May 8, 1956 J. E. JENDRISAK 2,744,359

METHOD AND APPARATUS FOR BENDING GLASS SHEETS OR PLATES

Filed March 27, 1951 2 Sheets-Sheet 1

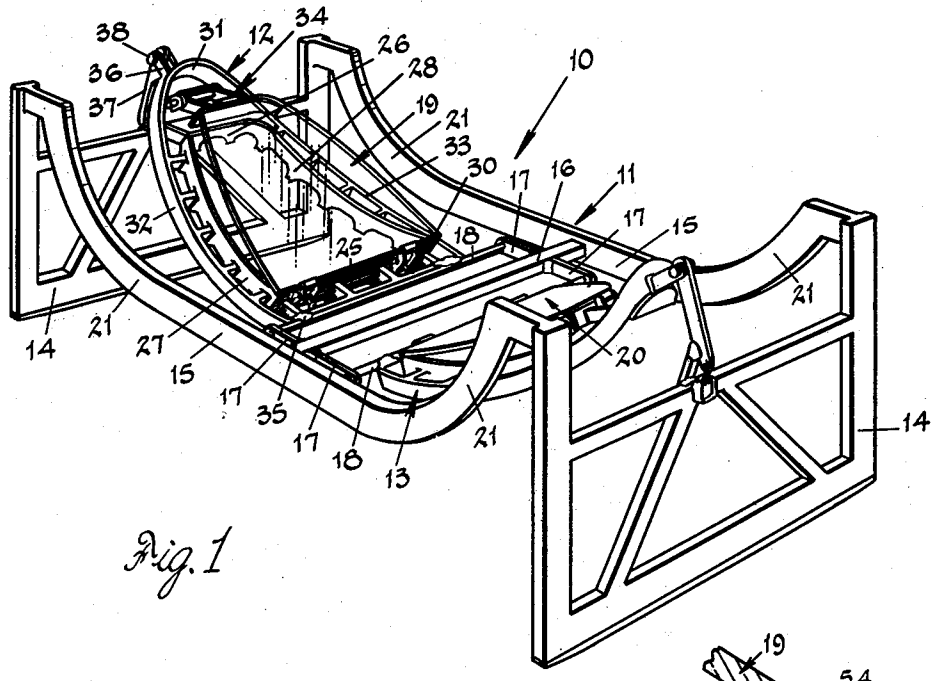


Fig. 1

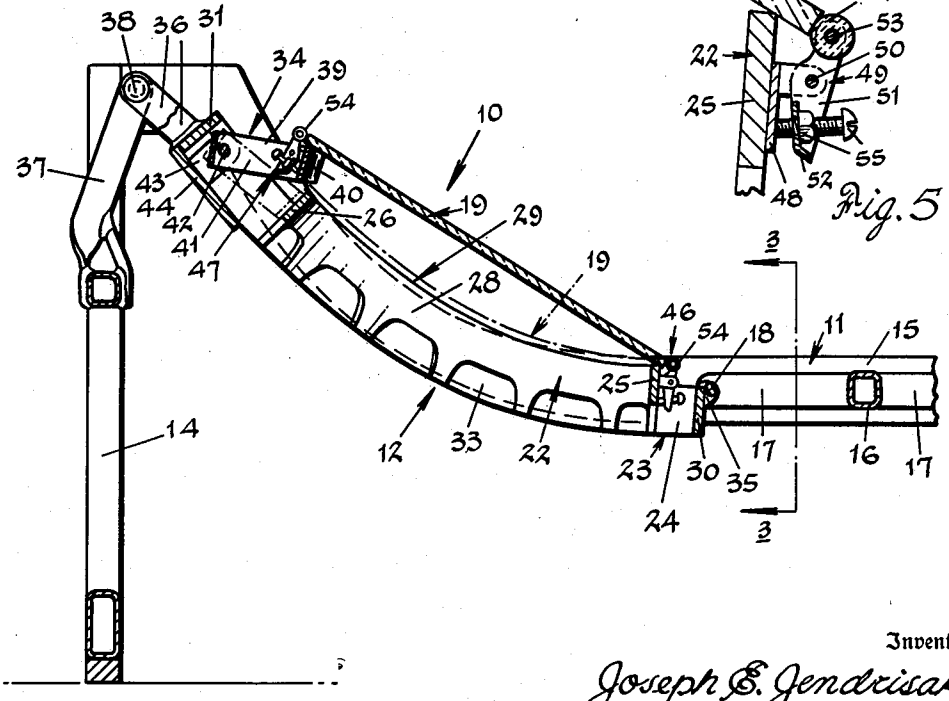


Fig. 2

Fig. 5

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METHOD AND APPARATUS FOR BENDING GLASS SHEETS OR PLATES

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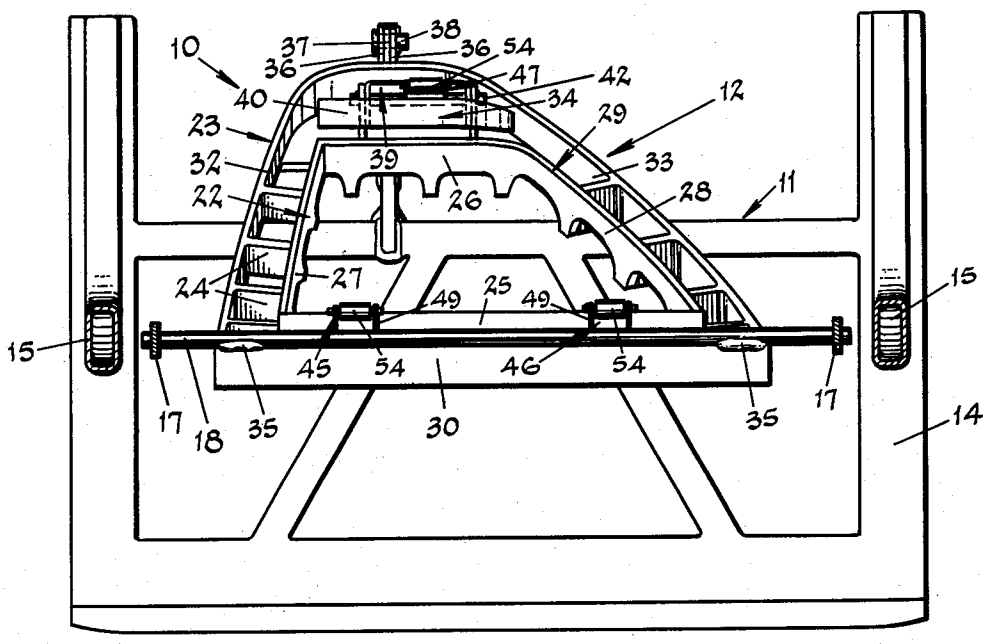


Fig. 3

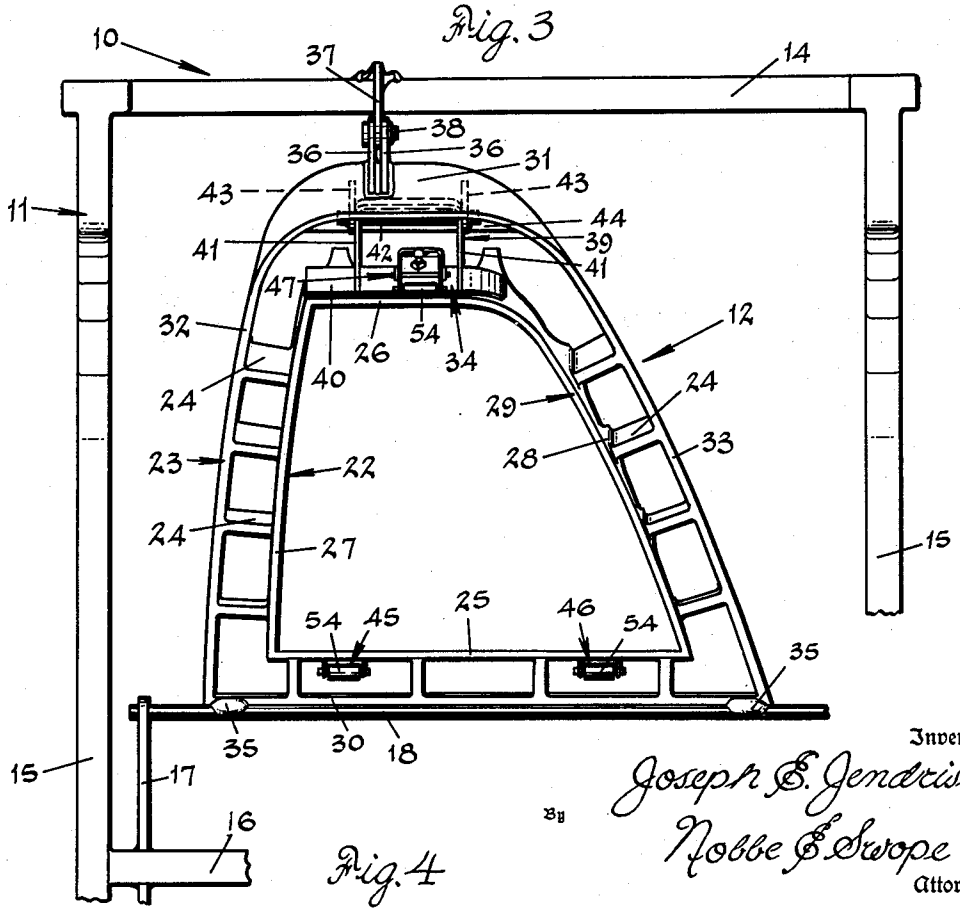


Fig. 4

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METHOD AND APPARATUS FOR BENDING GLASS SHEETS OR PLATES

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Application March 27, 1951, Serial No. 217,726

15 Claims. (Cl. 49—67)

The present invention relates to an improved method and apparatus for the bending of glass sheets or plates or other sheet material to predetermined curvatures.

Generally stated, the improved method of this invention is carried out by the use of novel apparatus which comprises a bending mold having a shaping surface of the desired curvature and preferably of the continuous ring type with which is associated means for supporting the glass sheet to be bent in an inclined position above the mold and for effecting a gradual lowering of the sheet during the bending thereof until it is deposited upon the shaping surface of the mold.

An important object of the invention is the provision of bending apparatus of the above character in which the mold is oriented at an angle to the horizontal, with the glass sheet to be bent being supported upon the mold at its lower end, in combination with means for supporting the upper end of the sheet in spaced relation to the mold and operable to lower the sheet during the bending thereof onto the shaping surface of the mold.

Another object of the invention is to provide, in bending apparatus of the above character, a mold having associated therewith means for supporting the upper end of the sheet comprising a pivoted support which serves to maintain the body of the sheet out of contact with the mold during the initial bending thereof but which operates to automatically swing downwardly as the sheet is progressively bent and to bring the sheet to rest upon the shaping surface of the mold at substantially the completion of the bending operation whereby sliding contact of the sheet with the mold will be avoided, thereby minimizing if not eliminating mold marks and other defects in the softened glass.

A further object of the invention is to provide, in bending apparatus of the above character, a mold having associated therewith such a pivoted support arranged to carry a flat sheet of glass to be bent above the shaping surface thereof and which is adapted to progressively lower said sheet as it becomes softened onto said shaping surface and to move out of contact with the glass upon completion of the bending operation.

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 perspective view of bending apparatus constructed in accordance with the invention;

Fig. 2 is a longitudinal vertical sectional view of one end of the bending apparatus;

Fig. 3 is a transverse vertical sectional view taken substantially on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary plan view of the end of the bending apparatus shown in Figs. 2 and 3; and

Fig. 5 is a vertical cross sectional view of one of the sheet locators.

Referring now to the drawings, the bending apparatus herein provided is generally designated by the numeral

10 and comprises a supporting rack 11 upon which are carried the two glass bending molds 12 and 13.

The rack 11 comprises an open, substantially rectangular tubular framework having opposite end sections 14 and longitudinally disposed side rails 15 connected to said end sections to provide a rigid structure. Arranged transversely between and secured to the side rails 15 intermediate the opposite ends thereof is a tubular bar 16 provided adjacent its ends with oppositely directed, longitudinally extending arms 17 in the outer ends of which are rotatably carried rods 18 that parallel bar 16.

In the present embodiment of the invention, the rack 11 is formed to carry the two molds 12 and 13 whereby two sheets of glass 19 and 20 may be simultaneously bent upon said molds. Although not essential, it is usually preferred that the molds be of the same shape and size so that similar and substantial duplication of curvature of the two sheets may be obtained. This is particularly advantageous in the production of matched pairs of bent sheets having the same pattern cut outline and curvature which will permit their subsequent use as end lights of a sectional assembly of two or more parts.

To this end, the molds 12 and 13 are arranged on the rack so that like parts of each mold will be centrally disposed, while the body of each mold is oriented at an angle to the horizontal to elevate one end of the mold body above the other so that during the bending operation the glass sheets will, upon softening, settle down upon and conform to the curvature of the molds in the proper manner. By way of illustration, the adjacent inner ends of the molds 12 and 13 are arranged on the rack 11 so as to be materially lower than the outer ends thereof. To facilitate processing of the glass subsequent to bending such as the tempering of the sheets by blasts of air, the side rails 15 of the rack 11 have their end portions 21 curved to generally correspond to the angular position of the molds.

Since the molds 12 and 13 are adapted to simultaneously produce similar curvatures in the respective glass sheets, they are of substantially the same construction, and a description of only one will be given. Thus, each mold is of the well known outline, peripheral or skeleton type and comprises an inner continuous ring 22 and an outer ring 23 spaced from said inner ring and connected thereto by webs 24. The inner ring 22 is formed of end portions 25 and 26 and side portions 27 and 28 connected together to form a ring of the desired outline. The side portions 27 and 28 are also bent longitudinally to a concave curve corresponding to the curvature of the finally bent sheet. If it is desired to produce compound bends, that is to say bending of a sheet along both of its axes, the end portions 25 and 26 may also be bent to a concave curvature. The upper edges of the side and end portions of the inner ring 22 constitute the shaping surface 29 of the mold.

The outer ring 23 is substantially of the same contour as the inner ring and comprises end portions 30 and 31 and side portions 32 and 33, said side portions being herein shown as converging toward one another into the arcuately shaped end portion 31 which is disposed opposite end portion 26 of the inner ring 22 and in spaced relation thereto to provide an open area in which is mounted a glass supporting member 34 which will be more fully hereinafter described.

Each mold 12 and 13 is carried in the rack 11 by means of the outer ring 23 which is suitably secured along its inner end portion 30 as by welding or the like to the rod 18 as indicated at 35. The inclination of the mold is obtained by the manner of support provided at the opposite end 31 of the ring. This support comprises a bifurcated bracket including spaced legs 36 secured to the

ring 23. The upper end of a substantially vertical strut 37 is received between the legs 36 and loosely connected therewith by means of a pin 38. The strut 37 is rigidly secured at its lower end to the end section 14 of the rack, and the length of this strut determines the extent of angularity of the mold.

The glass supporting member 34 comprises a substantially U-shaped element 39 and a bar 40 which is secured between the free ends of the legs 41 of said member, said bar being suitably finished upon its upper edge to form a supporting ledge for the adjacent end of the glass sheet. The supporting member 34 is located between the end portions 26 and 31 of the inner and outer rings 22 and 23 respectively and is pivotally mounted on a horizontal pin 42. The pin 42 is carried in ears 43 rising from a plate 44 secured to the end portion 31 of the outer ring. The particular arc described by the vertical swinging motion of the member 34 upon the pin 42 will permit the bar 40 to be swung upwardly to support one end of a flat sheet to be bent and to subsequently carry the sheet downwardly during bending thereof into registry with the shaping surface of the mold.

A flat glass sheet to be bent, such as sheet 19, is initially positioned relative to and supported above the shaping surface 29 of the mold as shown in Fig. 2 by the supporting member 34 at one end and at its opposite end by means of locators 45 and 46 carried by the lower end portion 25 of inner ring 22. The lower edge of the glass sheet 19 will thus be positioned and held in place by the locators 45 and 46 while the upper edge of the sheet will be carried upon the bar 40 and held in place by a locator 47, carried by the supporting member 34.

Each of the locators 45, 46 and 47, which, as shown, are substantially identical with those disclosed in my copending application, Serial No. 68,533, filed December 31, 1948, now Patent No. 2,551,607 comprises a bracket 48 on which is pivotally carried a frame 49 by means of a pin 50, said frame being composed of side plates 51 connected at their lower ends by a web 52 as shown in Fig. 5. At their upper ends, the side plates 51 carry a pin 53 on which is loosely supported a suitable locating element, such as a ceramic sleeve or coil spring 54. A range of pivotal movement is afforded the frame 49 by means of a bolt and locking nut arrangement 55 whereby the locating element 54 may be suitably adjusted inwardly or outwardly from the adjacent shaping surface. Outward movement of the frame 49 is restricted by the bolt 55. Preferably, the transverse spacing of the locators 45 and 46 between the side portions 27 and 28 of the ring 22 is such as to balance the weight of the glass sheet while the locator 47 is carried by the bar 40 generally midway between the ends thereof so as to evenly distribute the effective thrust of the unbent sheet.

In practice, and as shown in Fig. 2, a flat sheet of glass to be bent, such as the sheet 19, is placed upon the mold 12 with its lower marginal portion resting upon the lower end portion 25 of said mold and the adjacent edge thereof against the locators 45 and 46. While manually supporting the glass sheet at its upper end, the supporting member 34 is swung upwardly until the bar 40 engages the glass, at which time the locating element 54 of locator 47 will be placed in contact with the edge of the sheet. The length of the legs 41 of supporting member 34 and the position of the pin 42 relative to the end portion 26 of the ring 22 determine the arcuate path of motion described by said member. This path of motion, or swinging movement of the member 34, is intended to compensate for the length of the flat glass sheet as compared to the relatively shorter chord distance between the end portions 25 and 26 of the ring 22. Now, due to the strut-like character of the flat sheet, its inherent rigidity will react through the locator 47 on the member 34 to prevent downward swinging movement of the latter and likewise will operate to support the sheet above and in spaced relation to the upper portions of the shaping surface 29. In their angular relationship, the member 34 and the glass sheet 19 thus actually serve to support one another and in so doing will, more especially, space said sheet above the shaping surface 29.

When the glass has become heated to its bending temperature and due to its effective yet free support, there will be progressive settling from the lower marginal portion of the sheet on the end portion 25 of the ring 22, gradually upward on the side portions 27 and 28 and toward the opposite upper end portion 26. The settling of the glass as it softens will now weaken the initial angular relationship effected with the supporting member 34 and allow it to descend. And since the upper marginal portion of the glass is carried by said supporting member, despite the downward swinging movement thereof, the glass sheet will not be permitted to slide on the shaping surface 29 or over the surface of the end portion 26, but will be carried thereabove until substantially the end of the bending operation when said member 34, in its downward movement will deposit the glass on the shaping surface and move downwardly out of contact therewith.

By providing a glass supporting member 34, as herein set forth, it is now possible to locate pattern cut sheets of glass abovea mold shaping surface of similar outline and desired curvature in an easy operation and to bend the same without sliding of the glass upon the shaping surface of said mold. By suitably determining the range of swinging motion of the glass supporting member, it is also possible to achieve accurate registration of the glass on the mold throughout bending of the same and until the completion of the bending operation in a simple and efficient manner.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment of the same, but that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. In apparatus for bending sheets or plates of glass, a mold of ring type having a shaping surface of the desired outline, said mold being oriented so that one end is elevated above the other, stationary means at the lower end of the mold engageable by an edge of a sheet to be bent to locate the lower end of the sheet with respect to said shaping surface, and means movably mounted at the upper end of the mold engageable by and supporting the upper end of the sheet in spaced relation above said mold and operable to lower the sheet onto the shaping surface of the mold during the bending of said sheet.

2. In apparatus for bending sheets or plates of glass, a mold of ring type having a shaping surface of the desired outline, said mold being oriented so that one end is elevated above the other, stationary means at the lower end of the mold engageable by an edge of a sheet to be bent to locate the lower end of the sheet with respect to said shaping surface, and means pivotally carried at the upper end of the mold engageable by the upper end of the sheet to support the body portion of the said sheet between said ends in spaced relation above said mold and operable to lower the sheet onto the shaping surface of the mold during the bending of the sheet.

3. In apparatus for bending sheets or plates of glass, a mold of ring type having a shaping surface of the desired outline, said mold being oriented so that one end is elevated above the other, stationary means at the lower end of the mold engageable by an edge of a sheet to be bent to locate the lower end of the sheet with respect to said shaping surface, and means at the upper end of the mold including a bar pivotally carried therefrom for supporting the upper end of the sheet in spaced relation above the mold and operable to lower sheet onto the shaping surface of the mold during the bending of the sheet.

4. In apparatus for bending sheets or plates of glass, a mold of the ring type, a glass shaping surface having the desired outline formed on the mold conforming to the curvature of a glass sheet when bent, said mold being oriented so that one end is elevated above the other, stationary means at the lower end of the mold engageable by an edge of the sheet to be bent to locate the lower end of the sheet with respect to the shaping surface of said mold, a glass supporting member pivotally mounted at the upper end of the mold and movable into glass engaging position above the shaping surface and into glass disengaging position beneath said shaping surface, and means carried by the supporting member to engage the upper end of the flat sheet when the supporting member is in glass engaging position to support said upper end of the sheet in spaced relation above the mold shaping surface and operable to sustain said upper end of the sheet in engagement with the supporting member while the same is moving toward said mold shaping surface into the glass disengaging position at completion of the bending of the sheet.

5. In apparatus for bending sheets or plates of glass, a mold of the ring type, a glass shaping surface having the desired outline formed on the mold conforming to the curvature of a glass sheet when bent, said mold being oriented so that one end is elevated above the other, stationary means at the lower end of the mold engageable by an edge of the sheet to be bent to locate the lower end of the sheet with respect to the shaping surface of said mold, a glass supporting member pivotally mounted at the upper end of the mold and movable into glass engaging position above the shaping surface and into glass disengaging position beneath said shaping surface, and means carried by the supporting member to engage the upper end of the flat sheet when the supporting member is in glass engaging position, said first and last named means being initially cooperative through the sheet to hold the supporting member in glass engaging position and the upper end of the sheet in spaced relation above the mold shaping surface and during bending of the sheet into conformity with said shaping surface to sustain the upper end of said sheet on the supporting member as it lowers said upper end onto the shaping surface and moves to the glass disengaging position therebeneath at completion of the bending operation.

6. A method of bending glass sheets to a curvature corresponding to the shaping surface of a mold, comprising resting one end of a flat sheet of glass upon the mold while supporting the sheet with its opposite end out of contact with the mold, heating the sheet to bending temperature and gradually lowering the opposite end of the sheet during bending while maintaining the same out of contact with the mold until the entire length of the sheet is deposited upon the shaping surface of the mold.

7. A method of bending glass sheets to a curvature corresponding to the shaping surface of a mold, comprising resting one end of a flat sheet of glass in a stationary position upon the shaping surface of the mold while supporting the sheet with its opposite end above and out of contact with the mold, heating the sheet to bending temperature and gradually lowering the opposite end of the sheet during bending of said sheet while maintaining the said opposite end of the sheet out of contact with the shaping surface of the mold until the sheet substantially conforms thereto.

8. In a method of bending glass sheets to a curvature corresponding to the shaping surface of an inclined mold having one of its ends elevated above the other, the steps of locating one end of a sheet at the lower end of the mold shaping surface, initially supporting the other end of the sheet above the upper end of the mold in spaced relation to the shaping surface and in an inclined position with respect to the mold shaping surface, heating the sheet to bending temperature, and continuing to support said other end of the sheet during bending movement of the sheet while maintaining said end out of sliding contact with the shaping surface until the sheet is bent into substantial conformity therewith.

9. In a method of bending glass sheets to a curvature corresponding to the shaping surface of an inclined mold having one of its ends elevated above the other, the steps of locating one end of a sheet at the lower end of the shaping surface of the mold, initially supporting the other end of the sheet above the upper end of the mold to maintain the surface of the sheet in spaced and inclined relation to said mold shaping surface, heating the sheet to bending temperature, gradually lowering the other end of the sheet during its bending movement while maintaining said end out of sliding contact with the shaping surface of the mold until the sheet is bent into substantial conformity therewith, and finally depositing the said other end of the sheet onto said shaping surface.

10. In apparatus for bending sheets or plates of glass, a rack and a ring type mold supported therefrom in an inclined position, a shaping surface on the mold conforming to the curvature of a sheet when bent, a stationary sheet edge locating member carried by the lower end of the mold and adjacent the lower portion of the shaping surface, a sheet edge locating member pivotally mounted on the upper end of the mold and movable from a position above and spaced from the upper portion of the shaping surface to a position adjacent thereto, and means for adjusting said locating members inwardly and outwardly with respect to the upper and lower portions of the shaping surface.

11. In apparatus for bending sheets or plates of glass, a ring type mold supported in an inclined position and comprising an outer ring and an inner ring in spaced relation thereto, a shaping surface on said inner ring defined by the upper edge surface thereof, a stationary sheet edge locating member adjacent the shaping surface at the lower end of the inner ring, sheet supporting and locating means pivotally mounted on the upper end of the outer ring and including a sheet edge supporting member and a sheet edge locating member carried by said supporting member and adjacent the upper edge surface thereof, said supporting and locating means being movable from a position above and spaced from the upper end of the inner ring to a position adjacent thereto.

12. In apparatus for bending glass sheets or plates into conformity with a mold shaping surface, a sheet edge locator comprising a frame mounted adjacent said mold shaping surface and a ceramic member carried by said frame to contact said sheet edge when operatively mounted on said mold shaping surface.

13. In apparatus of the character defined in claim 12, said sheet edge locator including means for pivotally moving said frame about an axis substantially parallel to said adjacent mold shaping surface.

14. In apparatus for bending glass sheets or plates into conformity with a mold shaping surface, a supporting member for carrying an edge of a glass sheet into registry with said mold shaping surface during the bending of said sheet, a frame mounted adjacent said supporting member, and a ceramic locating member carried by said frame to contact said edge when carried on said supporting member.

15. In apparatus of the character defined in claim 14, plus means for pivotally moving said frame about an axis substantially parallel to said adjacent supporting member.

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