mold 11 is mounted on a rack 12 which includes side rails 13 extending along opposite sides of the mold and supported at their opposite ends by end members 14. As shown in FIG. 1, the side rails 13 are curved in elevation to conform with the curvature of the bent glass sheet.

In the bending phase of the operation, the rack and the mold carried thereby is moved through the heating chamber of a furnace (not shown) maintained at a sufficiently high temperature to heat the sheet to the softening point of glass whereupon the sheet sags under the influence of gravity into contact with the shaping surfaces of the mold and assumes the desired curvature.

To avoid handling the heated glass sheet after bending, the bending mold 11 is utilized to support the sheet during the tempering phase of the operation. Thus, upon leaving the furnace, the mold immediately enters the tempering area wherein opposed streams of cooling fluid, preferably air, are directed against the sheet carried on the mold from cooling means 15 disposed adjacent the path of travel of the sheets.

In general, the cooling means 15 comprises so-called blast heads 16 which include plenum chambers 17 and 18 disposed above and below the path of movement of the sheets and coupled to a source of air under pressure (not shown) together with outlet means 19 communicacting with the chambers and operable to direct the air from the plenum chambers toward the path.

The molds are moved through the tempering area on a conveyor 20 which includes two endless chains 21, each disposed in a closed loop having an upper substantially horizontal flight extending along the path at opposite sides of the lower plenum chamber 18 and adapted to receive one of the end members 14 of the rack. The upper flight of each of the conveyor chains 21 rides on the web 22 of a channel iron member 23 fixed between side channel irons 24 which together with a base plate 25 form rigid box-like supporting 26 for the conveyor chains. The supports extend along opposite sides of the path and are carried on the upper ends of upright pedestal 27 in the desired position relative to the lowermost plenum chamber. As shown in FIG. 1, each of the side channels 24 project upwardly above the web 22 of the channel member 23 to form an upwardly opening groove at the end members 14 of the rack 12 along the intended path.
Each of the conveyor chains is entrained around sprockets 28 disposed between the side channel irons 24 and fast on shafts 29 journaled in bearings 30 carried by the side channel irons to rotate in transversely of the path. The shafts 29 are rotated through the medium of drive sprockets 30 carried by the shafts 29 and coupled, by drive chains 31, to a suitable power source (not shown).

The rate at which the temperature of the sheets is reduced is dependent, in part, upon the volume of air directed against the surfaces of the sheets and upon the velocity at which this air flows over the surfaces. These factors, in turn, have been found to depend, to some extent, upon the spacing between outlet means 19 on the plenums 17 and 18 and the sheets; in other words, on how far the air must travel through the atmosphere to reach the surface of the sheet. In the illustrated embodiment, the plenums 17 and 18 are constructed so as to enable the outlet means 19 to be moved toward and away from the path traveled by the sheets. To this end, as shown in FIG. 1, the upper and lower plenum chambers 17 and 18 each include two sections 32 and 33 telescoped together to permit the innermost section of the path to slide back and forth on the outermost section 32 which, in the embodiment shown, is mounted in a fixed position. The sections 32 and 33 are held in any desired position relative to each other by bolts 34 attached to flanges 35 carried by each of the sections.

Each of the plenum chambers 17 and 18 includes an end wall 36 lying in a plane substantially parallel to the plane of the path along which the sheet moves. A plurality of spaced openings 37 which, as here shown, comprise elongated slots extending transversely of the path, are formed in the opposed end walls 36 to permit the air to escape from the chambers toward the path. As noted above, the air is directed from the chambers toward the path by the outlet means 19 which are mounted on the opposed end walls 36 in communication with the openings 37 and extend outwardly therefrom toward the path.

Herein, the outlet means 19 take the form of elongated fins or nozzles 38 extending transversely across the path and having a length equal to or slightly longer than the length of the glass sheet to be treated. Each of the nozzles 38 include side walls 39 which are inclined or tapered inwardly toward one another from the opening 37 in the wall 36 of the plenum chamber to a point adjacent the path which lies outside the sheet 40. The nozzle is completed by end walls 41 integral with the side walls 39 and inclined outwardly from the plenum toward the path. The outermost or orifice end of each nozzle 38 is shaped in elevation to conform to the curvature of the glass sheet to be tempered to insure equal spacing between the end of the nozzle and the sheet across the sheet. Thus as shown in FIG. 1, the nozzles disposed above the path have convexly curved orifice ends and those disposed below the path have concavely curved orifice ends.

As shown in FIG. 2, a number of nozzles 38 are spaced apart along the path with the nozzles carried by the upper and lower chambers being in vertical alignment to direct opposed streams of cooling air along paths extending normal to the surfaces of the glass sheet. The air flowing from each orifice 40 strikes the surface of the sheet and fans outwardly to flow over the surface and then escapes the nozzle to permit additional cool air from the nozzles to impinge upon the sheet surface.

It will now be appreciated that since the orifice ends of the nozzles are curved to conform to the curvature of the sheet being tempered, any change in the curvature of the sheet will vary the spacing between the orifice and the sheet and this variance in spacing could result in different portions of the sheet being cooled at different rates and thus being tempered to different degrees. To avoid this, and to enable the tempering apparatus to be used in treating sheets bent to a number of different curvatures, the nozzles are releatably attached to the plenums 17 and 18 so as to be interchangeably accommodated to accommodate sheets having axes extending in different curvatures.

As will be apparent, when production is varied, that is, when the curvature of the sheets to be tempered is modified, a change-over procedure is required in which all of the nozzles are removed from the plenum and replaced by nozzles having a corresponding curvature at their orifice ends. Naturally, this change-over procedure results in downtime of the apparatus and is therefore relatively expensive as regards both loss of production time and the man hours required to manually effect the switching of the nozzles.

To aid in reducing the cost of this change-over by reducing the man hours required to effect the operation, the present invention contemplates a novel means for attaching the nozzles to the plenums, which means permits changing the nozzles by merely sliding one nozzle off of the plenum and sliding a different nozzle in its place. To this end, the attachment means 42 of the present invention includes interfiting surfaces formed on the nozzle and the plenum 33 adjacent to the path to slide the nozzle to the plenum while permitting endwise sliding of the nozzles relative to the plenum. As herein shown, the interfiting surfaces comprise a lip 43 formed on each nozzle and projecting laterally outwardly therefrom, which lip is received in and slideable along guideways 44 on the exterior of the plenum.

In the illustrated embodiment, the guideways 44 are formed in a channel plate 45 fixed to the wall 36 of the plenum, as by threaded fasteners 46, adjacent each opening and comprise a groove 47 formed therein adjacent the opening 37, which groove opens inwardly toward the side wall to receive the lip formed on the nozzle. As best shown in FIG. 3, the plate 45 is generally U-shaped with the groove 47 extending around three sides of the opening 37 and with the remaining side being open to permit the lip 43 on the nozzle 38 to be slid into the groove.

In another of its aspects, the invention contemplates utilizing the pressure of the cooling air in the plenums 17 and 18 and flowing through the nozzles 38 to aid in locking the nozzles in place and in effecting a seal between the nozzles and the plenum. For this purpose the nozzles are constructed with somewhat flexible side walls 39 which yield outwardly under pressure, and such pressure serves to force air flowing through the nozzle to set the lip 43 firmly in the groove 47. Further, due to the taper of the side walls 39, as the air flows through the nozzle, forces are exerted against the side walls which tends to urge the nozzle away from the plenum and at the same time to force the walls away from each other. This combination of forces tends to lock the lip in position in the groove.

To further insure against leakage of air between the nozzle 38 and the wall 36 of the plenum, a sealing member 48 is provided which overlaps the joint between these two elements. In general, the sealing member 48 comprises a web of flexible material such as rubber or the like secured, at one end, to the inner surface of the wall 36 of the plenum and extending through the opening 37 and into the nozzle 38. The air flowing through the nozzle 38 from the plenum forces the sealing member 48 against the inner surface of the walls 39 and 41 of the nozzle to completely overlap the joint between the nozzle and the plenum.

In the present instance, the sealing member takes the form of a preformed sleeve 49 or tube of generally rectangular shape corresponding to the shape of the opening 37 which sleeve extends outwardly from the plenum through the opening and into the nozzle 38. Formed integrally with the innermost end of the sleeve, there is a flange 50 which extends laterally outwardly from the sleeve to engage the inner surface of the plenum wall 36 around the opening 37. The flange 50 is clamped to
the wall 36 of the plenum by bars 51 bolted to the wall of the plenum. Herein, as shown in FIG. 2, the fasteners 46 extend through the channel plate 45, the plenum wall 36, the flange 50 and the bars 51 to secure these elements in the desired position relative to each other.

As noted above, the sealing member 48, the sleeve 49 in the illustrated embodiment, is flexible so as to readily deform or yield to permit a nozzle 38 to be slid onto the plenum. Further, the member may be resilient, enabling it to resume its shape when the nozzle has been slid into place. The air flowing through the nozzle forces the sleeve 49 outwardly against the walls of the nozzle to insure against leakage of air past the joint between the lip 43 and the groove 47.

Two modifications of the attachment means 42, which modifications operate on the same general principle, are shown in FIGS. 5 and 6. In the modification shown in FIG. 5, a split tube 52 of resilient material such as rubber or the like is positioned around the opening 37 in the wall 36 of the plenum and is held in position by offset clips 53 attached by screws 54 to the plenum wall. The lip 43 on the nozzle 38 projects into the tube 52 through the slit formed therein so that the walls of the tube grip the opposite surfaces of the lip and effect a seal preventing the escape of air between the nozzle 38 and the wall 36 of the plenum.

In the modification shown in FIG. 6, an angle member 55 is provided adjacent the opening 37 in the wall 36 of the plenum with one leg 56 thereof attached to the wall as by screws 57 and with the other leg 58 extending outwardly from the wall and being inclined toward the opening. The legs 58 at opposite sides of the opening 36 are inclined toward one another so as to provide a taper similar to the taper of the side walls 39 of the nozzles 38. The distance between the opposed surfaces of the legs 58 is such as to permit the movement of the nozzle 38 relative to the legs 58 when the innermost end of the nozzles is adjacent the wall 36 of the plenum as shown in broken line in FIG. 6. When the nozzle is moved outwardly away from the wall 36, the side walls 39 thereof are wedged between the opposed legs 58 of the angle members 55 as shown in full line in FIG. 6. Thus, in operation the nozzle may be slid into position between the legs 58 and when pressurized air is introduced in the plenum, this air acts against the tapered side walls of the nozzle forcing the nozzle outwardly of the plenum wall 36 andbringing the side walls 39 thereof into engagement with the legs 58 of the angle members. When the supply of air to the plenum chambers is interrupted, the nozzle may be moved backwardly toward the wall 36 and removed from the plenum by sliding it endwise between the angle members 55. To further insure that a seal is effected between the abutting portions of the angle members 55 and the side walls 39 of the nozzles, pads 59 of resilient sealing material such as rubber, felt or the like may be attached to the mating surfaces.

It will now be appreciated that the novel attachment means of the present invention enables the nozzles of a blast head to be readily replaced with a minimum of effort while forming an effective seal between the replaceable nozzles and the plenum chamber of the blast heads. While the nozzles are freely slidable onto and off of the plenum chambers, when the supply of air to the chambers is interrupted, they are securely locked in place by the flow of the air from the plenum chambers through the nozzles.

It is to be understood that the forms of the invention herewith shown and described are to be taken as illustrative embodiments only of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention.

We claim:
1. In apparatus for tempering sheets of glass being moved along a predetermined substantially horizontal path, the combination of plenum chambers mounted above and below said path and having walls disposed in substantially horizontal planes extending parallel to said path, each of said walls having a plurality of elongated openings extending transversely across said path in closely spaced relation to one another, a plurality of elongated nozzles also extending transversely across said path, said nozzles having inclined side walls converging at their outer ends to form narrow slots, the inner ends of said side walls straddling said elongated openings, outwardly directed relatively narrow lips formed integral with the inner ends of said side walls and parallel to said plenum walls, elongated guide members extending parallel with said openings along the opposite sides thereof and closely adjacent thereto, means for securing said guide members to said plenum walls, said guide members having inwardly directed opposed portions extending transversely across said path and slidably receiving said lips therein to position said nozzles in close proximity to one another, said lips and guide members permitting said nozzles to slide endwise relative to one another onto and off of said plenum walls while serving to support said nozzles during sliding movement thereof, sealing means disposed between said side walls and said guide members, and means for supplying cooling fluid under pressure to said plenum chambers.

2. In apparatus for tempering curved sheets of glass as defined in claim 1, in which the side walls of the nozzles are flexible whereby said walls will be forced outwardly under the influence of the pressure of the air flowing from said plenum chambers through said nozzles to lock said lips in position in said guide members.

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