Aug. 18, 1925. 1,550,427

R. M. CORL

MANUFACTURE OF GLASSWARE

Filed May 29, 1920 5 Sheets-Sheet 1

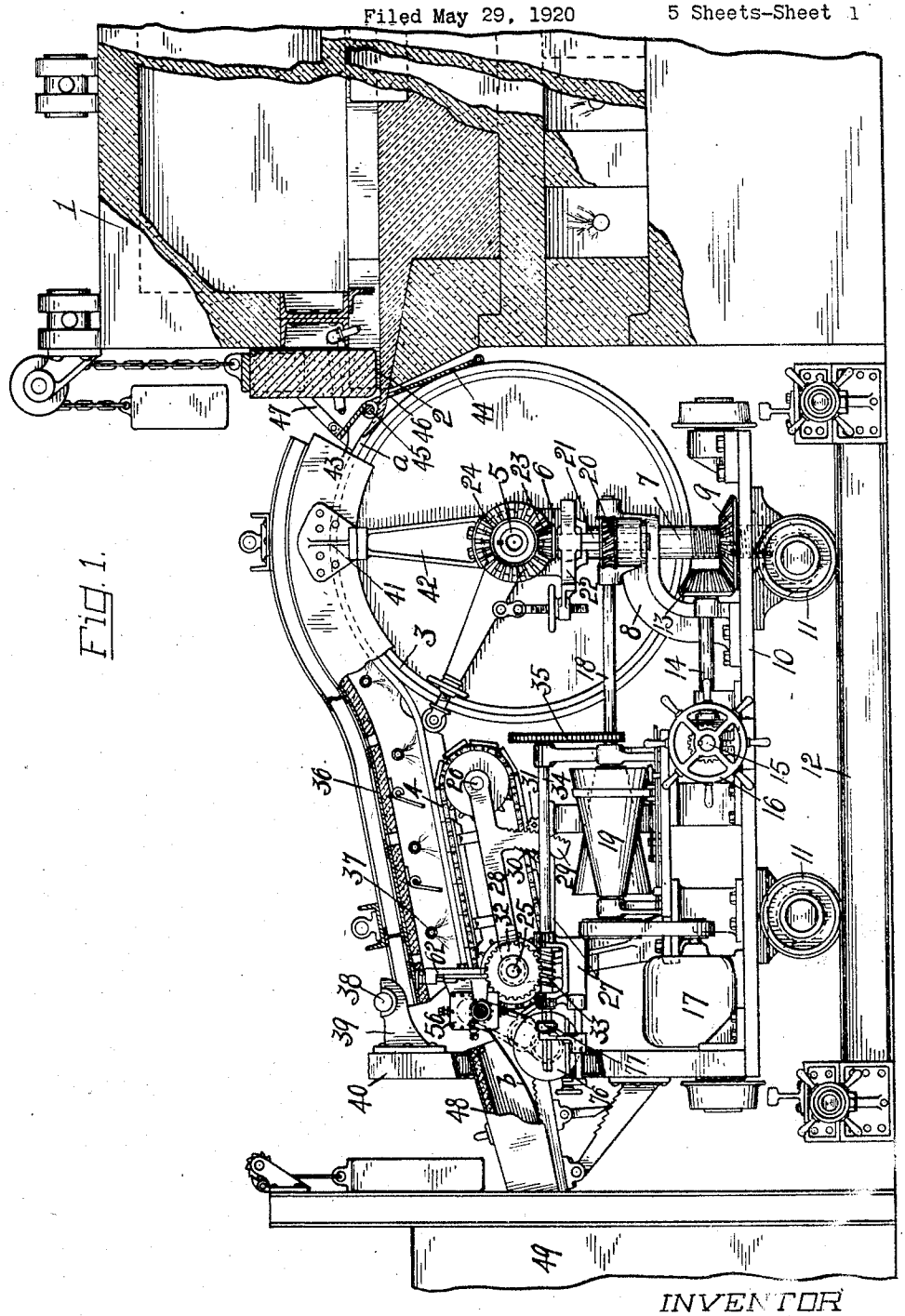


Fig. 1.

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MANUFACTURE OF GLASSWARE

Filed May 29, 1920 5 Sheets-Sheet 2

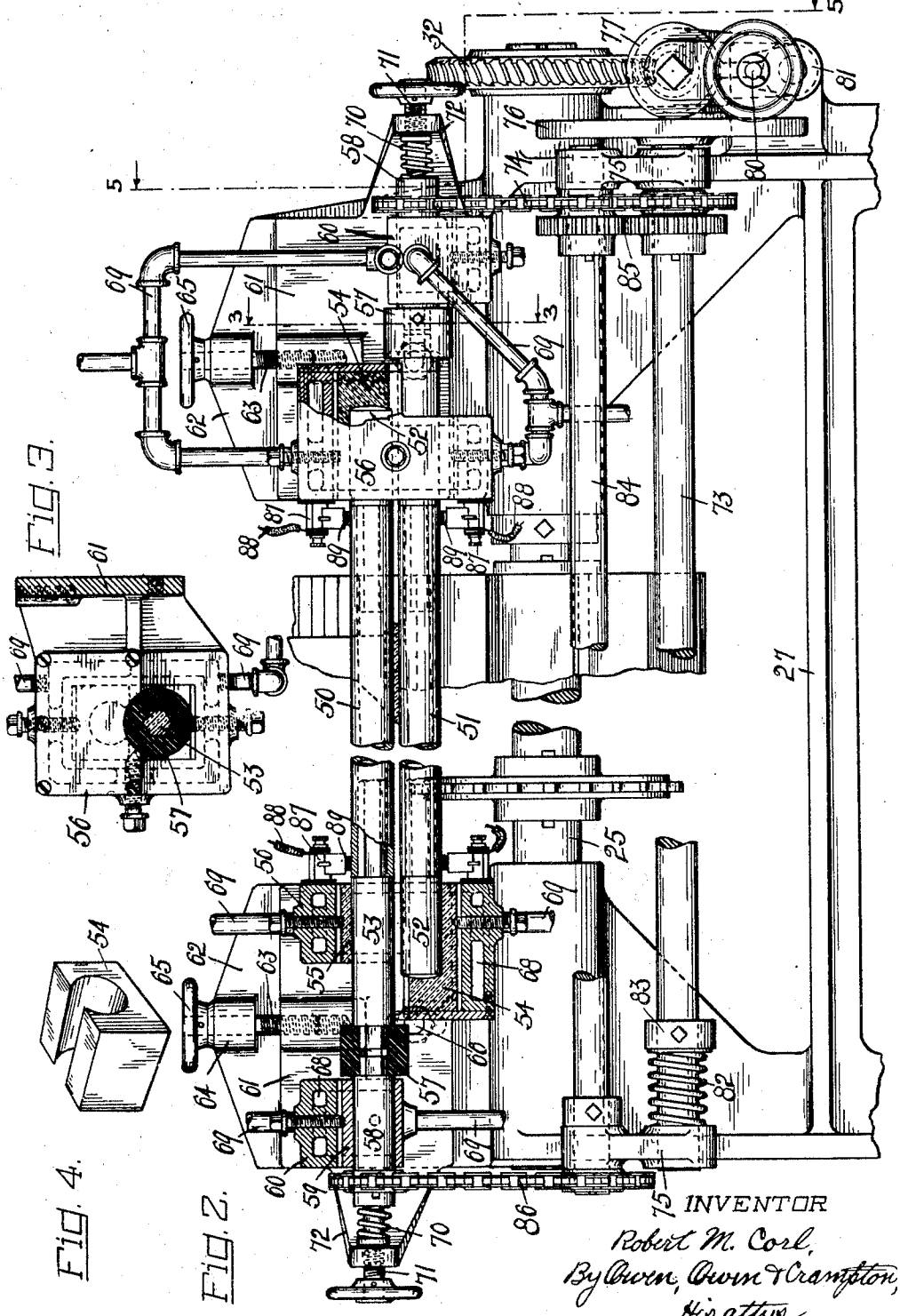


Fig. 3.

Fig. 4.

Fig. 2.

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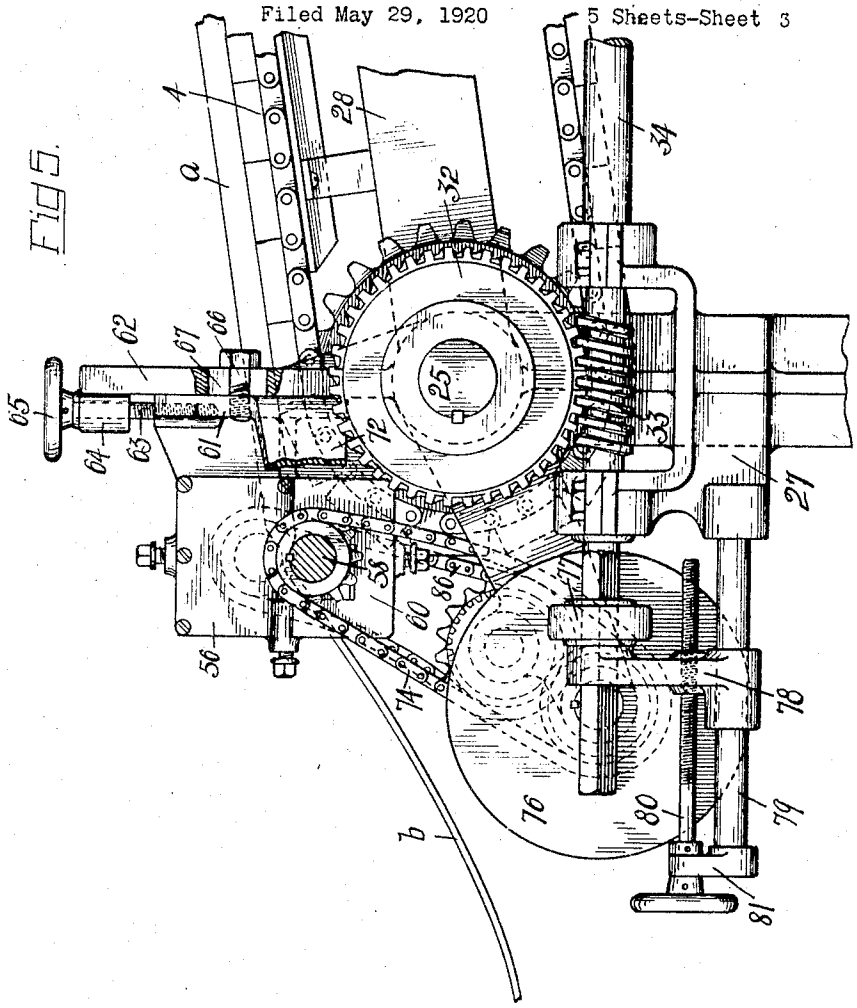
Aug. 18, 1925. 1,550,427

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MANUFACTURE OF GLASSWARE

Filed May 29, 1920 5 Sheets-Sheet 3

Fig 5.



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Aug. 18, 1925. 1,550,427.

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MANUFACTURE OF GLASSWARE

Filed May 29, 1920 5 Sheets-Sheet 4

Fig. 6.

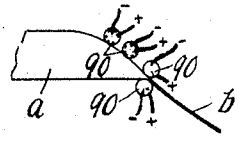


Fig. 7.

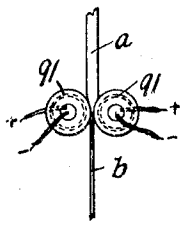


Fig. 8.

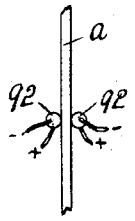


Fig. 9.

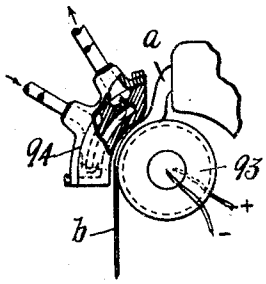


Fig. 10.

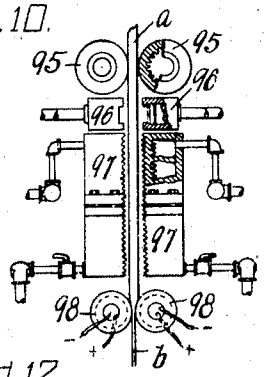


Fig. 11.

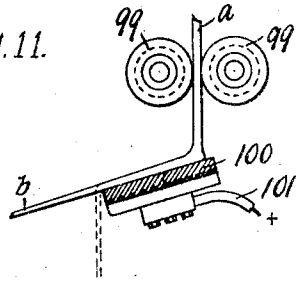


Fig. 14.

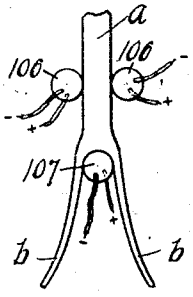


Fig. 12.

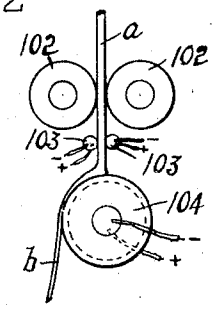
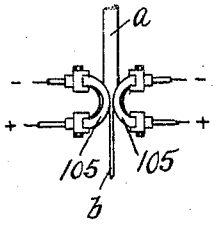


Fig. 13.



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Aug. 18, 1925

1,550,427

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MANUFACTURE OF GLASSWARE

Filed May 29, 1920

5 Sheets-Sheet 5

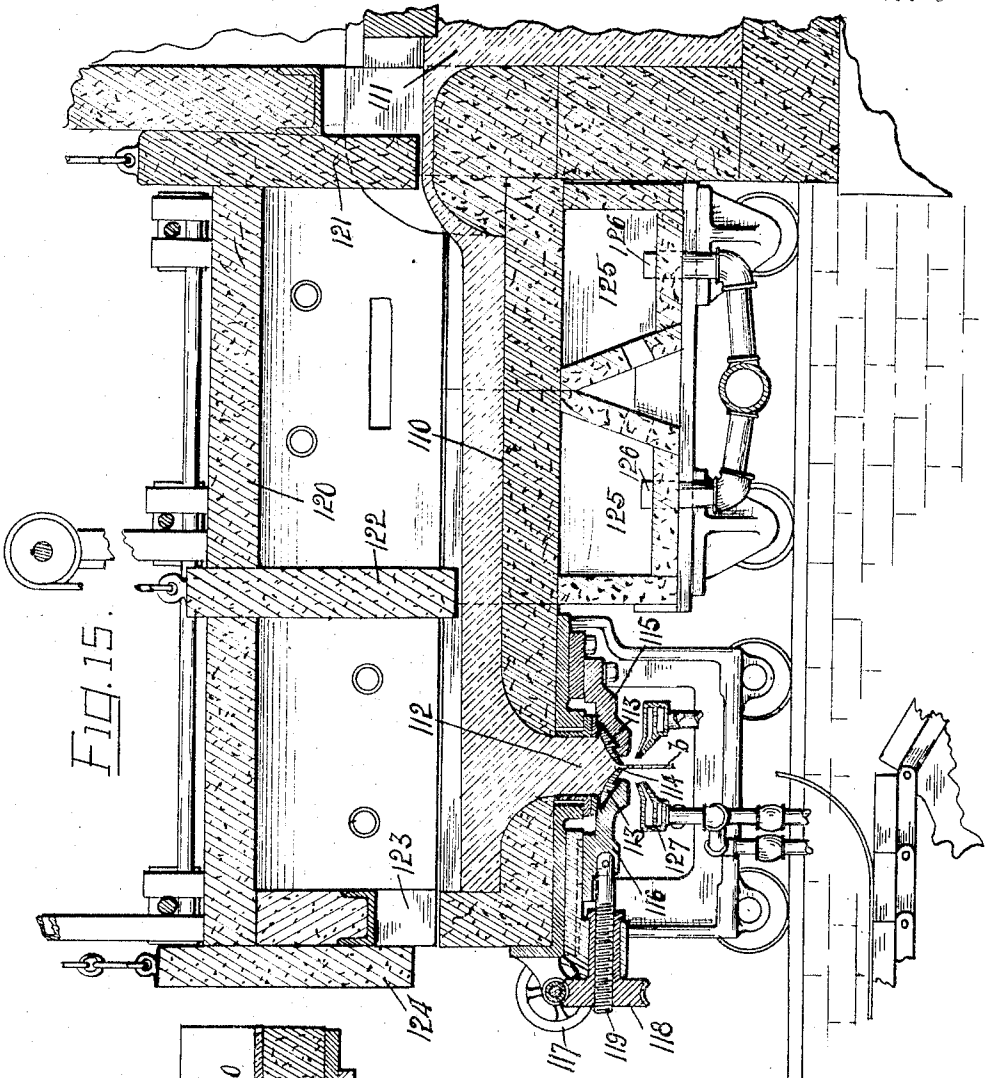


Fig. 15.

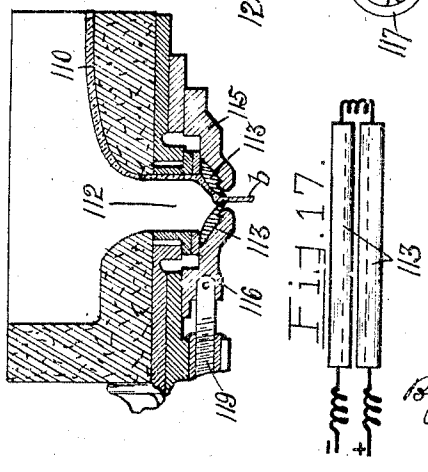


Fig. 16.

Fig. 17.

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Patented Aug. 18, 1925. 1,550,427

UNITED STATES PATENT OFFICE.

ROBERT M. CORL, OF MAUMEE, OHIO.

MANUFACTURE OF GLASSWARE.

Application filed May 29, 1920. Serial No. 385,391.

To all whom it may concern:

Be it known that I, ROBERT M. CORL, a citizen of the United States, and a resident of Maumee, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in the Manufacture of Glassware; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to the manufacture of glassware, and has for its object the provision of a method and means for manufacturing glassware, particularly sheet glass whereby the glass is obtained from a source of supply and conveyed or directed to a forming point, and there brought into contact with a solid heating means to form a continuous column of predetermined shape.

A further object of the invention is the provision of a method and means for converting a previously shaped mass of glass into a form of lesser thickness by the application of a converting heat to the mass by physical contact of a heating element therewith, whereby the temperature of the mass is raised sufficiently to flow glass therefrom. This includes flowing from a molten source of supply a sheet mass of glass of greater thickness than the finished sheet to render it easy to control, to reduce its sensitiveness to temperature changes and to give it a uniform temperature condition throughout and then applying a converting heat to the forward end portion of the mass by direct physical contact of a heating member therewith to cause a sheet of less thickness than the glass to flow therefrom.

A further object of the invention is to utilize the contact heating or converting means as a thickness gauge for the forming ware, and also as a surface glazing means therefor, whereby the sized or formed ware will have a natural heat finished surface.

Another object of the invention is to melt or impart to glass the proper forming temperature by the direct contact therewith of an electric resistance heating element.

Another object of the invention is the provision of an electric resistance heating element for direct melting, heating or gauging contact with glass, which element is composed of a material adapted to form an efficient electrical resistance for heating purposes which will withstand the deteriorating or breaking down action of high temperatures and the chemical action of molten glass.

The invention is fully described in the following specification, and while, in its broader aspect, it is capable of being practiced in numerous forms, a few embodiments only of means for practicing the same are illustrated in the accompanying drawings, in which,—

Figure 1 is a side elevation of an apparatus for practicing the invention, with parts broken away. Fig. 2 is an enlarged front elevation of the converting means thereof with parts broken away. Fig. 3 is a section on the line 3—3 in Fig. 2. Fig. 4 is a perspective view of one of the bearing blocks for the converting rolls. Fig. 5 is an enlarged section on the line 5—5 in Fig. 2 with parts broken away. Figs. 6 to 14 inclusive, are diagrammatical illustrations of different converting means for practicing the invention. Fig. 15 is a central longitudinal vertical section of a different form of apparatus for practicing the invention with parts broken away. Fig. 16 is a fragmentary view thereof with the glass flowing in sheet form to and through the slot between the heaters, and Fig. 17 is a diagrammatical view of the electric heating elements.

This application is filed as a continuation of my former application, Serial No. 272,572, filed January 22, 1919, for so much of the matter as is common to both.

Referring to the drawings, 1 designates a furnace or other suitable source of molten glass supply, which has an outlet 2 through which the glass may flow in the form of a sheet mass *a* of predetermined width or thickness. The sheet mass *a* in the present instance is illustrated as flowing onto and over a drum 3, rotating at the speed of movement or flow of the sheet, and thence over an endless conveyor or apron 4 to the point at which the converting heat is applied, which heat reduces the thickness of the sheet mass the desired extent, as indicated by the thin sheet *b*.

The drum shaft 5, which may be hollow for cooling purposes, is journaled at each

end of the drum in a bearing standard 6, which has a vertical shaft part 7 extending downward through the registering bearing in the bracket arm 8 and threaded at its lower end through a beveled gear 9. The bracket arm 8 is mounted on a frame 10 having supporting wheels 11, operating on respective rails 12, and the beveled gear 9 rests on said frame. A beveled pinion 13 is in mesh with the gear 9 and has its shaft 14 suitably journaled and in beveled gear connection with a shaft 15, carrying a hand wheel 16. It is apparent that a turning of the hand wheel will impart rotation to the shaft 9 and effect a raising or lowering of the associated standard 6, 7.

Rotation is imparted to the drum 3 from a motor 17 on the frame 10, which motor is connected to the shaft 18 through a variable speed device 19. The shaft 18 is journaled at its rear end in the bearing arm 8 and carries a worm (not shown) in mesh with a worm-wheel 20 supported by said arm. The worm-wheel shaft 21 is feathered or otherwise suitably projected through the worm-wheel for axial adjustment relative thereto, and has its upper end journaled in the bearing 22, in the head of the standard 6, and carrying a beveled pinion 23 in mesh with a beveled gear 24 on the adjacent end of the drum shaft.

The conveyor apron 4 passes around sprocket wheels on shafts 25 and 26, the former of which is journaled at its ends in opposite sides of a frame part 27, while the latter has the ends of its shaft journaled in the rear ends of carrying bars 28, which project rearward from the respective ends of the shaft 25, thus adapting the rear shaft 26 to have swinging vertical adjustment about the axis of the front shaft. Each bar 28 has an arm 29 projecting downward therefrom and provided on its front edge with ratchet teeth with which a dog 30, pivoted to the frame part 27 is adapted to engage to support the bar in adjusted position. The rear face of each arm 29 is in the form of a rack with which an adjusting pinion engages. It is thus evident that the inclination of the conveyor apron 4 may be easily and quickly adjusted to place it in desired relation to the drum 3, or to suit any vertical adjustment of the drum.

The shaft 25 is provided with a worm-wheel 32 in mesh with a drive worm 33 on a shaft 34, which is journaled in a part of the frame 27. The variable speed shaft 18 is in driving connection with the shaft 34 through the medium of a sprocket wheel and chain connection 35. It will be understood that the driving connection between the shaft 18 and drum 3 and between said shaft and the apron 4 is such that the drum and apron will be driven at the same speeds requisite to take care of the forward feeding of the sheet mass a from the furnace to the converting means.

The sheet mass a in its passage over the drum 3 is confined within a hood 36, which is intended to protect the sheet from outside temperatures, and is preferably provided with interior burners or other suitable heating means 37 distributed lengthwise thereof, for the purpose of creating a uniform heat condition in the sheet mass but not to raise its temperature sufficiently to effect a melting of the glass. The hood 36 has trunnions 38 at its forward end journaled in bearing brackets 39 extending rearward from the end of the standard 40 rising from the forward end of the frame 10, thus permitting the rear end of the hood to be swung upward out of operative position, or, if desired, the hood may be bodily raised from over the apron and drum. The hood at its rear end is provided with side rests 41 which may seat on the upper ends of vertical extensions 42 of the drum bearing standards 6 when the hood is in operative position.

The sheet mass a adjacent to its point of emergence from the furnace is protected partially from the cooling action of the outside atmosphere by upper and lower baffle plates 43 and 44, which are hinged together on a cross shaft 45 above the sheet. The lower plate 44 has an opening 46 at its upper end through which the sheet a passes and has its lower end bearing against the drum periphery. The upper plate 43 is supported in proper adjustment by one or more suspending arms 47. The formed sheet or ware b after passing from the converting means hereinafter described enters and passes through a protecting housing 48 into and through a leer 49. It is evident that outside temperature is admitted to the interior of the housing 36 through the rear end thereof and also from below to effect a cooling of the sheet mass sufficient to maintain its shape and that temperature within the housing 36 is regulated by the number of burners 37 from which flame is being admitted and the volume of such flame. The cooling of the sheet b within the housing 48 is effected by atmospheric temperature admitted to the interior of the housing or in any other suitable manner, as by the introduction of a cooling blast of air into the housing.

In my former applications, Serial No. 163,569, filed April 21st, 1917, and Serial No. 232,841, filed May 6th, 1918, I disclose the generic idea of flowing glass in sheet form from the shaped mass of glass by applying a converting heat to a localized area thereof, and the heating means illustrated in said applications for performing the converting action disclose the heaters as being out of contact with the glass, as is also the case with the species of the invention dis-

closed in my former applications, Serial No. 246,877, filed July 26th, 1918, and Serial No. 260,162, filed October 29th, 1918.

The sheet converting means with which I have provided the present apparatus contemplates the application of a converting heat to the sheet mass by direct contact of the heating agents therewith, this being accomplished in the present embodiment of the invention by a pair of heating rolls 50 and 51 disposed at opposite sides of the sheet mass and in direct contact therewith instead of being spaced from the sheet mass so that the converting heat is applied to the mass through an interposed film of air. The spacing of the rolls 50, 51 is the same as the thickness of the sheet *b* desired, so that such spacing determines the thickness of the sheet and serves as a gauging means therefor.

The rolls 50 and 51, or at least the portions thereof having contact with the sheet mass, are preferably electrically heated and must therefore be of a material which will stand a very high heat, and at the same time have sufficient electrical resistance to cause the passage of an electric current therethrough to generate a temperature sufficient to effect a melting and flowing of the glass in thinner sheet form from the sheet mass *a* at the point of contact therewith. Experiments have been made with heating rolls and other heating elements of nickel alloy, and it is found that such material will withstand the high heat conditions necessary to melt the glass, and will also withstand the chemical action from the hot contacting glass and offers a high resistance to the passage of an electric current therethrough. It will be understood however, that such material is merely cited as an illustration and is not intended to limit the rolls or heating elements to such material, as other high electrical resistance materials found to be satisfactory for the purpose may be used. Alloys suitable for the purpose are disclosed by the patents to Albert L. Marsh, No. 811,859, granted Feb. 6, 1906, and 859,608, granted July 9, 1907, an alloy of 80% nickel and 20% chromium, in accordance with the disclosure in Patent No. 811,859. having given good satisfaction.

In the present embodiment of my invention the rolls 50 and 51 are hollow in form and each is carried at one end by a journal member 52, and at its other end by a journal member 53, each of which members has a part at its inner end projected into the adjacent end of the respective roll and keyed or otherwise secured therein in a manner to prevent relative turning of the members with respect to their roll. These journals are reversed for the different rolls, and a journal 52 of one and 53 of the other roll are mounted together in respective bearing blocks 54, 55, which are mounted one over the other in spaced relation, in the present instance, within a bearing housing 56. The bearing blocks 54 and 55 are preferably formed of a suitable electrical insulating material and the block 54 for each bearing forms an outer end-thrust bearing for the respective journal 52 as illustrated, while the journal 53 in each case passes through its bearing block 55, and is connected at its outer end through a coupling collar 57 of insulating material with the drive member or shaft portion 58 of the respective roll. The drive member 58 is journaled in a bearing 59 carried by a bearing housing 60 which projects from a plate 61 as does also the adjacent bearing housing 56. The plate 61 is adjustably carried at the front side of a frame part 62 rising from the respective side of the frame 27 and is adjustably carried by a hand adjusting screw 63, which extends downward through a boss 64 in the frame part 62 and threads into the top of the plate. A hand wheel 65 is carried by the adjusting screw at its upper end and bears at its hub against the top of the boss 64. The plate 61 is rigidly clamped in adjusted position to its frame part by a screw 66, which projects through a vertical slot 67 in the frame part 62 and threads into the respective plate 61 (Fig. 5).

Each bearing housing 56 and 60 is made hollow for water cooling purposes, as shown at 68, and a cooling water or fluid is circulated therethrough by circulating pipes 69 leading to and from the same. A yielding end-thrust is imparted to the outer end of each roll by a coiled compression spring 70 interposed between the outer end of its member 58 and adjusting screw 71, which is threaded through a bracket arm 72 projecting from the respective plate 61.

The roll 51 in the present instance, has its drive member 58 in driving connection with a drive shaft 73 through a chain and sprocket connection 74, said shaft being journaled in bearing arms 75 projecting forward from the respective lower portions of the respective frame parts 62. The shaft 73 is driven from the worm shaft 34 through a friction drive connection, the friction disc 76 of which is carried at the outer end of the shaft 73, while the friction drive wheel 77 is carried by the shaft 34 and shiftable lengthwise thereof, transverse to the axis of the shaft 73, to effect a variation in the speed of driving of the shaft 73. A shifting arm 78 is connected to the wheel 77 and is mounted for sliding movements lengthwise of the shaft 34 on a rod 79 projecting forward from the frame 27. An adjusting screw 80 is rotatably mounted in a lateral extension 81 at the outer end of the rod 79 and is threaded through the shifting arm 78. The disc 76 is held in

yielding thrust contact with its drive wheel 77 by the action of a coiled expansion spring 82 on the shaft 73, the opposite end-thrust of the spring being against one of the bearings 75 and a collar 83 on the shaft. The shaft 73 is in driving connection with the jack shaft 84 through a pair of gears 85 of like size, said jack shaft being journaled in the bearings 75 above the shaft 73, and having a chain and sprocket wheel connection 86 with the drive member 58 of the roll 50. It is thus evident that the two rolls are driven at uniform speeds in opposite directions from the shaft 73 and that the speed of driving of such rolls is properly proportioned to the speed of advance of the sheet mass *a*. It is not important however, to proportion the speed of rotation of the heating rolls to the speed of advance of the sheet mass, as the speed of the rolls may be greater or less than the speed of advance of the sheet mass, and may also be in the reverse direction to the advance of the sheet, as occasion may require, as the flowing of the thinner or formed sheet *b* from the forward end of the sheet mass *a* will take place upon a heating of the mass to the necessary converting or flowing temperature irrespective of the speed or direction of rotation of the heating rolls. From experiments which have been carried out, it would appear that it is preferable in practice to impart a back driving rather than a forward driving movement to the rolls.

Secured to the bearing housings 56 at the ends of the rolls 50 and 51 are terminal posts 87 which are insulated from the respective housings and to which electrical leads 88 may be attached. Each post has an electric brush 89 in contact with the respective roll so that each roll is disposed in and forms part of an electric circuit, with one brush forming the positive and the other the negative connection with the roll.

The method which I have described for converting a sheet mass into a sheet of thinner form by the application of a converting heat through contacting heaters may be carried out by numerous means, and in connection with a sheet mass which may be of set or plastic form and moving horizontally, vertically or in any other direction. For instance, Fig. 6 illustrates a horizontally disposed sheet mass *a*, which may be in the form of an ingot, as more particularly disclosed in my former applications, Serial No. 163,569 and 232,841, the converting heat being applied thereto by contacting heating elements 90, which may be electrically heated and either have stationary or rolling contact with the sheet mass to effect the flowing of a thin sheet *b* therefrom. The rolling contact of the heaters is preferable in some cases as a continual changing of the point of contact of the heating elements with the mass is thereby effected.

In Fig. 7 the sheet mass *a* is shown as feeding downward between horizontally spaced contact rolls 91, downward between which the converted sheet *b* of thinner form flows.

In Fig. 8 the heating elements 92, which have opposed contact with a vertically moving sheet *a*, are employed for the purpose of sizing and surface glazing or finishing the sheet rather than for reducing its size.

In Fig. 9 the sheet mass *a* is shown as flowing from the source of molten glass supply onto a heating roll 93, which raises the temperature of the glass to a proper sheet forming viscosity so that the glass flows therefrom in thin sheet form *b*. 94 designates a cooling device by means of which the viscosity of the sheet may be more perfectly regulated under some conditions, and where desired the glass mass may be formed by the action of two different temperatures.

In Fig. 10 the sheet mass *a* is illustrated as passing downward between the gauging and feeding rolls 95, thence between temperature regulating devices 96 and 97, which may either effect a cooling or heating of the mass as desired, and thence between converting contact heaters or rolls 98, which cause a heating of the sheet mass *a* at the point of contact to flow a sheet *b* of thinner predetermined thickness therefrom.

In Fig. 11 the sheet mass *a* is shown as feeding down between rolls 99, and thence onto a contacting heater 100 of slab form from which the converted or softened glass may flow or be drawn in the form of a thin sheet *b*. One of the electrical connections for the plate 100 is designated 101.

In Fig. 12 the sheet mass *a* feeds down between a pair of rolls or guiding members 102, thence between initial temperature raising and gauging contact heaters 103 onto a heater 104 of roll form, from one side of which the glass, as it melts from the mass *a* is permitted to flow in sheet form *b* of desired thickness.

In Fig. 13 the sheet mass *a* feeds down between a pair of stationary heaters 105 which melt or impart the proper temperature to the mass at the point of contact and gauge the thickness of the sheet *b* flowing therefrom. The heaters 105 are made of varying cross section for the purpose of heat distribution in the converter 105.

In Fig. 14 the sheet mass *a* feeds between rollers 106 which may serve both to gauge and heat the sheet, and thence onto a converting heater 107 which splits the mass into two sheets.

In Figs. 15 to 17 the glass is maintained in its plastic state until flowed in final sheet form from the tank through the discharge slot, the electric resistance heaters being disposed at opposite sides of and forming the walls of the slot to give the glass the proper ware forming temperature and at the same time serving as sizing or thickness gauging means therefor. I am aware that it is old to flow molten glass through a slot bound by electric heaters in which the resistance elements are disposed within encasing shells, and I therefore do not claim such feature, but it is novel, so far as I am aware, and important to place the electric resistance elements of the heaters in direct heating contact with molten glass and to form such elements of a material which will withstand the high heat conditions necessary to heat the glass and the deteriorating chemical action of the molten glass, and will also offer a high resistance to the passage of an electric current therethrough.

In the apparatus illustrated in Figs. 15 to 17, 110 designates a trough communicating at one end with a source of molten glass supply 111, and having in its bottom a well 112, the bottom of which is formed by a pair of electric resistance heating bars or plates 113 cooperating to form an elongated discharge slot 114 therebetween, which gauges the thickness of a sheet *b* flowing therefrom. The heating bars preferably have downwardly projected thin edges or lips forming the slot walls. This is quite an important feature for without it the tendency of the glass flowing from the lip is to travel back a distance along the under surface of the lip or member forming the slot or opening, resulting in the formation of streaks and lines on the sheet surface. One of the heater bars is carried by a block or plate 115 fixed to the under side of the trough at one side of the slot and the other heater bar is carried by a movable block or plate 116, which is adjustable to vary the spacing between the two heater bars. The adjustment of the plate 116 is accomplished by the turning of a hand wheel 117, the shaft of which has a worm in mesh with a worm-wheel 118 threaded on the rod 119 projecting outwardly from the plate. The heater bars, if in series circuit, have a flexible electric connection at one and and each has at its opposite end either a positive or a negative connection with a source of electric supply as shown in Fig. 17.

The trough 110 is enclosed over its top throughout its length by a roof or top 120 cooperating with the trough to form a tempering chamber. The communication between the inner end of this chamber and the furnace or other source of supply is shown as being regulated by a gate 121, and the chamber is divided intermediate its ends into two compartments by a gate 122, each of which compartments may have burner openings 128 and openings to the atmosphere whereby a proper regulation of the temperature therein may be effected. The outer compartment is shown as having at its outer end an opening 123 to the atmosphere, which opening is regulated by a gate 124. The outer compartment is disposed over the well 112 so that a desired uniform temperature condition may be imparted to the glass therein. The portion of the trough over which the inner tempering compartment is disposed is mounted over heating chambers 125 having burners 126 projected therein. This effects a uniform tempering of the glass stream as it flows over the trough.

The sheet *b* as it emerges from the forming slot has a fluid directed against opposite sides thereof from nozzles 127, which fluid may be either of a cooling or heating nature as temperature conditions without the tank may require. These nozzles for such purpose may be connected both with an air and a gas supply whereby either a cooling air alone or air and gas mixed in ignited form may be directed against the sheet.

In Fig. 15 the well 112 is shown as filled with the molten glass, while in Fig. 16 the molten glass is shown as flowing in thin sheet form into the well and immediately through the slot between the heater bars. In both cases, however, the glass is given the final sheet forming temperature by the heater bar or bars with which it has contact and the sheet is sized by the spacing between the bars.

It will be understood that the various means shown for practicing the invention are merely illustrative of some of such means and are not intended to limit the practicing of the invention by said means, as numerous other means may be employed to carry out the method disclosed. I also wish it understood that the invention is not limited to the use of a sheet mass *a* of any particular consistency as it may be cold and melted by the contact heaters at the point of contact therewith to flow a sheet of lesser thickness therefrom, or it may have a temperature which is not sufficiently high to render it plastic in its nature before being acted on by the contact heaters, or it may comprise a plastic mass, the temperature of which may be lower than that which is proper to form a sheet therefrom and which is raised to the desired forming temperature or gauged as to size by the contact of an electric resistance heater or heaters therewith, this latter idea being illustrated more particularly in Fig. 9 and Figs. 15 to 17. I also wish it understood that the invention

is not limited to the forming of a stream or column of glass in sheet form, as it may be of rod, tubular or other form in cross section.

In all the figures s' own means may be used to secure a uniform temperature and viscosity throughout the mass *a* previous to its being reduced in thickness.

It is evident that the cross sectional size of the sheet or ware operated on can be controlled by the spacing of the connecting elements, for in the latter case, the higher the temperature the thinner will be the sheet or ware. It is also understood that width maintaining means for the formed sheet may be used when necessary or desired.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is,—

1. The method of forming sheet glass, which consists in feeding glass to a sheet forming point, and passing it at said point between electric resistance heaters in direct physical contact therewith to gauge its thickness.

2. The method of shaping glass, which consists in feeding glass into contact with and past the resistance element of an electric heater and thereby giving the glass a shape dependent upon the shape of said element, and allowing the glass to set in the shape so given.

3. The method of forming sheet glass, which consists in feeding glass to a sheet forming point, applying a temperature changing heat thereto at such point by direct physical contact of an electric resistance heater therewith to cause a flowing of the glass from such point in predetermined sheet forming consistency.

4. The method of forming sheet glass, which consists in feeding glass to a sheet forming point, bringing it in physical contact at said point with spaced electric resistance heating elements to heat the glass a predetermined extent to flow a sheet therefrom down between the elements having a thickness equal to the distance between said elements.

5. The method of forming sheet glass, which consists in continuously feeding a sheet mass of glass of set form to a predetermined point, raising the temperature of the sheet mass at said point by direct contact of a non-gaseous heating element therewith to flow a sheet of less predetermined thickness than the mass therefrom.

6. The method of forming sheet glass, which consists in continuously feeding a sheet mass of glass of set form to a predetermined point, raising the temperature of the sheet mass at said point by direct contact of spaced non-gaseous heating elements therewith to flow a sheet of glass from the mass down between the elements, the spacing of the elements gauging the thickness of the sheet.

7. The method of shaping glass, which consists in feeding a mass of glass into contact with a solid heated above the softening point of glass and above the temperature of the contacting glass, thereby causing the mass to assume a cross section dependent upon the shape of the solid, and, as the glass asumes the desired shape, passing it beyond the solid and allowing it to set in the shape assumed.

8. The method of shaping glass, which consists in feeding a mass of glass of set form into contact with a solid heated above the softening point of glass and above the temperature of the contacting glass, thereby causing the mass to assume a cross section dependent upon the shape of the solid, and, as the glass assumes the desired shape, passing it beyond the solid and allowing it to set in the shape assumed.

9. The method of forming a glass stream, which consists in feeding glass through electric heating means in contact with the electrical resistance thereof, and regulating the condition of said resistance so that the glass does not adhere thereto and at the point of contact is softened by the heating means and flows therethrough in a shape and size determined by the heating means.

10. The method of surface finishing glass, which consists in feeding glass between rotating heaters having contact with opposite sides thereof, whereby a melting heat is applied to the glass surfaces at the points of contact.

11. The method of forming glass ware, which consists in feeding glass between rotating electric resistance heaters in non-adherent contact therewith, the glass at the points of contact being melted by the heaters and flowing in predetermined shape from between the same.

12. The method of surface finishing glass, which consists in feeding glass between rotating heaters having contact with opposite sides thereof, whereby a melting heat is applied to the glass surfaces at the points of contact, the rotation of the heaters being reverse to the direction of feeding of the glass.

13. The method of continuously forming sheet glass, which consists in relatively moving a sheet mass of glass and a pair of heating elements, with the latter constituting the resistance elements of electric heaters and at opposite sides of the glass in contact therewith and the condition of the heaters so that the glass does not adhere thereto and so that they effect a melting of the glass and a flowing thereof in thin sheet form between the elements, the spacing of the elements determining the thickness of the formed sheet.

14. In an apparatus of the class described, a metallic heating element of high electric resistance having direct contact with a glass mass being acted on to effect a forming of glass at the point of contact.

15. In an apparatus of the class described, a heating element of nickel alloy having direct contact with a glass mass being acted on to effect a forming of the glass at the point of contact.

16. In an apparatus of the class described, a heated element having continuous non-adherent sliding contact with a glass sheet to effect a melting of the glass surface at the point of contact.

17. In an apparatus of the class described, a pair of heating elements of nickel alloy having direct continuous heating contact with the sides of a glass column to effect a gauging of the sheet at the points of contact.

18. In an apparatus of the class described, a pair of electrical resistance heaters of nickel alloy in direct continuous heating contact with the opposite sides of a glass sheet feeding therebetween to effect a melting of the glass surfaces at the points of contact.

19. In an apparatus of the class described, a heating element constituting the resistance element of an electric heater, means for feeding glass into direct contact with said heating element to effect a softening and changing of the shape of the glass at the point of contact.

20. In an apparatus of the class described, a pair of electrical resistance heating elements, means for continuously feeding glass between said elements in direct contact therewith to effect a melting of the glass surfaces at the points of contact.

21. In an apparatus of the class described, a pair of rotatable electric resistance heaters, and means for continuously feeding glass in sheet form between said heaters in direct contact therewith, whereby the glass is melted at the points of contact and caused to flow from the sheet in predetermined shape.

22. In an apparatus of the class described, a pair of heating rolls, means for continuously feeding glass between said rolls to effect a melting and changing of the shape of the glass by contact with the rolls, and means for imparting rotation to the rolls which is reverse to the direction of flow of glass therebetween.

23. In an apparatus of the class described, a pair of heating rolls, means for continuously feeding glass between said rolls in direct contact therewith to effect a melting and changing of the shape of the glass by contact with the rolls, and means for imparting predetermined rotation to said rolls, each of said rolls being disposed in an electric circuit and comprising a material capable of standing very high heat and which offers a resistance to the passage of an electric current therethrough to form resistance heating elements.

24. In an apparatus of the class described, a pair of electrically heated rolls, means for continuously feeding glass between said rolls in direct contact therewith, whereby a melting of the contacting surfaces of the glass is effected by the rolls, journals carrying and being of a different material than said rolls, bearings for said journals, and means for imparting rotation to said rolls and journals.

25. In an apparatus of the class described, a pair of electrically heated rolls, means for continuously feeding glass between said rolls in direct contact therewith, whereby a melting of the contacting surfaces of the glass is effected by the rolls, journals carrying and being of a different material than said rolls, electrical insulation bearings for said journals, and means for driving said rolls electrically insulated from the heating portions thereof.

26. In an apparatus of the class described, a roll having an electrically heated portion and journal members at the ends of said portion, bearings for said journal members, drive means for said roll connected to and insulated from one of said journal members, an electric circuit with which the heating portion of said roll is in series, and means for feeding glass into contact with the heating portion of said roll whereby a melting of the surface of the glass at the point of contact is effected.

27. In an apparatus of the class described, a roll having a heated portion and journal members of a different material at the ends of said portion, insulation bearings for said journals, one serving as an end-thrust bearing for the roll, drive means connected to one of said journal members and insulated therefrom, means exerting an axial thrust on the roll at the end thereof opposed to its end-thrust bearing, and means for feeding glass to said roll in contact therewith whereby the surface of the glass at the point of contact is melted.

28. In an apparatus of the class described, a pair of transversely spaced rolls each having an electric resistance heating portion and journal portions, bearings of insulating material for said journal portions, drive means insulatingly connected to each of said rolls, and means for feeding glass to and between the heating portions of said rolls in contact with each whereby a melting temperature is applied to the glass by the rolls at the points of contact.

29. In an apparatus of the class described, an electric resistance heating element to which molten glass does not adhere, and

means for continuously feeding glass in sheet form from a source of supply to and into contact with said element, the temperature of the element being sufficient to effect a melting of the glass at its point of contact therewith, whereby the condition of the sheet is changed by the melting action.

30. In an apparatus of the class described, a heating element, and means for feeding glass in sheet form from a source of supply to and into contact with said element, said means comprising a drum, a feeding apron, and means for driving the same at uniform speeds, the temperature of said heating element being sufficient to effect a melting of the surface of the glass at the point of contact therewith whereby the condition of the sheet is changed by the melting action.

31. In an apparatus of the class described, a rotatable electrically heated element to which molten glass does not adhere, means for continuously feeding glass to and into contact with said element from a source of supply whereby a melting of the glass at its point of contact with the heated element is effected to change the condition or shape of the glass, and means for rotating said element.

32. In an apparatus of the class described, a pair of transversely spaced electric resistance heating elements to which glass does not adhere, means for continuously feeding glass to said elements between the same and in contact therewith, whereby a melting of the glass at its point of contact with the heating elements is effected to change the condition of the glass.

33. In an apparatus of the class described, a pair of transversely spaced electrical resistance heating elements, means for continuously feeding glass in mass form from a source of supply to and between said elements in contact therewith, whereby a melting of the glass at its points of contact with the elements is effected and a column of different form caused to flow from the melted end of the feeding mass, and means enclosing the feeding mass and regulating the temperature thereof between the source of supply and said elements.

34. In an apparatus of the class described, a source of glass supply, auxiliary heating means, means for continuously feeding glass in sheet form from the source of supply to said heating means, baffle means between the source of supply and said feeding means to regulate the cooling of the sheet by outside temperature, said heating means being of a temperature sufficient to effect a melting of the glass sheet as it passes the same.

35. In an apparatus of the class described, an electric heating element of nickel alloy having direct heating contact with glass being acted on to form glass of predetermined shape therefrom.

36. In an apparatus of the class described, an electric resistance heating means of nickel alloy arranged to receive glass to be acted on in direct contact therewith, said means having a slot through which the glass acted on thereby flows, and means directing the movement of the glass to the heating means.

37. In an apparatus of the class described, an electric resistance heating element of nickel alloy arranged to have direct contact with a mass of glass to be acted on, and means to continuously advance the glass to said element whereby a sheet of predetermined thickness is flowed therefrom.

38. In an apparatus of the class described, opposed electric resistance elements of nickel alloy forming a slot therebetween, means for directing glass to be acted on to said elements in direct contact therewith to heat and flow the glass in sheet form at predetermined thickness through the slot which serves as a sizing means therefor.

39. The method of forming glass-ware which consists in continuously flowing from a molten source of supply a column of glass of greater thickness than the desired finished ware to render it easy to control and to reduce its sensitiveness to temperature changes, and applying heat to the forward end of the column at a distance from the forming source by direct physical contact of an electric resistance heating element therewith to surface melt the glass and cause a finished column of less thickness than the mass to flow therefrom.

40. The method of forming sheet glass, which consists in continuously flowing from a molten source of supply a sheet mass of glass of greater thickness than the finished sheet to render it easy to control and to reduce its sensitiveness to temperature changes and after the mass has become substantially set in form applying a converting heat to the forward end portion thereof by direct physical contact with a heating solid to cause a sheet of glass of less thickness than the mass to flow therefrom.

41. The method of forming sheet glass, which consists in flowing from a molten source of supply a mass of glass of greater thickness than the finished sheet to render it easy to control and to reduce its sensitiveness to temperature changes, passing the forward end of the mass between electric resistance heaters to which glass does not adhere in direct physical contact therewith to raise the temperature of the mass at the points of contact to flow a sheet from the mass.

42. The method of forming sheet glass, which consists in continuously flowing from a molten source of supply a sheet mass of glass which is of greater thickness than the finished sheet to render it easy to control and to reduce its sensitiveness to tempera-

ture changes, and after the mass has become substantially set in form applying a converting heat to the forward end portion thereof by direct physical contact of an electric heating element therewith to cause the glass to flow from the mass in a sheet of less thickness than the mass.

43. The method of forming sheet glass, which consists in continuously flowing from a molten source of supply a sheet mass of glass which is of greater thickness than the finished sheet to render it easy to control and to reduce its sensitiveness to temperature changes, and after the mass has become substantially set in form applying a converting heat to the forward end portion thereof continuous with the drawing by passing the mass between electric heaters in direct physical contact therewith, whereby a sheet is caused to flow from the mass and is gauged as to thickness by the spacing of the heaters.

44. The method of forming sheet glass, which consists in continuously flowing from a molten source of supply a sheet mass of glass, passing it through a temperature regulating chamber wherein it is permitted to cool sufficiently to maintain a shape and then bringing its forward end into physical contact with an electric heating means which melts the sheet mass to flow a sheet of less thickness therefrom, and carrying the finished sheet away from the sheet mass at the speed of flowing of the same from the mass.

45. The method of forming sheet glass, which consists in continuously flowing from a molten source of supply a sheet mass of glass, passing it through a heated chamber in which the sheet mass is permitted to cool to maintain a shape and then feeding the forward end of the mass between rotatable heating elements in direct physical contact therewith, whereby the glass is melted and caused to flow in finished form from the mass and has its thickness determined by the spacing of the heaters.

46. In a sheet glass forming machine, means forming an opening, the sides of which are formed of nickel chromium alloy, means for supplying glass to said opening, and means for heating the walls of the opening to raise the temperature of the glass supplied thereto and to cause it to flow in a predetermined form through the opening.

47. In a sheet glass forming machine, a metallic member of nickel chromium alloy onto which molten glass flows from a source of supply and downward from which it flows to form the sheet, and means for heating the member to maintain a predetermined temperature condition therein.

48. In a sheet glass forming machine, two metallic members of a nickel chromium alloy defining the walls of a slot or opening and onto which molten glass flows from a source of supply and downward from which through the slot the glass flows to form the sheet, and means for heating the members to maintain a predetermined temperature therein.

In testimony whereof I have hereunto signed my name to this specification.

ROBERT M. CORL.