May 16, 1933. K. E. PEILER 1,909,152

APPARATUS FOR FEEDING MOLTEN GLASS

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Fig. 2.

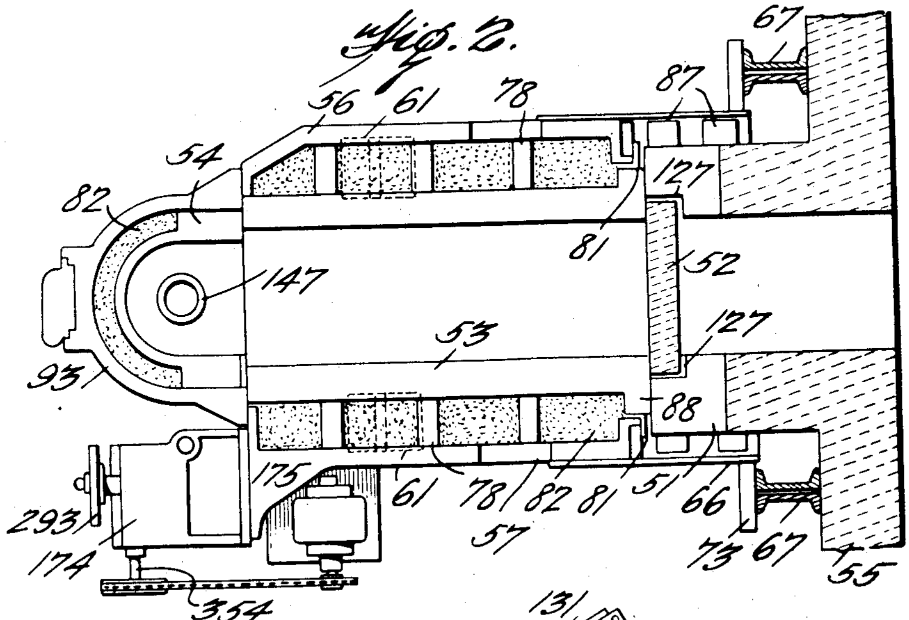
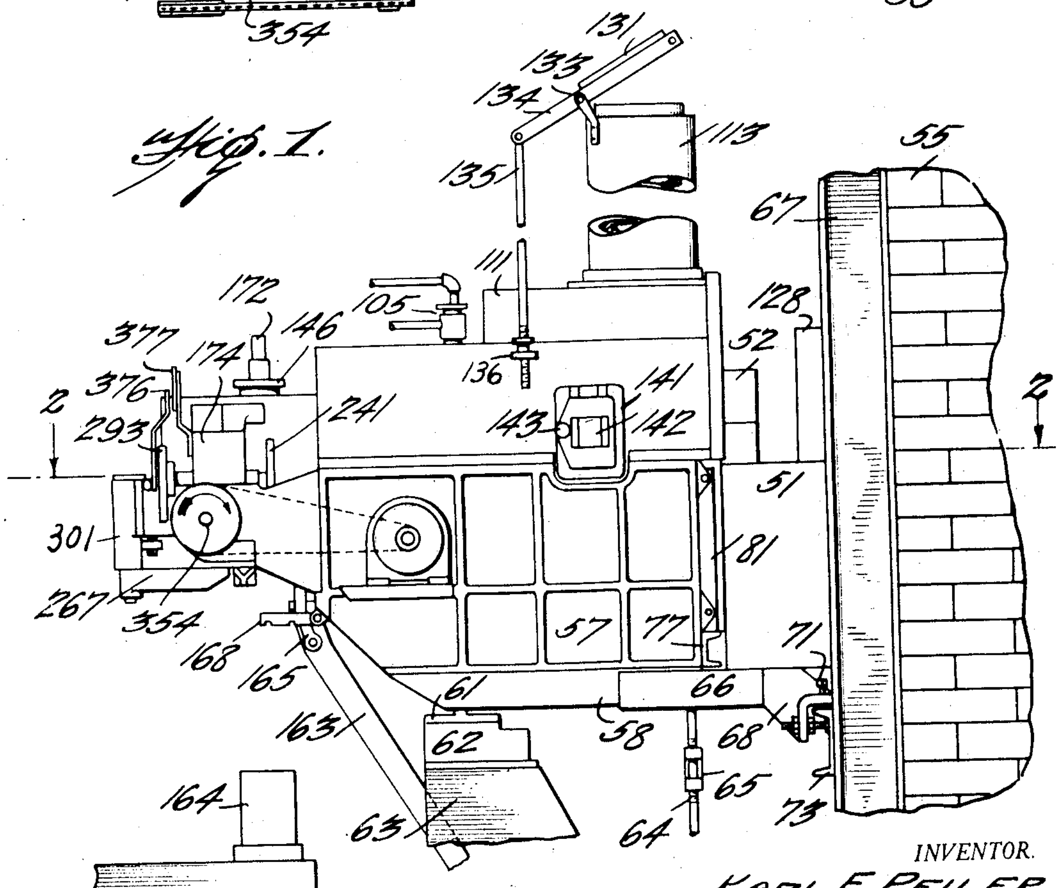


Fig. 1.



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APPARATUS FOR FEEDING MOLTEN GLASS

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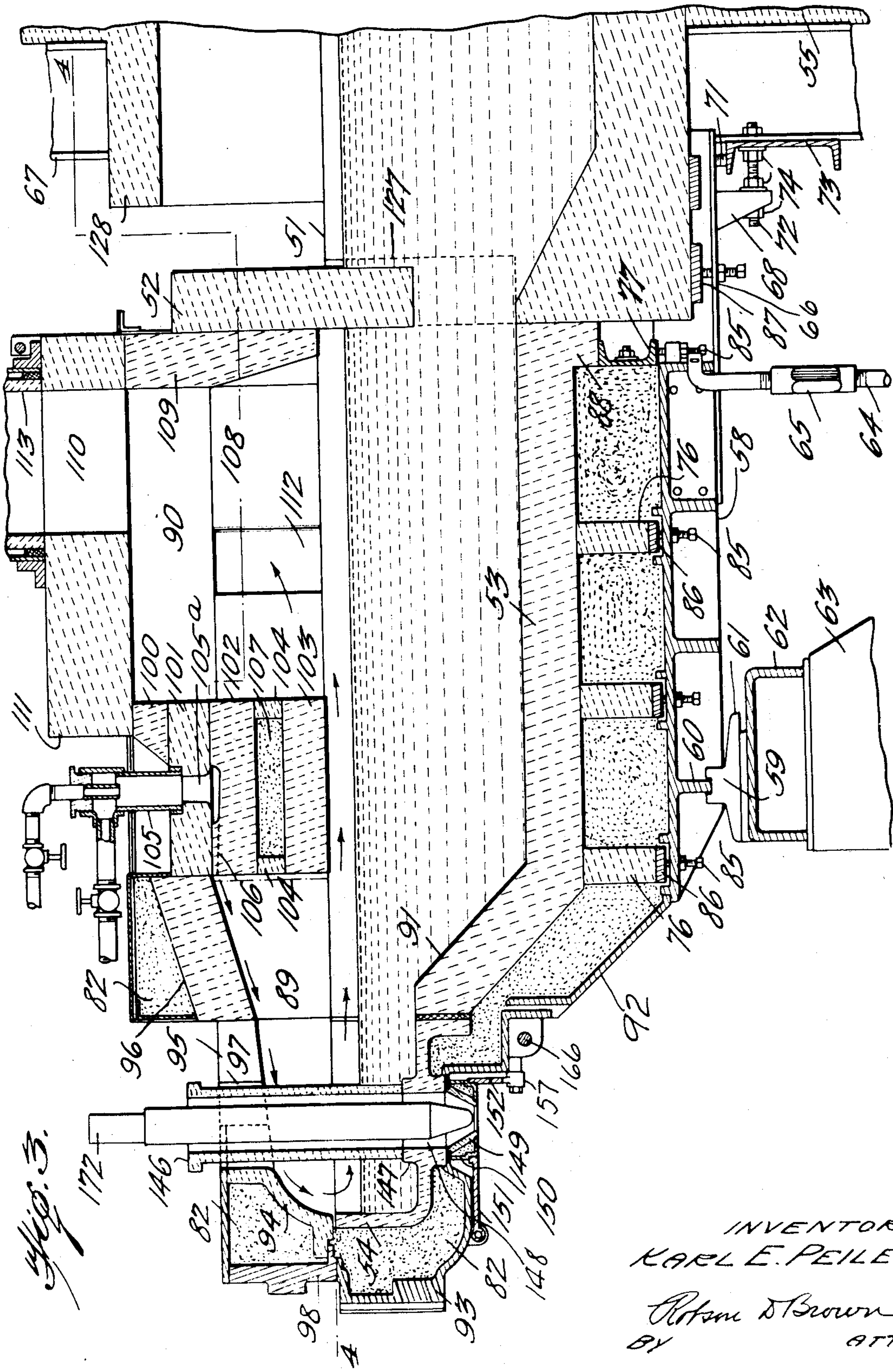

Fig. 3.

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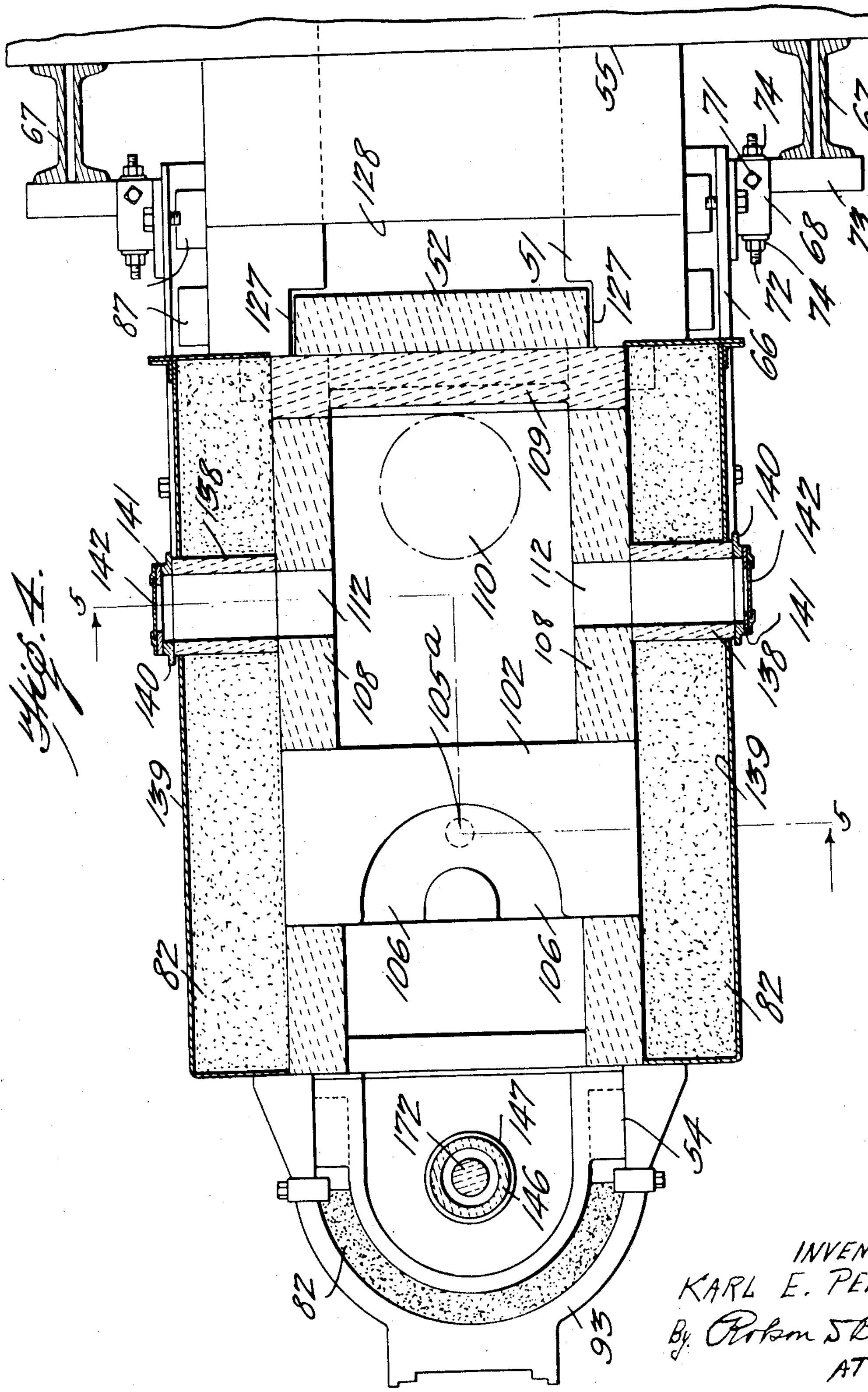

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Fig. 5.

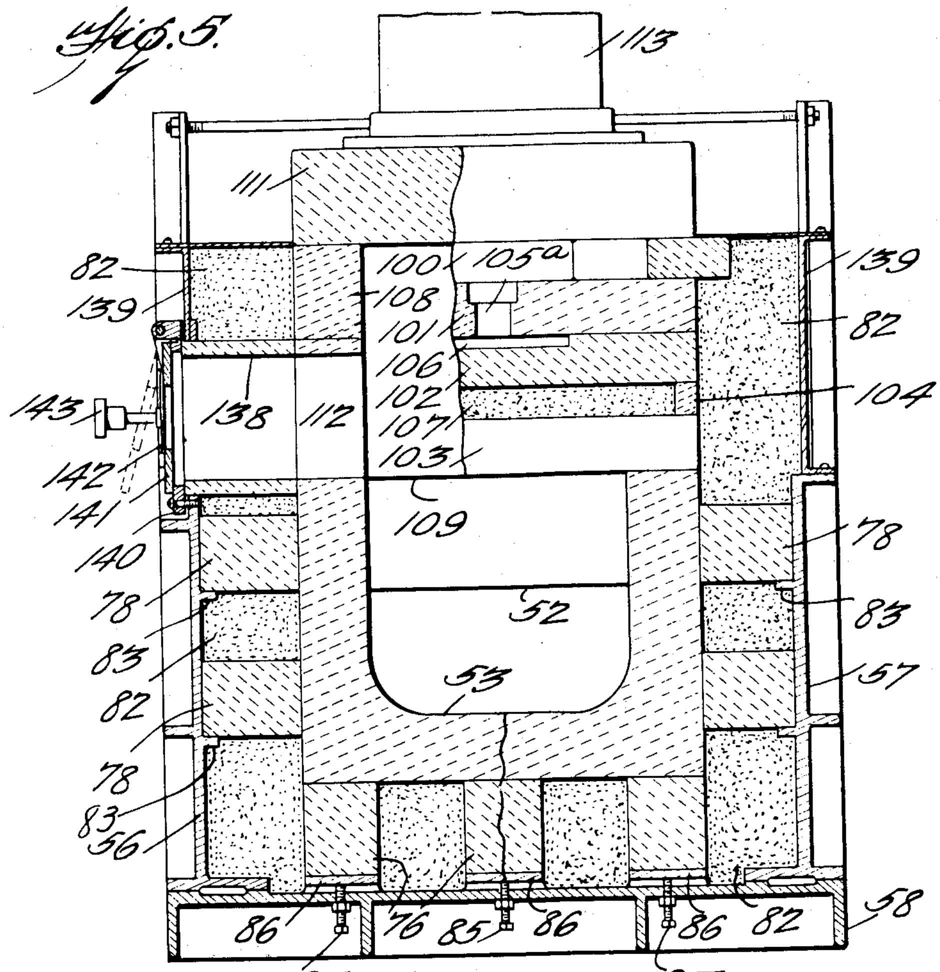
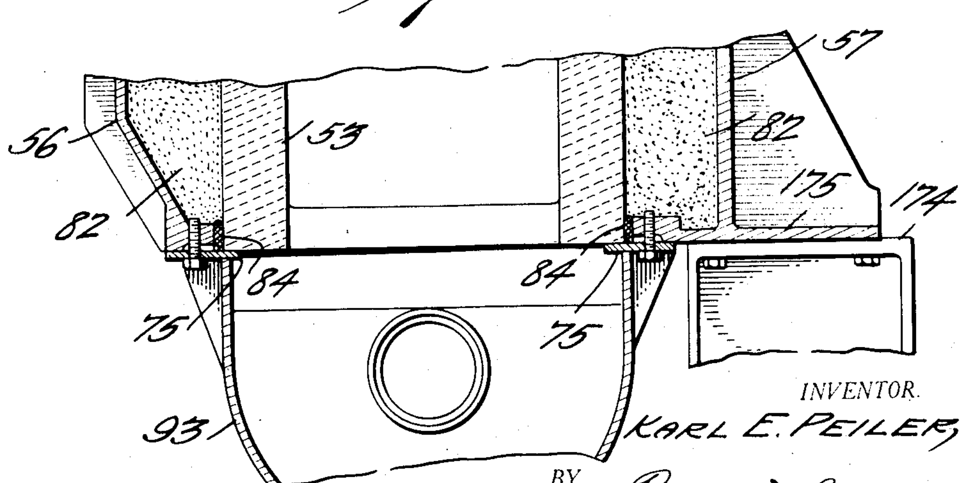


Fig. 6.



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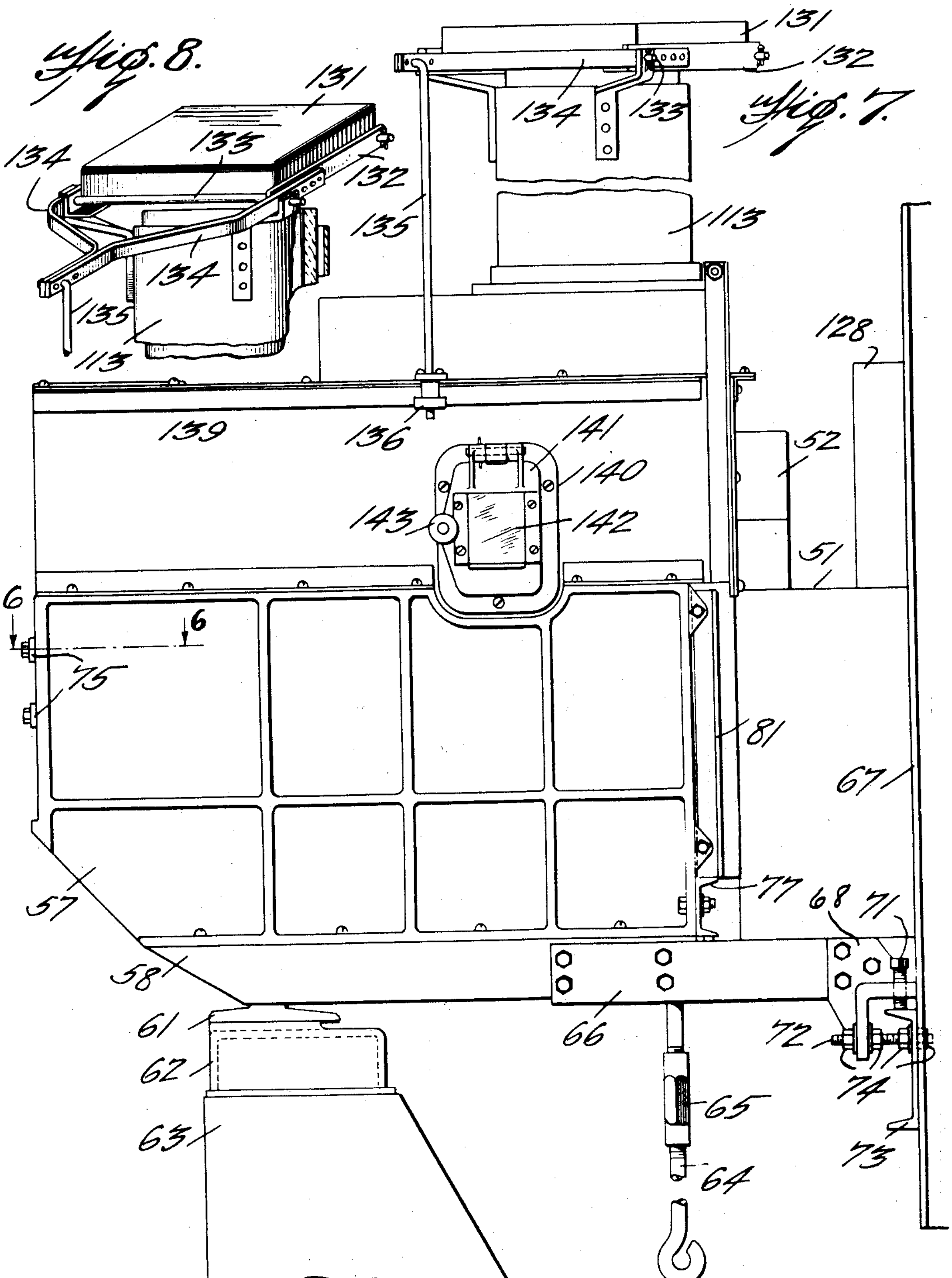

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Fig. 9.

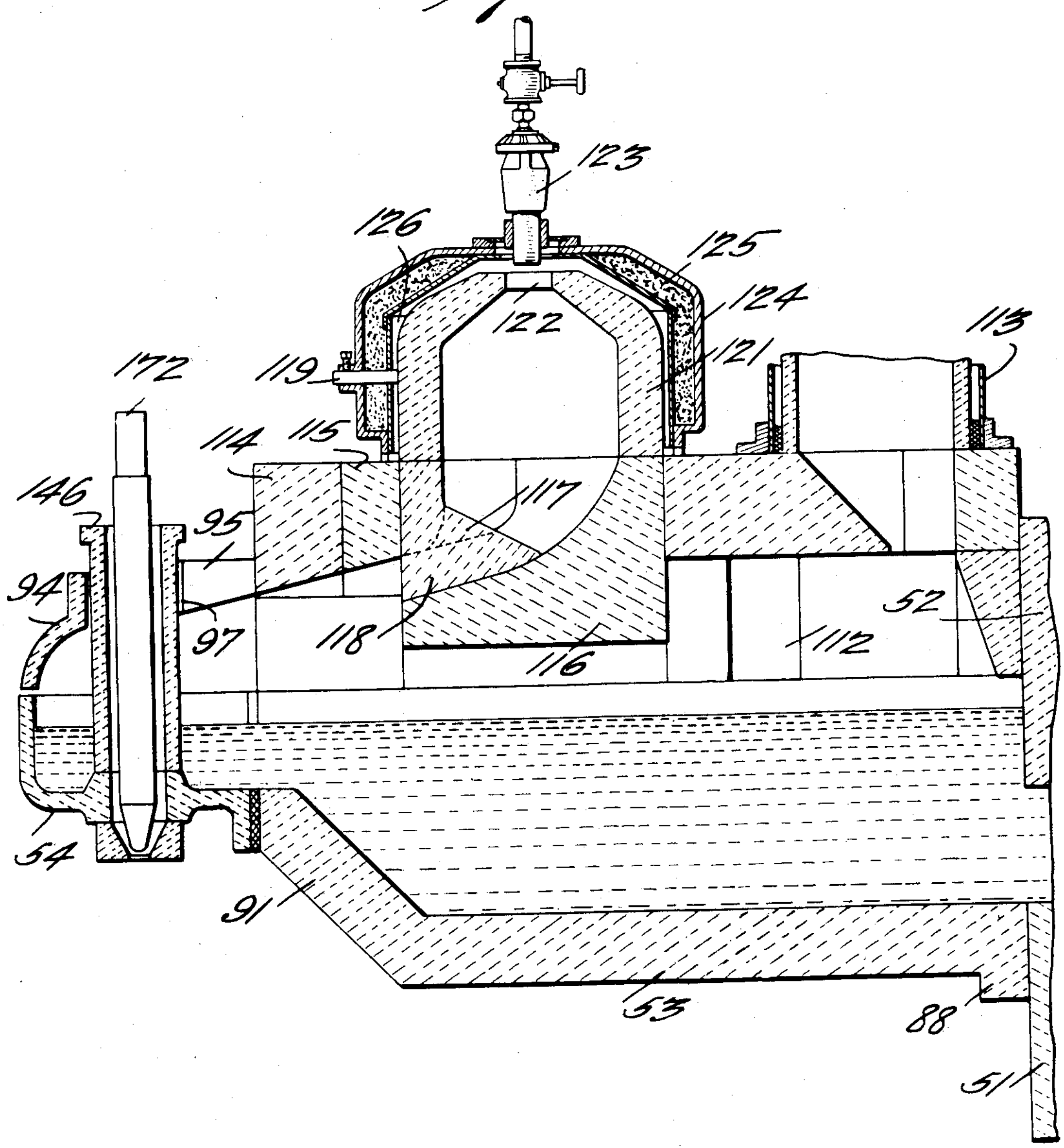

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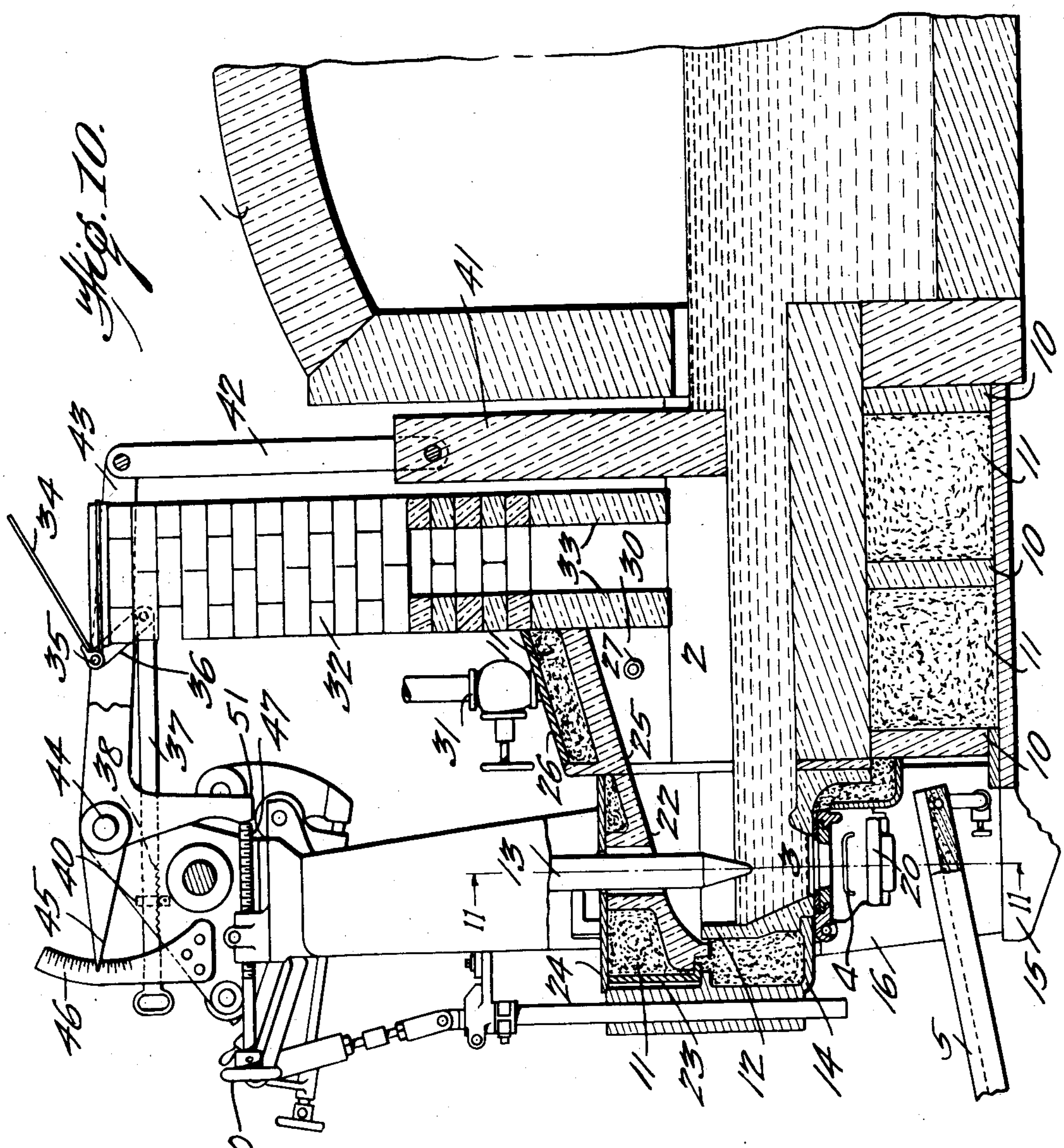
Fig. 10.



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APPARATUS FOR FEEDING MOLTEN GLASS

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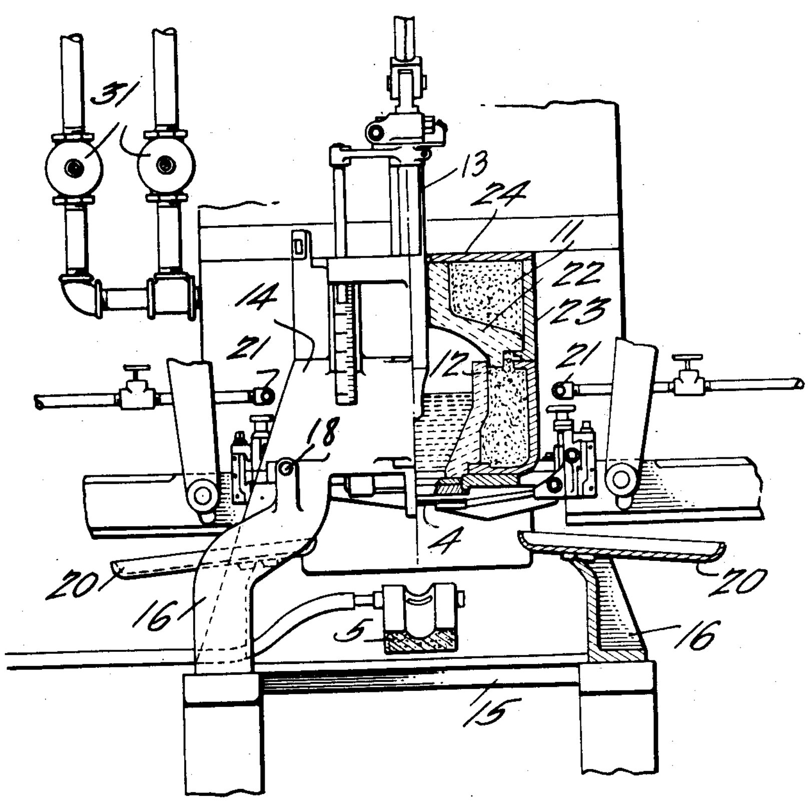
Fig. 11.



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Patented May 16, 1933

1,909,152

UNITED STATES PATENT OFFICE

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APPARATUS FOR FEEDING MOLTEN GLASS

Application filed November 26, 1927, Serial No. 236,025, and in Argentina March 31, 1920.

My invention relates to the art of delivering or feeding molten glass from a glass melting furnace or other container to the molds of a shaping machine and it has special reference to the control of the temperature and viscosity of the glass while the glass is being transferred from the melting furnace or other container to the point of delivery or feed outlet.

More specifically, my invention relates to the construction and mode of operation of a forehearth for receiving the glass from the melting furnace or other container and delivering the glass to a discharge outlet or delivery point in the proper condition to be fabricated into ware by an associated shaping machine.

In feeding molten glass from a tank furnace to shaping machines, it is now customary to flow the glass from the furnace into an auxiliary discharge chamber or forehearth extending from the furnace toward a delivery point where suitable means are provided for forming and separating the glass at the delivery point into a succession of mold charges. In order that the ware produced from these mold charges may be uniform in size and quality, the mold charges must be uniform as to their weight, shape, temperature and viscosity. Uniformity of weight and shape also depends in many feeders on uniform viscosity and temperature which is, therefore, doubly important. The viscosity depends partly on composition of the glass and partly on temperature, and hence proper temperature control is extremely important. Another requirement for proper quality and uniformity of glassware is that the mold charges from which the ware is made shall have the proper homogeneity. To secure proper homogeneity, all portions of the glass approaching the delivery point to form a mold charge must be as nearly the same viscosity and temperature as possible. This makes it important to be able to secure a uniform distribution of temperature and viscosity in the glass approaching the delivery point or feed outlet. The necessary uniformity of the mold charges cannot be produced without careful and accurate control of the temperature conditions in the forehearth since the large mass of glass in the melting furnace is subjected to many variations of temperature and viscosity, and such variations in the melting furnace cannot be economically avoided. Moreover, one furnace generally serves several feeders requiring different temperatures of glass.

The general object of the invention is to provide a new and improved forehearth which will supply and deliver molten glass in the best form and condition for use in the associated shaping machine. A more specific object is to provide such a forehearth having improved means for controlling the temperature of the glass approaching the delivery point and particularly for insuring the uniform distribution of temperature and viscosity in this glass.

Another object of my invention is to provide a forehearth wherein the temperature may be regulated and controlled independently of the temperature conditions in the melting furnace to which the forehearth is attached so that the desired conditions may be maintained in the forehearth in spite of various changes taking place in the draft, and temperature obtaining in the melting furnace.

Another object of my invention is to provide a forehearth in which the distribution of temperature may be controlled at will so that different local effects may be secured to meet the operating conditions. More specifically, it is the object to provide a forehearth of the character indicated having means for controlling the distribution of flames or heated gases therein and particularly to control the direction of projection or flow of such flames or heated gases.

Another object of my invention is to provide a forehearth of the character indicated composed mainly of refractory material and enclosed in a substantially gas tight metal container which prevents undue leakage of air or hot gases through the forehearth walls and enables temperature conditions in the forehearth to be accurately controlled.

A still further object of my invention is to provide a forehearth for conditioning molten glass having refractory parts in contact with the molten glass and in contact with the heated interior of the forehearth and having heat insulation surrounding these refractory parts, the insulation being reinforced with elements of sufficient strength to support the weight of the refractory parts and to hold the same in position.

A still further object of my invention is to provide in such a forehearth proper structural features for supporting and holding the forehearth in connection with a glass melting furnace and for permitting expansion and contraction and securing the desired alignment of their parts.

Among various features of the invention for the accomplishment of these objects, and such other objects as will appear, are the following. A forehearth for conducting the glass from the melting furnace to the discharge outlet or delivery point is provided with suitable means for controlling the temperature and condition of the glass discharged or delivered, independently of the temperature and conditions in the melting furnace. This forehearth is also constructed and arranged so as to permit free and independent expansion and contraction of the glass furnace and of the forehearth parts, and to permit proper location and adjustment of the forehearth relative to the furnace. The forehearth is provided with improved heating means and is particularly adapted to deliver glass at the discharge outlet in a homogeneous condition.

This application is a continuation in part of my copending applications for Letters Patent, Serial No. 294,792, filed May 5, 1919, now Patent No. 1,655,391, method of and apparatus for feeding molten glass, and of my copending application for Letters Patent, Serial No. 683,576, filed Dec. 31, 1923, now Patent No. 1,760,254, apparatus for feeding molten glass.

In the accompanying drawings:

Figure 1 is a side elevation of the apparatus of my copending application, Serial No. 683,576, filed Dec. 31, 1923, showing the forehearth and part of the glass melting furnace and a mold to which the charges are delivered, some details being omitted;

Fig. 2 is a plan view in section approximately on the line 2—2 of Fig. 1;

Fig. 3 is a side elevation of the same apparatus in larger scale and in section on the longitudinal center line through the forehearth and part of the glass melting furnace, certain parts being omitted;

Fig. 4 is a plan view in section taken substantially on the line 4—4 of Fig. 3;

Fig. 5 is a front elevation in section substantially on the line 5—5 of Fig. 4;

Fig. 6 is a plan view in section substantially on the line 6—6 of Fig. 7;

Fig. 7 is a side elevation of the same forehearth;

Fig. 8 is a detailed view in side elevation showing the open position of the stack damper;

Fig. 9 is a side sectional elevation similar to Fig. 3 but showing a different construction for heating the forehearth;

Fig. 10 is a side elevation of the apparatus of my copending application, Serial No. 294,792, filed May 5, 1919 shown partly in section along the center line of the forehearth with the shear mechanism omitted and showing the glass melting furnace and the forehearth; and

Fig. 11 is a front elevation taken partly in section along the line 11—11 of Fig. 10 of the center portion of the apparatus and shows the impeller outlet and shear carriers with the right hand shear in place and the left hand shear omitted.

The following is a copy of a portion of the specification of my copending application, Serial No. 683,576, filed Dec. 31, 1923 and describing the apparatus of Figs. 1 to 9, inclusive:

This embodiment of my invention comprises a forehearth connected to a glass melting tank or furnace and provided with a discharge outlet, together with mechanism for discharging the glass periodically, accumulating each discharge at the outlet to form it into a mold charge, and severing the charge.

The forehearth may include an extension 51 of the furnace walls by which it is connected to the furnace, and preferably comprises a separator or sealing block 52, a channel or conduit 53, and a bowl or discharge chamber 54, provided with suitable covers, casings, supports and temperature control means. As shown in Fig. 3, the glass flows from the furnace 55 under the sealing block and into the forehearth by gravity.

One of the features of this invention comprises means for suitably supporting the forehearth and its glass conducting channel, so that it may be properly connected and aligned with the glass furnace, and yet be free to move with the furnace to permit the contraction and expansion of each. For this purpose the forehearth is preferably carried by a casing, comprising side walls 56 and 57 (Figs. 1, 5 and 6) and a bottom plate 58, which also permits suitable insulation of the forehearth. The inner end of the bottom plate 58 is connected with the steel bracing of the furnace, and may be supported thereby. It is supported at its outer end by means such as a pair of iron shoes 61 (Figs. 1, 2 and 3) which are free to slide horizontally in any direction upon a cap 62 of the pier 63, as the furnace expands or contracts.

The supporting shoes 61 are also preferably arranged to permit the forehearth to be tilted longitudinally upon the shoes, to permit the adjustment of the inner end of the forehearth into conformity with the level of the adjacent end of the furnace, and to allow that inner end to follow changes of the furnace level caused either by expansion, contraction or settling of the furnace. The shoes 61 are preferably made with raised portions 59 which may be fixed or may be adjustable jack screws, supporting the outer end of the bottom plate 58 by one of its transverse ribs 60 (Fig. 3), these raised portions acting as a pivot upon which the forehearth may tilt longitudinally as its inner end is raised or lowered by the adjusting screws 71, or as it follows changes of the furnace level above referred to. By these means the forehearth may be adjusted to any desired level or position and the furnace and forehearth are free to expand or contract or settle independently without straining them or displacing the forehearth from glass flowing connection with the furnace.

To prevent accidental longitudinal tilting of the forehearth during repair or construction work if it should become overbalanced by excess weight in front of the supporting shoes, holding-down means may be provided, such as tie rod 64 connected to a fixed anchorage beneath, and provided with a turn buckle 65 which may be adjusted to hold the forehearth in the desired position.

The rear end of the forehearth is held firmly against the furnace walls without exerting undue pressure thereon and may move with these walls when they are moved by expansion or contraction or settling of the furnace. To provide vertical and horizontal adjustment of the rear end of the forehearth to hold and align it relatively to the furnace, rear supports are provided, comprising angle irons 66 (Figs. 1 to 4, and 7) extending from the bottom plate 58 toward wall braces 67 of the furnace 55, each extension carrying a bracket 68 with a supporting screw 71 and a tie rod 72 (Figs. 3, 4 and 7). The supporting screws 71 rest on a bearing bar 73 which is bolted to the adjacent furnace iron work, such as the wall braces 67. The tie rods 72 pass loosely through holes in the brackets 68 and the bearing bar 73, and are adjusted by nuts 74 on either side of these members; whereby the forehearth may be moved toward or from the furnace, and into even contact therewith. When the nuts 74 are adjusted, the tie rods act to swing the forehearth in any horizontal direction. By means of the screws 71, the rear end of the forehearth may be adjusted vertically. In this way the forehearth may be connected to and held back against the furnace in the desired position and alignment without undue thrust on the abutting blocks of the furnace walls. As the furnace walls move under the influence of heat, the furnace iron work or wall braces 67 and the forehearth move with them as a unit without exerting undue stress which would crack or distort the walls.

Adjustable bars 75 (Figs. 6 and 7) carried by the forehearth casing 56 and 57 bear against the front end of the channel 53 to hold it firmly against the extension 51. These straps also provide for inequalities in the lengths of the channel and casing structure.

To provide spaces for suitable heat insulation of the channel 53, it is carried on a series of refractory support blocks 76 and a bearing bar 77 (Figs. 3 and 7) and braced or held securely in position sideways by a series of refractory brace blocks 78 and angle irons 81 (Figs. 2 and 7). This holds the channel in the desired position and yet provides a space between the channel and the metal casing to hold heat insulating material 82, such as kieselguhr.

The brace blocks 78 fit between the channel 53 and the casing 56 and 57, being supported in horizontal position by the ledges 83, (Fig. 5) and they may be luted tightly in place with plastic clay or held with set screws, so as to bear firmly against the channel walls and brace them against the pressure of the molten glass. The channel may also be braced at its outer end by fire clay packing 84 (Fig. 6) packed between the channel and the side walls 56 and 57 of the casing.

The support blocks 76 and the bearing bar 77 are preferably adjustable in height as by screws 85 (Figs. 3 and 5) threaded into or carried by the bottom plate 58, each block 76 having a metal plate 86 interposed between it and its adjusting screw. This construction enables the supports to be adapted to structural variations, such as inequalities in the channel 53, and enables the weight of the channel and parts carried thereby, to be equally distributed on the various supports, thereby minimizing the danger of cracking. It also allows the channel 53 to be adjusted to the desired level independently of the forehearth casing, which is particularly convenient during erection of the apparatus. The extending portion 51 of the furnace may be supported by cross bars 87 (Figs. 3 and 4) carried by the angle irons 66 and independently adjustable for height by screws, or it may be supported in any convenient manner by the furnace structure.

The channel 53 may be made in one piece of suitable refractory material and is preferably provided with an outwardly turned flange 88 (Figs. 2 and 3) at its back end, which fits against the extension 51 of the furnace and forms a joint of sufficient depth to prevent leakage of glass. The extension of the outer edges of the flange beyond the insulation allows the outer portion of the joint to be exposed to the air, thus chilling the glass in the joint sufficiently to prevent leakage.

The channel is preferably made deep enough throughout the greater portion of its length to hold a body of glass of large cross section, so that it may flow slowly. The front end of the floor of the channel is inclined upwardly at 91 (Fig. 3) to provide a gradual reduction of the depth of glass near the discharge bowl. This inclined portion 91 is also protected by insulating material which is retained in place by a metal apron 92, forming part of the enclosing casing of the forehearth.

At the outer end of the channel 53 and forming a shallower extension thereof is the discharge bowl 54 formed of suitable refractory material. It is held by the metal casing 93 which is attached to the walls 56 and 57 of the main casing of the forehearth and which is made larger than the bowl to hold insulating material 82 between them, (Figs. 3 and 4). The glass flows from the furance through the channel 53 and into the discharge bowl, whence it discharges through a well and outlet under the control of regulating devices to be described later.

The forehearth is adapted to serve as a means for conditioning or re-conditioning the glass as it flows through the forehearth from the furnace to the forehearth outlet, and is provided with suitable heating means and draft control means, which are operated and controlled independently of the varying conditions of draft, heat and homogeneity existing in the melting furnace, so as to deliver the glass at the forehearth outlet uniformly in a homogeneous condition and at the temperature desired for feeding the glass in mold charges of the desired weight and shape. The desired conditions are difficult, if not impossible to obtain or to control in the melting furnace itself, because of the great mass of glass therein and the difficulty of heating that mass uniformly to the temperature desired for feeding the glass in compact charges of the desired weight, shape, temperature and uniformity. For this purpose the forehearth is provided with a firing or combustion space which is sealed off above the glass level from the firing or combustion space in the melting furnace, and is heated by suitable burners, from which flames are projected into the forward or delivering end of the forehearth and are then directed backwardly over the surface of the glass in the forehearth, the products of combustion passing out through a draft stack located over the rearward end of the forehearth. For convenience in thus controlling and directing the heat, the firing space is preferably divided into two chambers (Fig. 3), a front chamber 89 at the discharge end, and a rear chamber 90 toward the furnace end of the forehearth, these chambers being partly separated by a baffle formed by the blocks 102, 103, 104, extending downwardly toward the surface of the glass, so as to deflect the flames or heated currents close to the surface of the glass as they pass backwardly under the baffle. The forehearth walls enclosing the fire space and glass are made of refractory material and are as far as possible provided on their outer sides with heat insulating material, enclosed and retained by suitable metallic casings.

The front chamber 89 is enclosed by an arched front cover 94, (Figs. 3 and 9) a pair of mating side covers 95 each forming a half arch, and a sloping cover block 96 resting on side walls. The front cover 94 and the side covers 95 are cut away as shown, (Figs. 3 and 9) to form a circular opening 97 through which the discharge controlling members 146 and 172 operate, and are readily removable without disturbing these members.

Behind the front chamber 89 is a baffle formed of refractory blocks 100, 101, 102, 103 and 104 (Figs. 3 and 5) bridged across from the side walls of the channel 53. The upper block 101 is provided with an opening 105—a into which a suitable burner 105 (Fig. 3) discharges a controllable mixture of gas and air into a port 106 formed in the block 102. This port is preferably horse shoe shaped as shown in Fig. 4, whereby the burning mixture is discharged into the forehearth in a divided stream. To prevent the fuel mixture from igniting prematurely in the port 106, the port block 102 is kept relatively cool by heat insulation 107 supported by the block 103 and retained in place by the refractory blocks 104.

The rear chamber 90 back of the baffle is enclosed by side walls 108 and a rear wall 109 carrying a cover block 111. A sealing block 52 extending into the glass seals the chambers 89 and 90 from the fire spaces above the glass level in the furnace. Each side wall 108 is provided with a port 112 for admitting cooling air to aid in conditioning the glass when desired, and the cover block 111 is provided with an opening 110 leading to a suitable exhaust stack 113.

A modified arrangement, more particularly of the burner and to some extent also of the burner and fire spaces, is shown in Fig. 9. Here the fuel space is extended above the forehearth, the extension with its insulating means being more readily removable and renewable. Above the forehearth and forming an extension of the combustion or mixing chamber in the forehearth is an inverted refractory bowl 121, provided with a burner opening 122 into which any suitable form of gas or oil burner may discharge. For purposes of this illustration, an adjustable gas burner 123 of the induction type is shown. The inverted bowl 121 is surrounded by metallic casing 124, provided with heat insulation 125, and enclosing an annular air space 126 between the casing and the bowl. Air drawn into the annular air space 126 by inductive action of the burner enters all around the open lower edge of the casing 126, is preheated by its passage over the heated bowl 121, and is then injected through the opening 122 into the bowl chamber. The casing 124 is centered with the bowl 121 by means of adjustable pins or screws 119 disposed around the side wall of the casing and bearing against the bowl, so as to equalize the width of the annular space and distribute the consequent inflow of air equally on all sides. This results in conservation of the heat, which instead of being lost by radiation to the surrounding air is confined by the insulated casing 124 and is moreover taken up by the entering air and returned to the inside of the bowl, the heated air also improving the combustion conditions.

From the bowl 121 the space extends through ports 118 formed in the burner block 116 and in a dividing block 117, which divides the passage for the burning gases into ports of the desired number and having the desired size and distribution, as in Fig. 3. The blocks 116 and 117 in this case form a baffle similar in effect to that shown in Fig. 3, dividing the firing space into two chambers. In the construction shown in Fig. 9, the cover in front of the baffle is made in separate pieces 114 and 115, one or both of which may be removed to allow of inserting a gate to stop the flow of glass from the forehearth while the discharge bowl is being replaced. This, however, is a feature which may also be applied to the construction shown in Fig. 3 by suitable design.

In both of the constructions shown, the temperature conditions in the forehearth may be controlled independently of the temperature conditions in the melting furnace, to properly condition or re-condition the glass. The spaces in the forehearth and in the melting tank above the glass line are separated from each other to prevent the flow of air and gases between the furnace and the forehearth above the glass line, so that the fire spaces in the forehearth are not affected by the draft or temperature conditions in the furnace, thus permitting independent control of the heating conditions in the forehearth.

The rear wall 109 (Fig. 3) of the forehearth serves as a partial separating member, which may be supplemented by a separator or sealing block 52 extending below the glass level (Fig. 3). This block bridges across the furnace extension 51 and fits into recesses 127 (Fig. 2) formed in the side walls of this extension, fitting against the rear end of the channel 53 and the rear wall 109 of the forehearth. To further complete the seal, the joint between the rear wall and the sealing block may be sealed by a fire clay luting. The depth to which the separator block 52 is immersed in the glass may be varied as desired to draw glass from the furnace into the forehearth from a higher or lower stratum. Since the temperature of the glass in the furnace is hottest at the top and is progressively cooler toward the bottom, the depth to which the separator 52 is set permits hotter or colder glass to be drawn from the furnace as desired.

The extension 51 from the furnace may be partly or fully covered by covers 128, some of which may be removable, to facilitate replacing or adjusting the separator 52. It may at times also be desirable to remove a section or sections of the cover 128 in order to cool the glass flowing from the melting furnace into the body of the forehearth.

The stack 113 connected with the opening 110 in the cover block 111, may consist of a metallic casing lined with suitable refractory material. At the upper end of the stack is a refractory damper 131 (Figs. 1, 7 and 8) carried in a frame formed by angle irons 132 pivotally mounted on a rod 133, so that the damper may be tilted by bars 134 connected with an operating rod 135. The lower end of the rod passes through a fixed bracket on the forehearth casing and is threaded for a hand nut 136, which is held against the bracket by the weight of the damper. By turning this hand nut 136, the damper may be adjusted to control the amount of draft applied to the fire spaces in the forehearth by the stack.

In order to secure a better control of the draft conditions in the forehearth, the metallic casing enclosing the forehearth and the structure of the refractory parts and their braces is adapted to form a tight closure. Such parts as the sealing block 52 and certain of the cover blocks are arranged to make close joints and adapted to be luted with fire clay. The opening 97 fits the discharge control means closely, so that uncontrolled leakage between the fire space and the outside air is reduced to a minimum.

The air ports 112 for admitting cooling air to the rear fire space when desired are also provided with close fitting closures to minimize leakage. Refractory thimbles 138 (Figs. 4 and 5) abut against the refractory side walls 108 in register with the port openings 112 therein and extend through the insulation 82 and the side of the upper forehearth casing 139. A collar 140 carried by the casing fits closely against the end of the refractory thimble and holds it in place against the side wall. The joint between the collar and the thimble and between the thimble and the side wall is preferably tight. The collar 140 carries a swinging door 141 pivoted thereon and carrying a transparent window 142 made of mica or heat resisting glass. The door is adapted to fit closely against its supporting collar 140 when closed, and may be opened to any desired extent by screw 143 threaded into the door and bearing against the collar. By thus adjusting the door opening, the desired amount of cooling air may be admitted into the forehearth or it may be positively shut off. The transparent window has the great advantage of permitting a view of the interior of the fire space, as for inspecting the fire conditions, without such interference therewith as would be caused by opening the door for such inspection. If the door were opened for this purpose, the increased amount of air admitted would so alter the draft and firing condition as to give an incorrect indication of the conditions existing when the door is properly adjusted.

By means of combination of the heating burner, controllable stack draft, controllable admission of cooling air, and the general arrangement for firing, the glass delivered by the forehearth may be properly conditioned and kept uniformly at the desired temperature in spite of variations of temperature occurring in the glass furnace. The burner projects a divided flame forward toward the discharge end of the forehearth, so that the flame impinges against and flows along the cover blocks, then turns downwardly and flows back along the surface of the glass toward the rear of the forehearth under the baffle plate 103, as indicated by the arrows in Fig. 3. The burner may be regulated by suitable valves to control the amount of fuel and air admitted. Depending on the setting of the burner and the draft conditions, the flame or heat therefrom will be projected toward the front end of the forehearth a determinable distance, either deflecting downwardly against the front cover 94 and around the tube 146, or turning downwardly to assume its backward course at a point nearer the burner ports 106. Some of the flame may turn downwardly closer to the burner nozzle, and other portions may be projected further forward, so that a "horse-shoe" flame is produced, which gives an extremely even heating effect in the front end of the forehearth. This tends to bring the glass around the flow outlet to an even temperature and helps to produce a homogeneous mold charge. As the flame travels backwardly under the baffle, and spreads throughout the greater space 90 back of the baffle; its temperature falls progressively, so that the glass is subjected to a gradually increasing heat effect, as it progresses from the rear to the front of the forehearth. This is advantageous, as will be explained later.

The temperature of the rear fire space 90, which is naturally lower than that of the front fire space 89, may be further controlled by the regulated admission of cooling air through the ports 112. This air cools the hot or burning gases coming from the front fire space, and escapes up the stack with them. The amount of cooling air admitted depends not only on the adjustment of the air port doors, but also on the setting of the stack damper, which controls the draft inducing the supply of cold air.

The adjustments of the stack damper 131 also influences the course and position of the flame from the heating burner. With any given burner adjustment, an increase of draft by raising the stack damper causes the flame to turn downward and backward nearer to the baffle and tends to increase the temperature of the rear fire space 90. Conversely, a decrease of draft by lowering the stack damper throws the burner flame further forward and tends to lower the temperature of the rear fire space 90. If, for any setting of the stack damper, the burner be adjusted to deliver more fire or for more fuel relatively to the air supply, the flame will be thrown further forward, and if it be turned down to deliver less fire or to burn less fuel in proportion to the air, the flame will not be thrown so far forward, but will turn down and move backwardly under the baffle sooner than it would if more fuel is supplied. The effect of the stack draft on the flame in the front fire space 89 is varied by the degree of opening of the cooling air ports. If, with any given setting of stack damper, the cooling ports are opened wider, the burner flame will be thrown further forward. In other words, the effect of the stack draft in pulling the fire further back or letting it go further forward depends on the amount of air which is admitted by the cooling air ports to satisfy this draft, and on the amount of fuel projected by the burner to satisfy the draft.

The character of the flame delivered by the burner is important. The flame should not be too short or quick burning as this produces only a local heat with resultant uneven temperature in the glass. There should, however, always be enough air for complete combustion and to prevent a smoky flame, which is not so easily controlled and tends to deposit carbon in the glass. The character of the flame may be varied within limits so as to produce a longer or shorter flame. It is preferable to adjust the burner to produce a clear flame which is neither smoky nor short and quick burning, and which allows a maximum of control by the stack damper and produces an even heating effect, especially in the front fire space 89 of the forehearth, when the glass is nearing the completion of its progressive conditioning treatment. Such a flame may easily be drawn back or allowed to burn further forward in the forehearth by respectively raising or lowering the stack damper.

By adjusting these various factors, the temperature of the glass being delivered may be raised or lowered from the temperature of the glass in the furnace. This may be done within a certain range by adjustment of the burner alone. If, however, the glass in the furnace is too hot as it flows into the forehearth, it may be cooled by admission of cooling air through the cooling ports. In doing this, it is preferable to cool the surface of the glass slightly below the temperature at which it is desired to deliver it, so that then when the glass is subjected to the action of the flame in the front fire space, it will attain the desired temperature and be uniform throughout. If the glass from the furnace is too cold, the burner may be adjusted to supply more heat and the flame may, if necessary, be drawn well back into the rear fire space 90 so as to extend its heating effect over the entire length of the forehearth.

The glass flowing from the furnace and through the forehearth tends to be hotter on top and progressively colder toward the bottom. It also tends to be colder at the sides of the forehearth than at the center line. This is because of the temperature variation between upper and lower layers in the furnace and because of the cooling influence of the bottom and side walls of the forehearth. The insulation 82 helps to minimize this influence and so to minimize cold streaks in the glass. The double fire space with the even heat in front also helps to equalize the temperature of the glass in the relatively shallow layer flowing from the front of the channel into the discharge bowl 54 and permits the delivery of homogeneous mold charges therefrom.

That embodiment of my invention shown by Figs. 10 and 11 is described by the following portion of the specification of my copending application, Serial No. 294,792, filed May 5, 1919.

The invention is herein shown embodied in a machine having the necessary mechanical movements and adjustments, and cooperating with a conduit projecting from a glass furnace, from which the molten glass is thus delivered in mold charges to an assoociated molding or shaping machine.

The molten glass flows from the glass furnace 1 through a channel or conduit 2 (Fig. 10) to an outlet 3. It is there acted upon by an impeller 13 mounted for vertical movement, and provided with various adjustments. As it issues periodically in regular cycles from the outlet, it forms successive gathers from which mold charges are severed by shear blades 4 reciprocating below the outlet. The separated mold charges fall upon a moistened chute 5 and slide upon it to the molds mounted on the table of the associated shaping machine.

The channel 2 is made of refractory material surrounded on the bottom and sides by heat insulation 11. At the outer end of the channel is an outlet spout 12, the interior of which is shaped so as to coact with the impeller 13. This spout is held in an iron frame or case 14, which also serves as a retainer for the insulation 11, the spout being surrounded with insulation, except at the outlet 3.

The bed 15 is carried by the same foundation which supports the base of the machine. It serves to support the channel 2 by means of intermediate refractory supports 10 and carries two brackets 16 clamped thereto by screws and which support the spout case 14. The brackets also carry set screws 18 which bear against projections on the spout case and hold the spout against the end of the channel. These screws may be adjusted to allow for expansion and contraction of the channel and spout. The brackets also carry removable drip pans 20 for receiving the cooling water dripping from the shear blades 4 and from the sprays 21.

Over the spout is a cover 22 of refractory material carried in a metal case 23 which also serves as a retainer for heat insulation 11, the metal plate 24 serving to keep the insulation in place. The plate 24 and cover 22 have openings through which the impeller projects. Back of this cover and over the channel is another refractory cover 25 formed so as to retain heat insulation 11 which is covered by a metal plate 26 to keep it in place.

The channel and spout are heated by suitable means, such as a gas burner 27, which projects through the side wall block 30. This burner is provided with air and gas valves 31 for regulating the flame, which partly fills the space over the molten glass. The products of combustion are carried off by the fire brick stack 32 carried on refractory lintels 33, which bridge the channel and are separated at their ends by refractory blocks. At the upper end of the stack is a damper 34 carried on a pivot 35 and adjustable through an arm 36, and connecting rod 37 having a handle at its outer end and provided with notches 38 engaging with a stop 40, thus allowing the damper to be set at any desired opening. By appropriately adjusting the burner and damper the proper temperature may be maintained in and over the channel and spout. The insulation acts to conserve the heat, and the radiation from the rear assists in heating the outlet end, thus tending to maintain a uniform temperature throughout.

A gate 41 for regulating the glass flow is suspended by links 42 from arms 43 fast on the shaft 44 at each end thereof. The right-hand arm 43 bears a pointer 45 registering with a scale 46 to indicate the setting of the gate. A screw 47 carrying a hand wheel 50 bears against an extension 51 of the right-hand gate arm 43, thus allowing the position of the gate to be adjusted by turning the hand wheel 50. The glass surface in the furnace 1 is preferably maintained at a higher level than that desired in the spout 12 and the level or head desired in the spout may be maintained by adjustment of the gate.

In operation, the gate 41 is raised to the proper point to maintain the desired head of glass over the outlet and the machine is set in motion, reciprocating the impeller and the shears. The molten glass issues from the outlet under the combined influence of gravity and the action of the impeller, which times and controls its accumulation in gathers which are successively suspended from the outlet ring and from the impeller end. For each complete reciprocation of the impeller there is a reciprocation of the shears which severs a mold charge from each suspended gather. After each severing operation the freshly cut end or stub remaining below the outlet, and forming the lower end of the succeeding gather, is moved upwardly, or its downward movement is retarded, by the action of the impeller.

The relation of the diameter of the gather to the outlet size depends partly on the speed of the machine and the viscosity of the glass, as these influence the elongation and consequent reduction in diameter of the glass column issuing from the outlet.

The embodiments shown and described herein are only several of many possible embodiments of the invention. It should be understood that the various features of the invention may be modified both in structure, combination and arrangement to adapt the invention to different uses or different conditions of service. While the forehearths herein shown are particularly adapted to discharge the molten glass through a feed outlet, yet they may also be employed for delivering glass in proper condition to a gathering point for use with suction gathering apparatus, such as that shown in the copending application of Peiler and Barker, Serial No. 218,398, filed Sept. 9, 1927, or such as that shown in my copending application Serial No. 24,789, filed April 21, 1925, now Patent No. 1,785,209.

I claim:

1. Apparatus for feeding molten glass having in combination, a forehearth, a bridge member above the glass in the forehearth, a burner above the bridge member, and heat insulating material between the bridge member and the burner.

2. A forehearth connected with a glass melting furnace and comprising a refractory container for molten glass, an outer metallic casing spaced from the container, rigid refractory struts interposed between the casing and the container, and heat insulation filling the space around the struts.

3. A forehearth connected with a glass melting furnace and comprising a refractory container for molten glass, a casing spaced from the container, supporting struts resting on the casing underneath the container to support the container, side braces interposed between the container and casing to hold the container against horizontal movement with respect to the casing, and heat insulation in the space between the container and the casing.

4. A forehearth connected with a glass melting furnace and comprising a refractory container for molten glass, a supporting casing spaced from the container, a plurality of independently adjustable vertical supports for the container carried by the casing, and heat insulation in the space between the container and the casing.

5. A forehearth connected with a glass melting furnace and comprising an outer support, a plurality of vertically adjustable struts supported by the support, a refractory container for the glass supported by the struts, and heat insulation around the struts between the container and the support.

6. A forehearth comprising a refractory container for molten glass, a casing around the container, and means for adjusting the container with relation to the casing.

7. A forehearth comprising a refractory container for molten glass, a casing around but spaced from the container, insulating material between the casing and the container, and means for adjusting the relative position of the casing and the container.

8. A forehearth comprising a refractory container for molten glass, a casing around the container, and means on the outside of the casing for adjusting the position of the container relative to the casing.

9. A forehearth comprising a container for molten glass connected to a glass melting furnace and adapted to be raised, lowered, and tilted, and a plurality of independently vertically adjustable supporting means for raising, lowering, or tilting the container.

10. A forehearth connected with a glass melting furnace, comprising a refractory container for molten glass, a casing for the container, means for adjusting the casing with relation to the furnace, and means for adjusting the container with relation to the casing.

11. A forehearth for glass furnaces, com-

prising means for vertically adjusting the end adjacent the furnace, a bearing block supporting the projecting end, and having a pivotal connection with the forehearth, and a supporting member having a plane surface upon which the bearing block rests, whereby the block is free to move with the forehearth under the influence of heat.

12. The combination with a glass melting furnace provided with wall braces, of a forehearth projecting from the furnace and comprising a refractory container for the glass and an outer casing, rigid connections between the casing and the wall braces, said connections being adjustable in length to secure the desired relation between the furnace walls and the refractory container, whereby motion of the furnace is communicated to the forehearth through the wall braces and casing.

13. In apparatus for discharging glass from a melting tank, a forehearth having a discharge outlet adjacent to its outer end to which the glass flows from the tank, means for supplying a divided stream of a combustible mixture to the space above the glass rearwardly of the discharge outlet and for projecting the divisions of such stream forwardly at opposite sides of said forehearth space, and an exhaust stack communicating with the space above the glass in the forehearth rearwardly of said combustible mixture supply means.

14. In apparatus for discharging glass from a melting tank, a forehearth having a discharge outlet adjacent to its outer end to which the glass flows from the tank, a transverse baffle bridging the forehearth above the glass level rearwardly of the discharge outlet, a substantially U-shaped passage in said baffle opening at its ends at the front of the baffle at opposite sides of the longitudinal median line of the forehearth, means for projecting a combustible mixture through the end portions of said passage into the space above the glass at the front of the baffle and toward the front wall of the forehearth, and an exhaust stack communicating with the forehearth rearwardly of said baffle.

15. A forehearth connected with a glass melting tank and comprising a refractory container for molten glass, a casing outside of the container and adjustably spaced therefrom, and heat insulation in the space between the container and the casing and held in place thereby.

Signed at Hartford, Connecticut, this 22nd day of November, 1927.

KARL E. PEILER.