

April 22, 1969

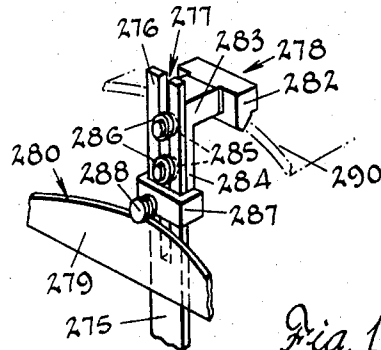
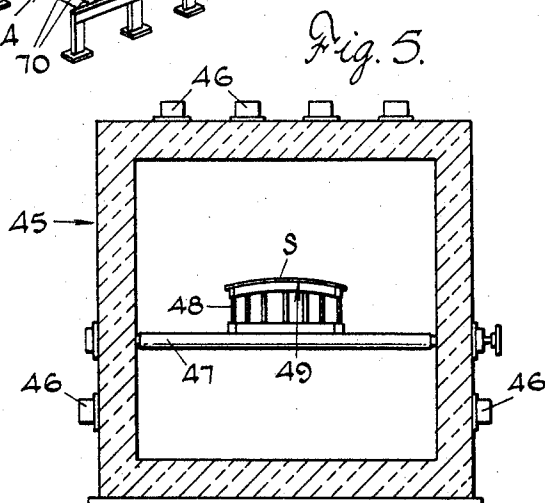
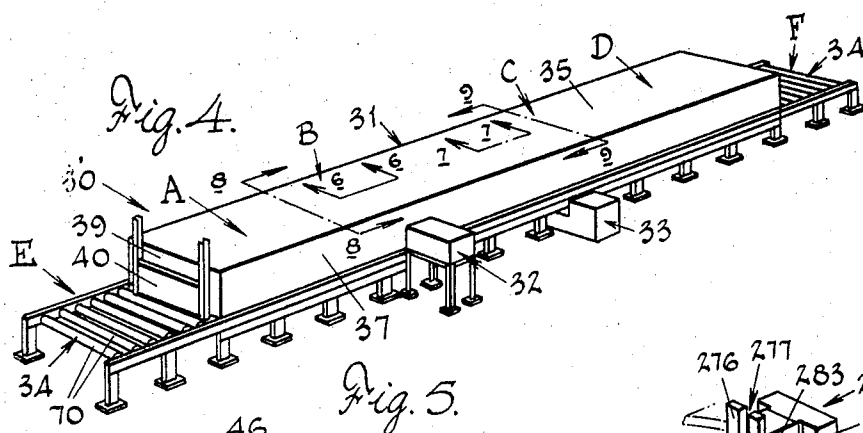
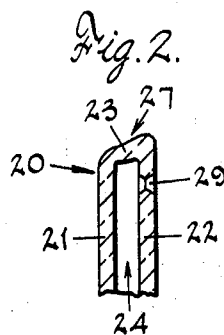
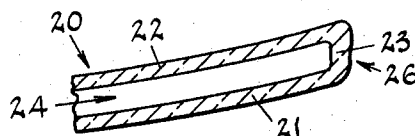
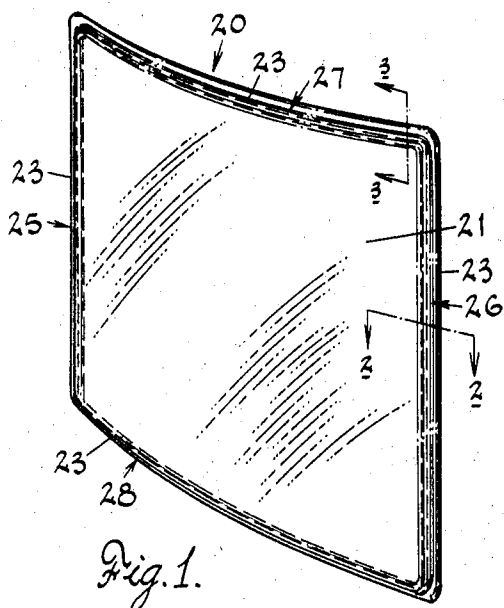
E. W. BABCOCK

3,440,031

APPARATUS FOR PRODUCING MULTIPLE SHEET GLAZING UNITS

Filed May 9, 1966

Sheet 1 of 4



INVENTOR.
Eugene W. Babcock
BY
Nobbe & Swope
ATTORNEYS

April 22, 1969

E. W. BABCOCK

3,440,031

APPARATUS FOR PRODUCING MULTIPLE SHEET GLAZING UNITS

Filed May 9, 1966

Sheet 2 of 4

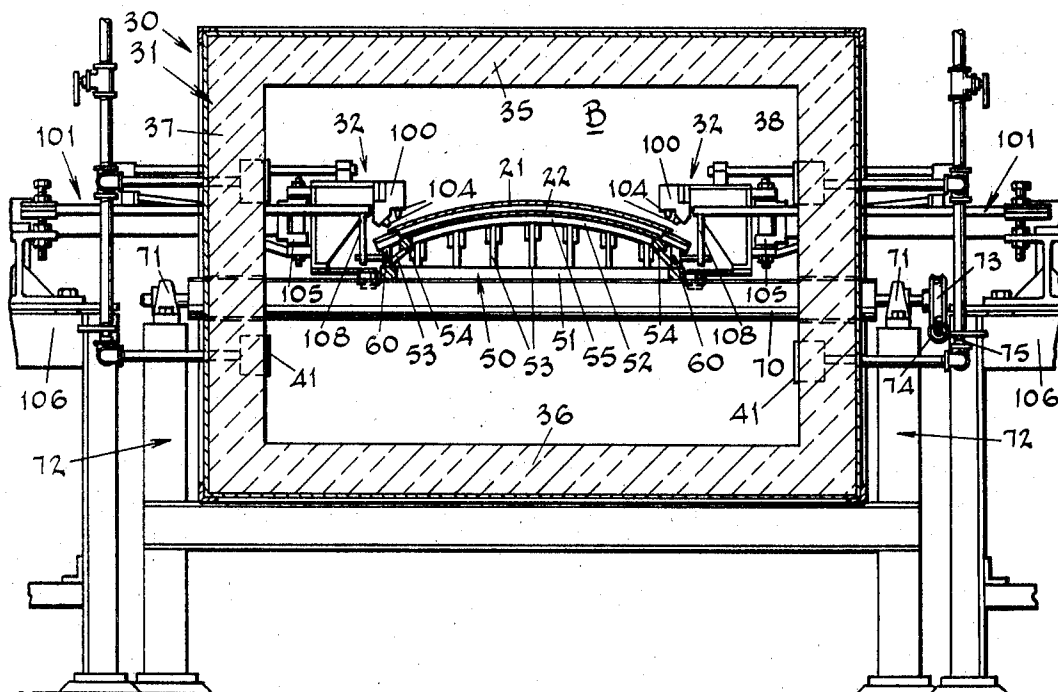


Fig. 8.

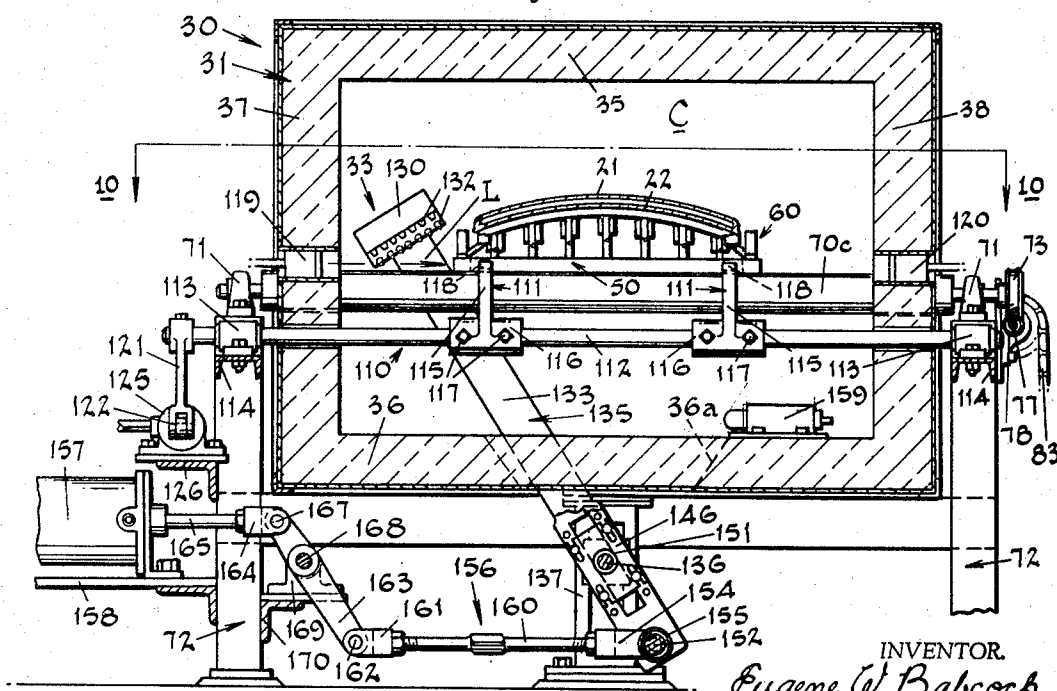


Fig. 9.

INVENTOR.
Eugene W. Babcock
BY
Nobbe & Swope
ATTORNEYS

April 22, 1969

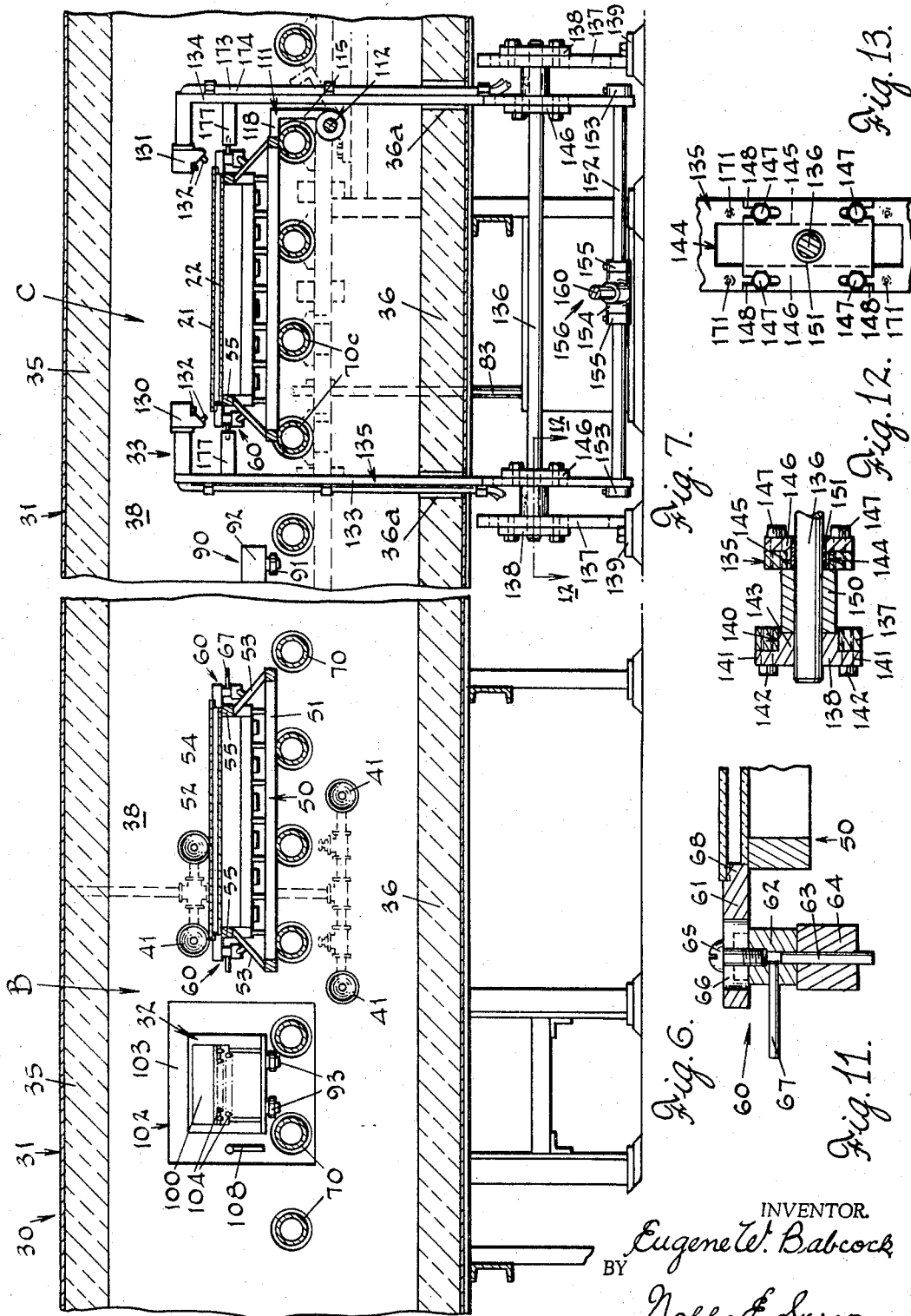
E. W. BABCOCK

3,440,031

APPARATUS FOR PRODUCING MULTIPLE SHEET GLAZING UNITS

Filed May 9, 1966

Sheet 3 of 4



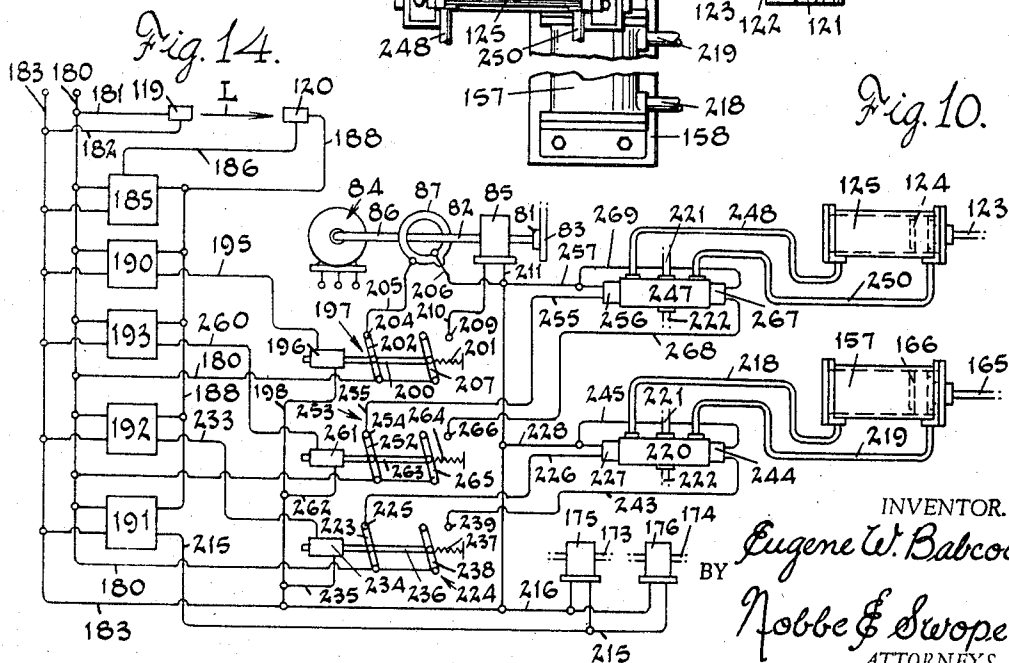
INVENTOR
Eugene W. Babcock
BY
Hobbs & Swope
ATTORNEYS

E. W. BABCOCK

APPARATUS FOR PRODUCING MULTIPLE SHEET GLAZING UNITS

Filed May 9, 1966

Sheet 4 of 4



INVENTOR.

Eugene W. Babcock

Nobbe & Swope
ATTORNEYS

1

3,440,031

APPARATUS FOR PRODUCING MULTIPLE SHEET GLAZING UNITS

Eugene W. Babcock, Perrysburg, Ohio, assignor to Libbey-Owens-Ford Company, Toledo, Ohio, a corporation of Ohio

Filed May 9, 1966, Ser. No. 548,812

Int. Cl. C03c 27/00

U.S. Cl. 65—152

4 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for producing all-glass multiple sheet glazing units which are curved about one axis. The already-bent sheets are supported horizontally in spaced, face-to-face relation and conveyed past a first sealing station where stationary burners heat the straight edges to fuse them together, and then to a second sealing station where they are stopped while a movable burner follows the curved edges.

This invention relates broadly to multiple sheet glazing units and particularly is concerned with an improved method and apparatus for producing curved all-glass multiple sheet glazing units wherein bent glass sheets are sealed together in spaced parallel relation.

It is known that multiple sheet glazing units, comprising two or more sheets of glass, can be made by sealing the same entirely around their marginal edge portions in spaced parallel relation to provide a hermetically sealed dead-air space therebetween. In view of their insulating as well as condensation-preventing qualities, such units have been installed with considerable advantage as windows for buildings, show cases, vehicles, refrigerators and the like. However, until the present invention, the production for and utility of such glazing units has been restricted more or less to the fenestration of window openings or like installations permitting only the use of units including flat sheets of glass.

According to at least one known manner of producing such units, a pair of spaced glass sheets are moved between concentrated sources of heat causing the marginal edge portions of the side of the sheets parallel with the path of their continuous movement to soften and bend into fused relation with one another. On a practical basis and through the use of apparatus disclosed in the patent to Olson et al., No. 2,761,249, suitably supported and spaced glass sheets are moved continuously in a substantially straight path past and between opposed sources of heat to the end that the transversely opposed marginal edge portions will be simultaneously sealed together. In a sequentially occurring operation, the remaining marginal edge portions are sealed or fused together in a similar manner.

As herein contemplated, an improved apparatus is adapted to produce all-glass multiple sheet glazing units, of which the sheets are cylindrically bent to substantially the same curvature, by carrying the same along a straight path of movement between opposed sources of concentrated heat to seal transversely disposed sides of the sheets and then moving similar sources of heat in an arcuate path, while the sheets remain stationary, relative to the remaining sides of the bent sheets to seal the same in substantially the same manner.

A prime object of this invention is therefore to provide an improved method for producing all-glass multiple sheet glazing units formed with bent or curved sheets of glass.

Another object of the invention is to provide an improved method of and apparatus for producing all-glass multiple sheet glazing units formed of spaced glass sheets bent about a common axis and sealed in spaced parallel relation by the provision of an integral side wall between the peripheral edge portions thereof.

2

Another object of the invention is to provide improved apparatus including means for supporting bent sheets of glass in spaced parallel relation and carrying the same along a straight path of movement to effect the simultaneous sealing of the flat sides of the said sheets disposed in parallel to the path of movement and to then effect similar sealing of the arcuate sides of the sheets disposed transversely to the said path of movement.

Another object of the invention is to provide apparatus of the above character wherein sources of concentrated heat are arranged in transversely spaced relation to the substantially straight, horizontal path of movement of a pair of bent glass sheets to soften and fuse the marginal edge portions of the flat sides of the sheet into sealed relation as the sheets are moved past the sources of heat and to then move sources of concentrated heat arcuately and transversely to the path of sheet movement to soften and fuse the marginal edge portions of the bent sides of the sheets into sealed relation while the same are stationary.

Another object of the invention is to provide apparatus of the above character including means for supporting opposed sources of concentrated heat for movement along an arcuate path, for halting movement of a pair of spaced bent glass sheets along a substantially straight, horizontal path between said sources of heat, causing the said sources of heat to move past the bent sides of the glass sheets to seal the same and then remove the glass sheets from the arcuately moving heat sources.

Another object of the invention is to provide in apparatus of the above character means for varying the radius of curvature of the path of movement of the arcuately moving sources of heat to permit the sealing of multiple sheet glazing units including pairs of bent glass sheets of one series wherein the curvatures substantially differ from the curvatures of the paired bent sheets of another series.

A further object of the invention is to provide in apparatus of the above character means for producing movement of the heat sources in two directions and thus along a path substantially aligned with the radial line of curvature simultaneously with their arcuate movement to permit the sealing of multiple sheet glazing units including a pair of glass sheets that have been bent into conformity with a compound curvature.

Other objects and advantages of the invention will become more apparent during the course of the following description when read 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 a curved all-glass multiple sheet glazing unit produced in accordance with the invention;

FIG. 2 is a horizontal sectional view of the glazing unit taken on line 2—2 of FIG. 1;

FIG. 3 is a vertical transverse sectional view of the glazing unit taken on line 3—3 of FIG. 1;

FIG. 4 is a perspective view of an apparatus for producing the unit;

FIG. 5 is a fragmentary transverse section of a furnace in which pairs of glass sheets may be bent to the desired curvature;

FIG. 6 is a longitudinal, vertical section of the apparatus taken on line 6—6 of FIG. 4;

FIG. 7 is a similar longitudinal, vertical section of the apparatus taken on line 7—7 of FIG. 4;

FIG. 8 is a transverse vertical section of the apparatus taken on line 8—8 of FIG. 4;

FIG. 9 is a transverse, vertical section taken on line 9—9 of FIG. 4;

FIG. 10 is a horizontal section of the apparatus as taken on line 10—10 of FIG. 9;

FIG. 11 is an enlarged detail view of a glass sheet support arm;

FIG. 12 is a horizontal section taken on line 12—12 of FIG. 7;

FIG. 13 is a fragmentary detail view;

FIG. 14 is a diagrammatic view of the control system; and

FIG. 15 is a fragmentary perspective view of a modified form of the invention.

Referring now particularly to FIGS. 1 and 2 of the drawings, there is shown a curved, all-glass multiple sheet glazing unit, designated by the numeral 20, and comprising bent glass sheets 21 and 22, respectively, integrally joined together by side walls 23 between the marginal edge portions of the sheets to form a hermetically sealed, dead-air space 24 therebetween (FIG. 2). The glass sheets 21 and 22 will be seen to include flat wall portions 25 and 26 and cylindrically bent wall portions 27 and 28. Disposed adjacent a side wall 23 and in at least one corner of the unit, a dehydration hole 29 is provided in one sheet, such as the sheet 22, as in FIG. 3; the hole or holes 29 being ultimately sealed to hermetically close the air space 24.

As herein described, it is believed readily understandable that the curvatures to which the sheets 21 and 22 have been bent about a common axis is only shown by way of example and that sheets bent to cylindrical or compound curvatures of larger and/or smaller radii are considered to be within the spirit of the invention.

As seen in perspective in FIG. 4, an apparatus, generally designated by the numeral 30, for producing curved, all-glass multiple sheet glazing units in accordance with the present invention, includes a tunnel-type furnace 31 having a preheating section A, a first sealing section B having burner assemblies 32, a second sealing section C having a burner assembly 33, and an annealing lehr or cooling section D. Extending entirely through the furnace 31 is a power driven, horizontally disposed roll conveyor 34 with a forward loading area E and a rearward unloading area F. Generally speaking, the furnace 31 is formed by suitably insulated walls and, as more specifically shown in FIGS. 6, 7, 8 and 9, includes a top wall 35, bottom wall 36 and oppositely disposed vertical side walls 37 and 38. As well, an opening in the front wall 39 of the furnace, and the rear wall in the same manner, is closed by a vertically movable door 40 to permit access and removal of glass sheet-carrying racks into and out of the heated atmosphere of the furnace. As shown in FIGS. 6 and 8, the side walls 37 and 38 are equipped with burner units 41 that are instrumental in providing the desired range of temperature in the preheating section A and to maintain the sheets in a heated condition throughout the sealing operations.

A pair of glass sheets, preparatory to the formation of a curved all-glass unit 20, are first assembled in superimposed relation and are then bent to the desired curvature. This is conventionally accomplished, as illustrated in FIG. 5, by passing the pair of sheets, while supported on a bending mold, through a furnace. As herein shown, the furnace 45 is provided, in its walls, with heating sources 46 and a horizontally disposed roll conveyor 47. A pair of flat glass sheets S when supported on a mold 48 are carried by the conveyor 47 through the heated atmosphere of the furnace and, after settling while heat softened into conformity with the shaping surface 49 of the mold, are suitably annealed in a subsequent zone of gradually reduced temperature.

Although the glass sheets are herein shown as bent to the shaping surface of a substantially continuous rail 49 which includes at least two oppositely disposed convex sections, it will be appreciated that the same or like curvatures can be obtained on the surfaces of shaping rails which include oppositely disposed concave sections. In this respect, the glass sheets can also be bent so that

they will later be more accurately spaced from one another by employing the techniques set forth in Patent 2,377,849, issued June 12, 1945. As provided in this patent, a spacer sheet, of suitable material such as glass and of desired thickness, is interposed between the sheets to be bent with the inner, opposed surfaces of the sheets being coated with a suitable parting material that will prevent adherence between the sheets when they are subjected to bending temperatures.

As will be more fully hereinafter set forth in detail, the pair of bent glass sheets, such as the sheets 21 and 22, are then arranged one above another in fixed spaced relation on a suitable support rack in the loading area E of the apparatus and are brought to a temperature above their point of strain in the preheating section A of the furnace 30. They are then carried between concentrated sources of heat from the burner assemblies 32 in the first sealing section B to cause the marginal edge portions of the flat side portions 25 and 26 to be progressively heat-softened, united and fusingly sealed to one another. The sheets are then moved forwardly and halted in the second sealing section C whereupon the concentrated sources of heat from the burner assembly 33 are moved past the marginal edge portions of the curved side portions 27 and 28 to seal the same together in substantially the same manner. The completed unit is thereafter conveyed into and through the annealing section D from which it is eventually delivered into the unloading area F.

As seen in FIG. 8, the transverse dimension of the uppermost sheet 21 is relatively larger than the lower sheet 22; this being also true of the other or longitudinal dimension as in FIG. 6. The peripheral portions of the upper sheet therefore project outwardly beyond the corresponding peripheral portions of the sheet 22 therebeneath. Thus, the outwardly projecting marginal edge portions of the sheet 21, upon being heated, are deflected downwardly and are thus adapted to form the side wall 23 extending continuously around the sides of the completed unit.

To this end, the pair of bent sheets are arranged in superimposed, spaced relation on a rack, generally designated by the numeral 50, and including a base 51 and a frame 52, carried on the base by suitably spaced posts 53. The frame 52 is substantially the same in size as the size of the lower glass sheet 22 and is formed to conform to the curvature thereof along two opposite longitudinally disposed sides. Thus, the side portions 54 of said frame are flat or straight and are substantially parallel to the axis of curvature of the remaining curved side portions 55. The uppermost bent sheet is supported in spaced relation to the upper surface of the frame and more especially to the bent sheet 22, when located thereabove, by means of arms 60 that are adapted to initially maintain the predetermined spaced distance between the sheets and then be sequentially moved from such position of support as the fusing operation proceeds and about which more will be said later.

As illustrated in FIG. 11, each support arm 60 generally includes a bar 61 carried on the upper surface of a block 62; said block being rotatably mounted by a pin 63 on a bearing member 64 fixed on the posts 53 of rack 50. The bar 61 is adjustably secured to the block 62 by a screw 65 passing through a slotted opening 66 in the bar whereby the said bar is movable inwardly or outwardly according to the adjacent edges of the glass sheets. The block 62 is provided with a horizontal, outwardly-directed handle 67 by which the arm 60 is adapted to be swung from the operative position of FIG. 11 to a second position in which the bar 61 is substantially parallel to the edges of the sheets. More particularly, by means later to be described, the handles 67 of the support arms 60 are sequentially engaged, as the heating and fusion of the sheets' edges along two opposed sides is carried out, to remove the inner ends 68 of the bars 61 from the position of support in advance of the fusion step.

5

When the sheets are properly mounted on a rack 50, while the same is in the loading end E of the conveyor 34, the door 40 is raised to permit entry of the assembly into the preheating section A of the furnace. After a suitably timed interval during which the glass sheets are properly heated to a temperature above the point of strain, the continued movement of the rack will convey the heat-softened sheets into the area of the first sealing section B and between the burner assemblies 32 located therein.

In viewing FIGS. 8, 9 and 10, the conveyor 34 consists of a plurality of horizontal and transversely disposed rolls 70 which project through the side walls 37 and 38 of the furnace and at their shaft ends are journaled in bearings 71 mounted on a framework 72 of structural channels and pedestals. One end of each roll 70 is equipped with a gear 73; the entirety of the gears being driven by associated worm gears 74 on a shaft 75. As indicated in FIG. 10, the end-most rolls of the first heating section B are independently driven from a source of power (not shown) which circumstance is also applicable to the rolls at the entry end of the annealing section D.

The rolls 70c in the second heating section C are operatively driven by an individual shaft 77 having worm gears 78 meshed with gears 73 on the ends of the respective roll shafts. The shaft 77 is journaled in bearings 79 on framework 72 and is equipped with a sprocket gear 80. As more fully shown in connection with FIG. 14, the sprocket gear 80 on shaft 77 is actively associated with a similar gear 81 on driven shaft 82 by means of sprocket chain 83; shaft 82 being coupled to a source of power 84. Cessation of rotation of the shaft 82 is controlled by a brake device 85 while the shaft is disengaged from motor driven shaft 86 by an electromagnetic clutch 87.

While considering FIG. 10, it will also be noted that guide members, such as are indicated generally by the numeral 90, are arranged along the path of movement of the rack 50 to maintain the same substantially in "centered" relation to the longitudinal axis of the furnace. This is particularly important as the rack is carried between the burner assemblies 32 in the first sealing section B as well as when the rack approaches the area of the second sealing station C. While the exact details of the guide members can obviously be varied, as herein shown, they comprise a plurality of ball-bearing rollers 91 carried by beams 92 which are adapted to be adjustably supported on the side walls 37 and 38. Also as in FIG. 6, guide rollers 93 are carried on the lower portions of the burner assemblies 32 to accurately maintain the involved marginal edge portions of the sheets in substantially precise relation to the heat sources thereof.

Referring now to the first sealing section B, the burner assemblies 32 are arranged along the side walls 37 and 38 and are adapted to function on the marginal edge portions of the straight sides of the sheets located in parallel with the path of rack movement or the longitudinal axis of the furnace. As seen in FIGS. 6 and 8, each burner assembly 32 includes a burner head 100 with means 101 for adjustably mounting the same in proper elevation with respect to the straight sides 25 and 26 of the upper and lower glass sheets on a rack 50. This type of mounting means 101 is generally located adjacent the exterior surface of the side walls 37 and 38 and aligned with openings or ports 102 provided therein; such openings being suitably closed by shutter panels 103. The burner head 100 is equipped with rows of burner tips or nozzles 104 and is located within the furnace by a framework 105 projecting through the respective port 102 and carried on the mounting means 101 externally of the furnace. As aforementioned, the inwardly disposed end of the framework 105 is provided with the rollers 93 which are adapted to engage the longitudinal disposed sides of a rack 50, parallel to the direction of movement thereof. The rollers further operate to shift the burner mountings

6

at each side of the furnace when necessary to insure that the burner tips are properly located above the edges of the sheets to be acted upon. The means for supplying the burner heads with combustible gases and/or coolant and the means for movably supporting the framework 105, such as on a base frame 106, while not herein shown and described in detail, is fully set forth in U.S. Patent No. 2,761,249 above referred to.

Also carried by each burner head is a "knock-out" lever 108 which is positioned forwardly of the rows of tips 104. The lever is so located as to be easily engaged by the handles 67 of the support arms 60 along the respective sides of a rack 50 and thereby successively swing the bars 61 of related arms 60 out of supporting position as the edges of the sheets approach and are progressively moved beneath and through the highly heated atmosphere produced by the flames from the tips 104.

In this connection, it will be appreciated that, as areas of the marginal edges of the upper and lower sheets are progressively subjected to the heat of the burner flames, they are elevated in temperature sufficiently to attain a softened, fusible condition. And, since the greater width of the softened marginal edge portion of the upper sheet overhangs the corresponding marginal edge portion of the lower sheet, it sags or bends downwardly into sealing relation therewith. Upon further movement of glass through the flames of the burner area, the then sealed edges fuse integrally together and thus form a side wall 23 of the unit.

As the rack 50 is moved forwardly along the conveyor 34 from the area of the burner assemblies 32, sealing of the flat side portions 25 and 26 will be accomplished and the partially completed unit advanced into the area of the second sealing section C. It is to be noted that sealing of the flat side portions 25 and 26 is produced during continuous forward movement of a rack 50. According to one mode of operation, the sealing operation for the remaining two sides of the unit is carried out when the associated rack reaches a predetermined point and is temporarily halted.

As the rack 50 arrives within the defined area of second sealing section C, the leading end thereof comes into contact with a barrier device generally designated by the numeral 110. This barrier includes a pair of transversely spaced stop members 111 carried on a rock-shaft 112 journaled at its ends in bearings 113 on channels 114 of the framework 72. As best seen in FIG. 7, each stop member 111 is formed with an upwardly directed arm 115 and has a hub 116 fixed on the shaft 112 by bolts 117. Each arm 115 has a horizontally disposed contactor element 118. Substantially simultaneous with halting of the rack by the barrier device 110, the leading portion of the rack is instrumental in initiating a cycle of the second sealing operation by the interruption of a beam of light L originating in one component of a signal device including a lamp or light source 119 mounted as in the side wall 37 and normally influencing the activity of a receiver or photo-cell 120 similarly mounted as in the side wall 38, FIGS. 9 and 10; the related operation being set forth in connection with the discussion of FIG. 14. The shaft 112 of the barrier device 110 at one outwardly directed end fixedly carries a lever arm 121 which by clevis 122 is connected to the rod 123 of piston 124 contained in a cylinder 125. As shown in FIGS. 9 and 10, this cylinder is mounted by a platform 126 on the framework 72.

The burner assembly 33, which effects sealing of the curved edge portions 27 and 28, is formed by a pair of burners 130 and 131 that are equipped with rows of nozzles 132. Each burner is mounted at the upper end of an arm 133 and 134 comprising upright elements of a swingably-mounted framework generally designated by the numeral 135. The arms are freely movable through slotted openings 36a in the bottom wall or floor 36 of the furnace 31. Each of the arms is swingably mounted on an annular rod 136. The rod 136 is mounted at its opposite

ends in similarly former brackets 137 having blocks 138 in which the rod ends are secured. Each bracket is vertically supported by its integral base 139 and has an elongated slot 140 therein. As viewed in FIG. 12, the blocks 138 are substantially T-shape in cross-section and are formed with flanges 141 secured by bolts 142 to the respective bracket 137. The leg portions of each block on their inwardly directed surfaces form a guide element 143 interfitting with a slot 140.

As also seen in FIGS. 7 and 12, the arms 133 and 134 are formed with elongated slots 144 in which the guide elements 145 of journal blocks 146 are received. The blocks are secured to the proximate surface of the respective arms by bolts 147 passed through notches 148 in the flanged extensions 149 of the blocks. Preferably, spacing collars 150 are located between the opposed wall surfaces of the blocks 138 and 146. A sleeve bearing 151 is provided in a centrally located bore in each of the journal blocks to serve as a trunnion in which each arm is swingably mounted on the rod 136. Adjacent the lower end of each arm, an opening is provided for receiving the respective end of an annular bar 152, parallel to the rod 136, which is restrained from endwise movement by lock collars 153. Medially in its length the bar 152 carries a T-shaped fitting 154 that is engaged at its ends by lock collars 155 thereby permitting rotation of the fitting on bar 152 without undesired endwise movement. The fitting comprises the end element of an actuator linkage generally designated by the numeral 156 and operatively associated with a cylinder 157 mounted by platform 158 on the framework 72. If desired, a stop device 159 can be employed to limit forward swinging movement of the framework 135.

The linkage 156 includes a rod 160 secured at one end to the fitting 154 and having a clevis 161 attached to its opposite end. By means of axle 162, the clevis is connected to one end of a rock-lever 163 which at its opposite end is connected to a clevis 164 at the end of rod 165 of piston 166 (FIG. 14), by axle 167. The rock-lever 163 is supported on a shaft 168 journaled at its ends in bearings 169 on a bracket 170 attached to the framework 72.

As set forth in an earlier portion of the specification, the utility of the sealing apparatus and practicality of the burner assembly 33 is not restricted to the arc of one cylindrical curvature to which a pair of glass sheets can be bent in the production of a curved all-glass glazing unit. In fact, a variety of types of curved glazing units can be produced with the initial use of bending molds having a shaping surface which include curved sections of one radius or another and with support racks, such as the rack 50, the rails 55 of which are shaped to a selected new curvature. Also, the desired distances between the burners 130 or 131 and the axis of the support rod 136 as well as the distances between the rod 136 and the bar 152 can be similarly adjusted.

To this end, the arc through which the lower ends of arms 133 and 134 can be swung is adapted to be varied by adjustments in the positions of blocks 146 within the slots 144 of the arms. This can be readily accomplished by loosening of bolts 147 and shifting of the block within the limits of notches 148 or advancing, in either direction, i.e. upwardly or downwardly, and replacement of the bolts in additional tapped holes 171. This manner of adjustment can also be initially employed to precisely locate the arms with regard to the parallel rod and bar 136 and 152. For substantially the same purpose, the blocks 138 can be shifted within the confines of the slots 140 to "level" the rod 136 before the bolts 142 are tightened.

The burners 130 and 131 are connected to sources of combustible gas and oxygen by lengths of flexible tubing 173 and 174 from valves 175 and 176 (FIG. 14), through which the pressures of the flames of nozzles 132 can also be regulated. Also, the arms 133 and 134 carry blocks 177 which are adapted to actuate the support arms 60 as previously described.

In reviewing the operation of forming a curved all-glass glazing unit, and having particular reference to sealing of the curved sides of the sheets, attention is now directed to FIG. 14 wherein the electrical and pressure systems are illustrated. Thus, when the rack 50 has been carried into the area of the second sealing station C, further movement is halted as the leading side of the rack contacts the stop members 111. Substantially simultaneously, the rack interrupts the light beam L from the lamp source 119 to the photo-cell receiver 120. Source 119 is in circuit with source line 180 by lines 181 and 182 to the opposite source 183. The circuit of receiver 120, on the other hand, is controlled by timer relay 185, in circuit with source lines 180 and 183, which normally completes a circuit to the receiver by line 186. When beam L is interrupted, receiver 120 establishes a circuit by line 188 to timer (T.R.) 185 and timing relays (T.R.) 190, 191, 192 and 193. T.R. 190 monitors a period of time during which the conveyor rolls 70c will remain idle; T.R. 191 monitors a period of time during which restriction valves 175 and 176 will permit an increased supply of gas and oxygen to be directed to the burners of sealing units 130 and 131 and T.R. 192 is adjusted to monitor an interval of time during which the burners or sealing units are carried to the opposite end of their path of motion. Timer relay 193 becomes active when the sealing operation has been effected to swing the stop members 111 from engagement with the rack 50 after which the conveyor rolls 70c are again driven by the source of power 84 to carry the rack and completed unit to the annealing section D. After line 188 has been completed from receiver 120 to timer relays 185, 190, 191, 192 and 193, T.R. 185 is activated to open the circuit of line 186 until the sealing operation has been consummated and the rack removed from the area. This temporarily renders the photo-cell receiver idle.

Timer 190 establishes a circuit by line 195 through the solenoid 196 of relay switch (R.S.) 197 and line 198 to opposite source 183. Armature 200, against the bias of spring 201, is adapted to deenergize electromagnetic clutch 87 which connects the output shaft 86 of motor source 84 with driven shaft 82, on which sprocket 81 is mounted, while also activating brake device 85. To this end, switch arm 202 normally completes a circuit from source 180, contact 204 and line 205 through clutch 87 and line 206 to source line 183 and, when solenoid 196 is energized, will be caused to open said circuit. Likewise, associated switch arm 207 will be moved to complete a circuit from source line 180, contact 209 and line 210 through brake 85 and line 211 to source line 183 thereby halting rotation of shaft 82 and consequently the conveyor rolls 70c driven by the shaft 77.

During this interval, timer 191 has completed parallel circuits from source line 180 by line 215 through restriction valves 175 and 176 and line 216 to opposite source 183. This operates to increase the intensity of the burner flames at nozzles 132 of burners 130 and 131 to the desired temperature for the sealing action.

Cylinder 157 is connected by pipes 218 and 219 to four-way valve 220 which is conventionally connected to a source of pressure by pipes 221 and 222. When the sealing frame 135 is at rest, as in FIG. 9, by way of example, a circuit is completed from source line 180, switch arm 223 of relay switch (R.S.) 224, contact 225 and line 226 through end 227 of valve 220 and line 228 to opposite source line 183. This operates to supply pressure through pipes 218 and 221 to the head end of cylinder 157 and pipe 219 and 222 to the return pressure side. However, when timer 192 has monitored the desired period of time, a circuit is completed by line 233 through the solenoid 234 of R.S. 224 and line 235 to opposite side 183. In consequence, armature 236, against bias of spring 237, causes switch arm 223 to disengage contact 225 to open the circuit of line 226 and simultaneously move associated switch arm 238 to circuit closing relation with con-

tact 239. This will make a circuit from source line 180 and line 243 through the end 244 of valve 220 and line 245 to opposite source line 183. The resulting direction of pressure through pipe 219 to the rod end of cylinder 157 will move piston 166 inwardly thereby causing the sealing frame 135 to be swung forwardly through its arcuate path. Upon reaching the limit of its motion as determined by the stop device 159, the frame is halted while T.R. 191 "times out" to open the circuit of line 215 to valves 175 and 176. This results in a reduction of pressures to the burner units 130 and 131.

At this point and upon completion of the fusing operation, T.R. 193 becomes functional to remove the stop members 111 from contact with the rack 50. Normally the stops are maintained in their upper position by the direction of pressure from supply pipe 221 through the four-way valve 247 to pipe 248 and the head end of cylinder 125; pipe 250 to valve 247 connecting the rod end of said cylinder to return pipe 222. This direction of pressure through valve 247 is maintained by reason of an electrical circuit from source line 180, switch arm 252 of R.S. 253, contact 254 and line 255 through end 256 of the valve 247 and line 257 to opposite source 183. When T.R. 193 is active, a circuit is completed by line 260 through the solenoid 261 of R.S. 253 and line 262 to opposite source line 183; this serving to actuate armature 263, against the bias of spring 264, and open circuit of line 255 at contact 254 while engaging associated switch arm 265 with contact 266. The end 267 of valve 247 is thus energized by a circuit from source line 180, switch arm 265 and contact 266, line 268 through said valve end and line 269 to the opposite source line 183. The valve 247 will now deliver fluid from pressure pipe 221 through pipe 250 to the rod end of cylinder 125. This will move the piston 124 and associated rod 123 inwardly and through lever 121 rock the shaft 112 to swing the stop members 111 downwardly and release the rack.

T.R. 190 ceases to function at this time, breaking the circuit of line 195 through the solenoid 196 of R.S. 197 and permitting spring 201 to move the armature 200 and related switch arms 202 and 207. In one instance, the arm 202 again engages contact 204 to restore the circuit of line 205 to the electromagnetic clutch 87 while the arm 207 breaks the line circuit through brake 85 to deenergize the same. Resumption of the drive to sprocket chain 83 causes the rolls 70c to remove the rack 50 toward the annealing area D.

T.R. 193, at the termination of its monitor interval and after movement of the rack from the area of sealing station C, opens the circuit of line 260 whereupon inactivity of solenoid 261 of R.S. 253 permits spring 264 to reverse armature 263. Switch arm 265 is now swung to open the circuit of line 268 at contact 266 while switch arm 252 resumes engagement with contact 254 to restore the circuit of line 255 to end 256 of valve 247 whereupon the direction of pressure via pipe 248 will cause return of the stop members 111 to their positions above the conveyor rolls 70c.

During the final sequence of a sealing operation as produced by the foregoing circuitry and the controls thereof, T.R. 192 "times out" to break the circuit of line 233 to the solenoid 234 of R.S. 224. Spring 237 is now permitted to move the armature 236 to its normal position in which switch arm 223 reengages contact 225 while switch arm 238 is freed from contact 239. The following reversal of the circuits of lines 226 and 243 shifts the direction of pressure through valve 220 with resulting movement of the piston 166 toward the rod end of cylinder 157. Obviously, the sealing frame 135 is thus returned to its starting position.

Lastly to time out is the T.R. 185 which restores the circuit of line 186 to the photo-cell receiver 120. Since the departure of a rack 50 from the area of sealing station C again places the receiver 120 under the influence of the beam L from light source 119, the control system is

again conditioned to repeat a full cycle of sealing operation when a subsequent rack is moved into engagement with the stop members and the beam L is again interrupted.

While the utility of the sealing apparatus of this invention has been described in connection with all-glass multiple sheet glazing units including two sheets initially bent to the cylindrical curvature of a desired radius, it is further contemplated to employ such apparatus in the production of similar glazing units formed with spaced glass sheets bent to agree with a so-called "compound" curve. That is to say—the curved sections of a mold's shaping surface will be finished to continuously include an arcuate surface of one radius and an adjoining arcuate surface of a different, longer or shorter, radius. For this purpose, there is shown in FIG. 15, a modified form of framework including spaced arms, one being designated by the numeral 275. The arm of this modified construction is formed with a bifurcated end 276 to provide an elongated notch 277. A burner assembly 278 is intended to be slidably supported with respect to the notch 277 and to be moved therealong according to a template member 279 having a surface 280 of a generated compound curve. The template is understood to be replaceable and one is mounted on the floor 36 of the furnace in spaced relation to each of the respective arms 275 of the framework.

The burner assembly 278 includes a burner 282 mounted on a support member 283 having a depending wall 284 that is in sliding contact with the opposed surface of the arm 275. The wall 284 is equipped with ball-bearing rollers 285 adapted to traverse the opposed surfaces of the notch 277 and are retained therein by washers 286. The lower end of the wall 284 is formed with a strap portion 287 encircling the arm 275. A grooved roller 288 is rotatably supported on the strap portion and functions as the support element for the burner assembly with reference to the template member 279. That is to say—as the arms are swung in an arcuate path about the axis of the support rod 136, the rollers 288 will traverse the surfaces of the templates to simultaneously cause the burner assemblies to move upwardly and downwardly in agreement with the template surface.

During a sealing operation, a rack carrying a partially sealed unit, indicated in broken line by the numeral 290, is halted in the area of the second sealing station C and upon interruption of the light beam L will cause the control system illustrated in FIG. 14 to function in the previously described manner. According to the modified aspects of the invention, however, as the framework including a pair of arms 275 is actuated by the cylinder 157 to swing forwardly, the grooved rollers 288 will traverse the surfaces 280 of their respective templates 279 whereupon the burner assemblies 278 will progressively rise and then descend. This will carry the flames of the heat sources progressively across the marginal edge portions of the curved edges of the sheets in substantially the same manner as earlier set forth.

In an alternative type of apparatus it is contemplated that the path of movement of the pair of bent sheets will more nearly approximate an L-shaped path or a U-shaped path such as is disclosed in the aforementioned Patent No. 2,761,249. That is to say—the sheets will be carried along a straight path from a loading area through the preheating zone and the area of the first sealing station. As herein set forth, this will position the flat marginal edge portions of the sheets parallel with path of movement and consequent sealing of these edge portions in the first sealing area. The sheets then enter a corner area so as to be carried along a path of movement at substantially a right angle to the original path. This will position the curved marginal edge portions of the sheets such that they be disposed parallel to the path of movement.

Now, according to the contemplated alternative type of apparatus, the burner assemblies in the area of the second sealing station are slidably mounted as shown in

FIG. 15. In the present instance, however, the support arms are fixed in a vertical position and the template member associated with each burner assembly is adapted to be moved along a path parallel to the path of movement of the bent glass sheets. Thus, as a pair of bent sheets are moved between the burner assemblies, the templates are caused to move in synchronism and move the assemblies in a vertical direction according to the generated template surface. In this connection, it is to be noted that the control surface of the template in this event can be generated by a cylindrical curve or a compound curve.

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, as well as various procedural changes may be resorted to without departing from the spirit of the invention.

I claim:

1. Apparatus for producing all-glass multiple sheet glazing units which are curved about one axis only, comprising means supporting said sheets in parallel face-to-face relation in a substantially horizontal position, a conveyor for moving said supporting means through a heating furnace along a predetermined path parallel to the straight edges of said sheets, a first pair of burners disposed in a fixed position on opposite sides of said path and adapted to direct concentrated heat against the marginal portions of the straight edges of said sheets to fuse the same together as the sheets move along said path, a second pair of burners spaced from the first and spaced apart along said path, means supporting said burners to move transversely to said predetermined path along an arcuate path corresponding in curvature to the curved edges of said sheets and adapted to direct concentrated heat against the marginal edge portions thereof when said sheet supporting means is positioned between said burners, means for stopping said sheet supporting means between said burners to position said sheets for fusion of their marginal edges by said burners, means for moving said second burners along said arcuate path, and means supplying combustible gas to said first and second pairs of burners.

2. Apparatus for producing all-glass multiple sheet glazing units as defined in claim 1, in which said means supporting said second pair of burners comprises a pair

of elongated arms attached to said burners and extending downward therefrom below said conveyor, base members mounted in a fixed position beneath said conveyor, means mounting said arms on said base members for pivoting movement about an axis parallel to said predetermined path, and means linking said arms together for simultaneous movement, said means for moving said burners comprising a reciprocating actuator operatively connected to said arms.

3. Apparatus for producing all-glass multiple sheet glazing units as defined in claim 2, in which said means mounting said arm on said base member comprises a plate received in an elongated slot formed in said arm, a cylindrical shaft attached to and extending horizontally from said base member, a bearing carried by said plate and supporting said plate on said shaft for rotation thereon, and means attaching said plate to said arm in any one of a plurality of positions along said slot.

4. Apparatus for producing all-glass multiple sheet glazing units as defined in claim 2, in which each of said second pair of burners is received in a lengthwise slot formed at the upper end of said arm, said apparatus further comprising means retaining said burner for free up and down movement within said slot, a template mounted alongside said transverse path adjacent said arm and having a cam surface corresponding to the curvature of the sheets formed thereon, and a cam follower carried by said burner and adapted to contact said cam surface thereby causing said burner to move up and down within said slot to follow the curve generated on said cam surface when said arm is reciprocated.

References Cited

UNITED STATES PATENTS

2,573,266	10/1951	Melcher et al.	65—152
2,761,249	9/1956	Olson et al.	65—58 X
3,202,494	8/1965	Woods et al.	65—152 X

DONALL H. SYLVESTER, *Primary Examiner.*

R. V. FISHER, *Assistant Examiner.*

U.S. Cl. X.R.

65—58, 271