Jan. 3, 1933. K. E. PEILER 1,893,061

FOREHEARTH FOR MOLTEN GLASS

Filed Sept. 19, 1929 8 Sheets-Sheet 1

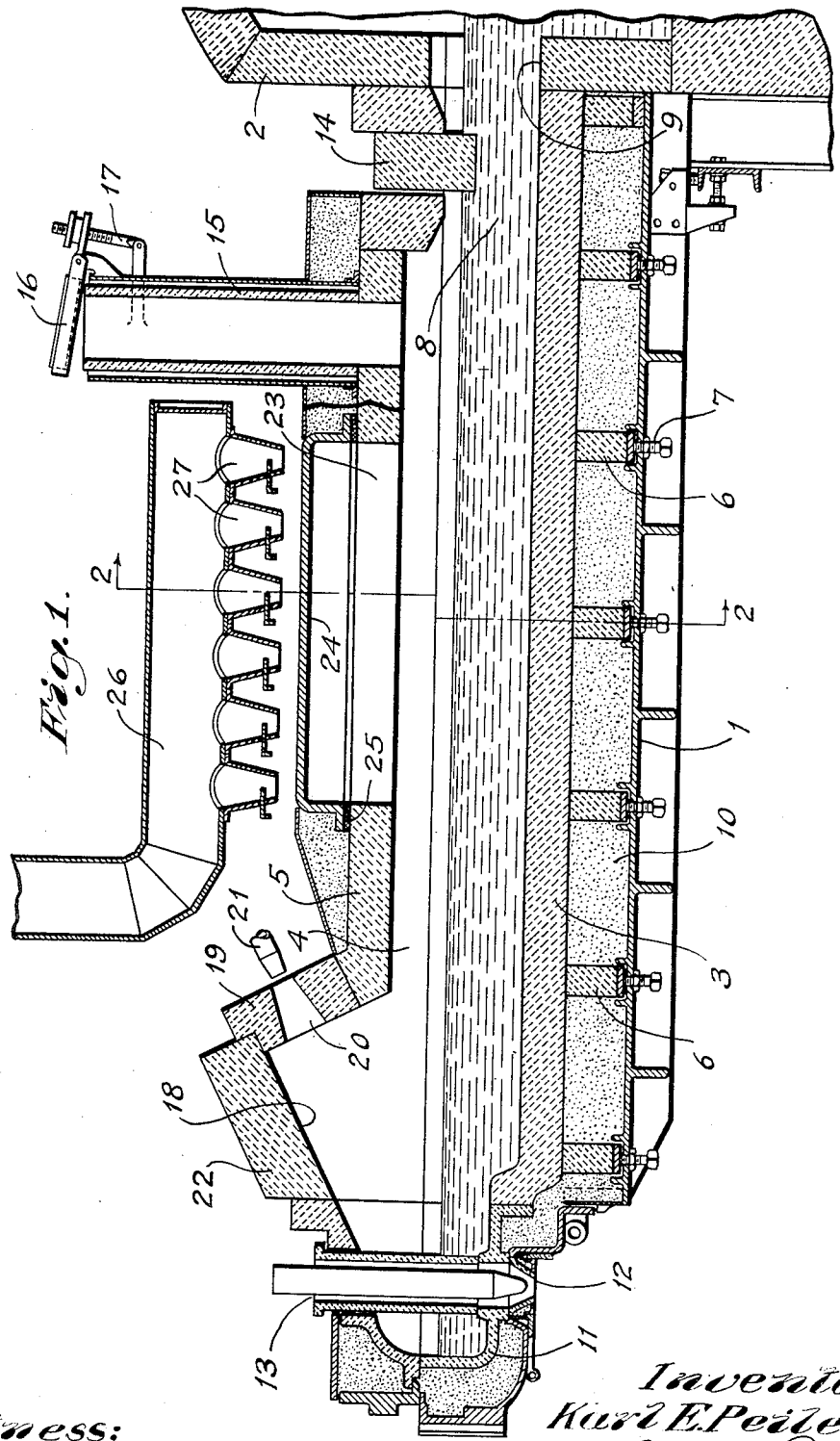


Fig. 1.

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FOREHEARTH FOR MOLTEN GLASS

Filed Sept. 19, 1929 8 Sheets-Sheet 2

Fig. 2.

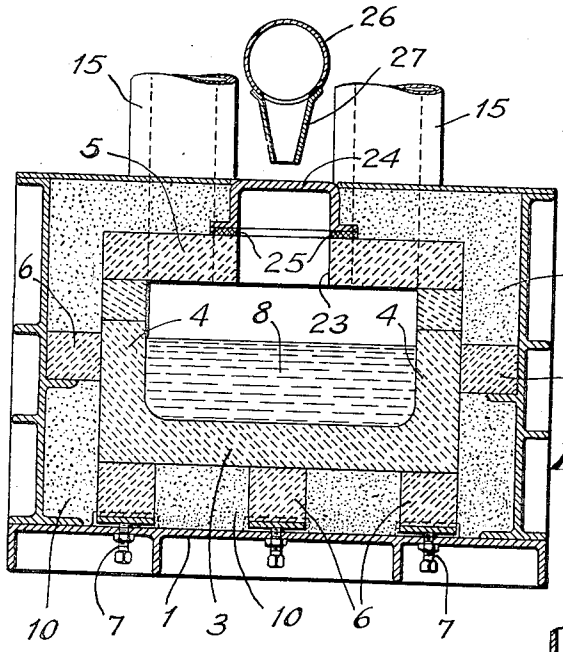


Fig. 4.

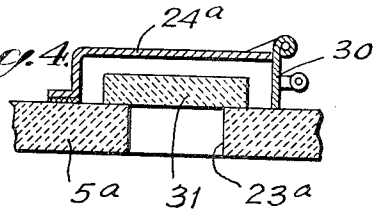


Fig. 3.

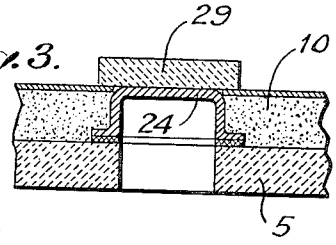
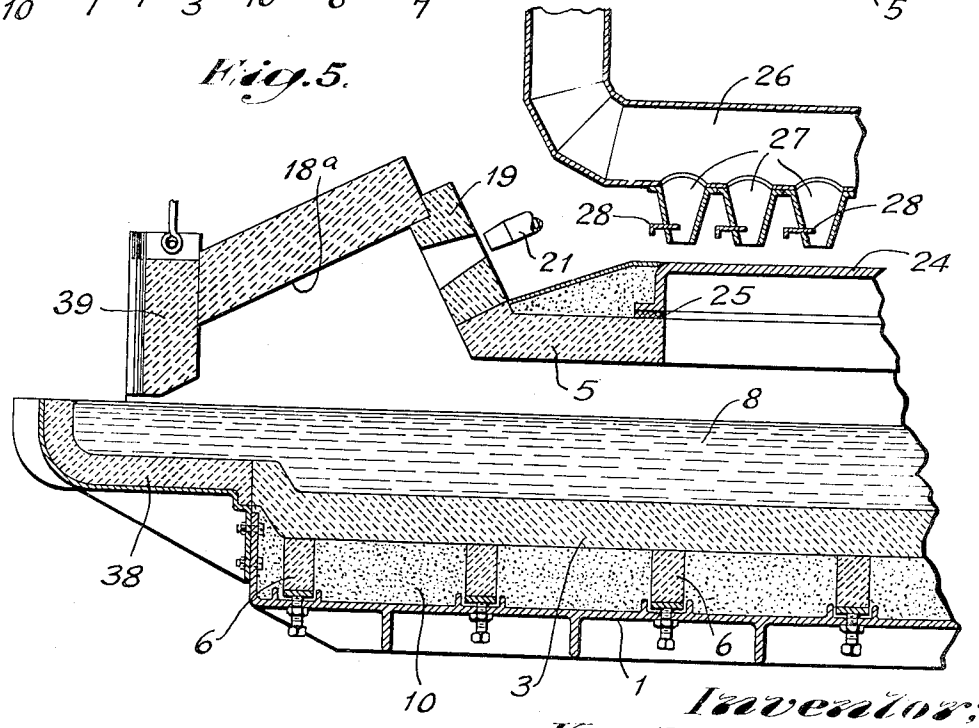


Fig. 5.



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FOREHEARTH FOR MOLTEN GLASS

Filed Sept. 19, 1929 8 Sheets-Sheet 3

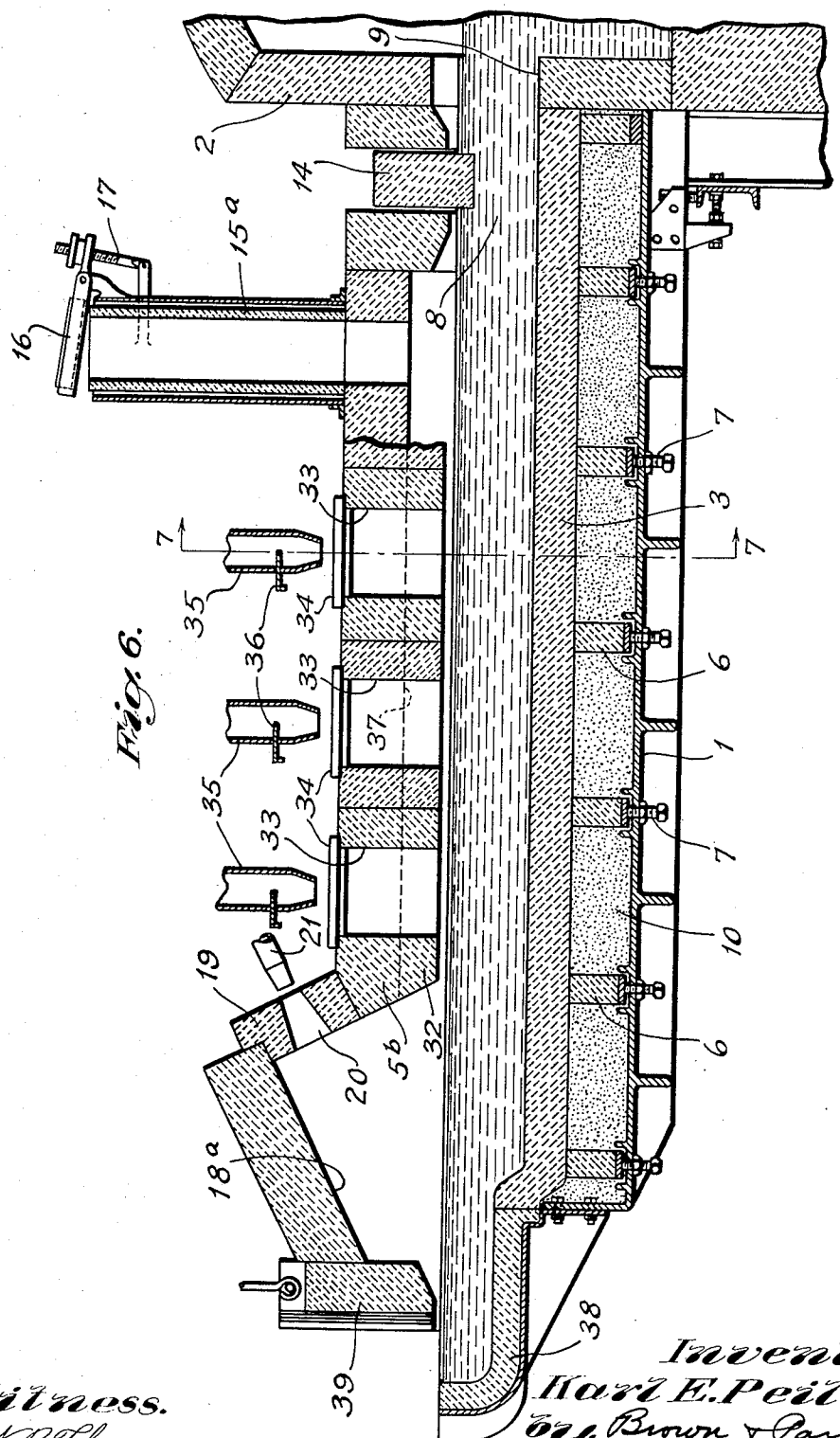


Fig. 6.

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Jan. 3, 1933. K. E. PEILER 1,893,061

FOREHEARTH FOR MOLTEN GLASS

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Fig. 7.

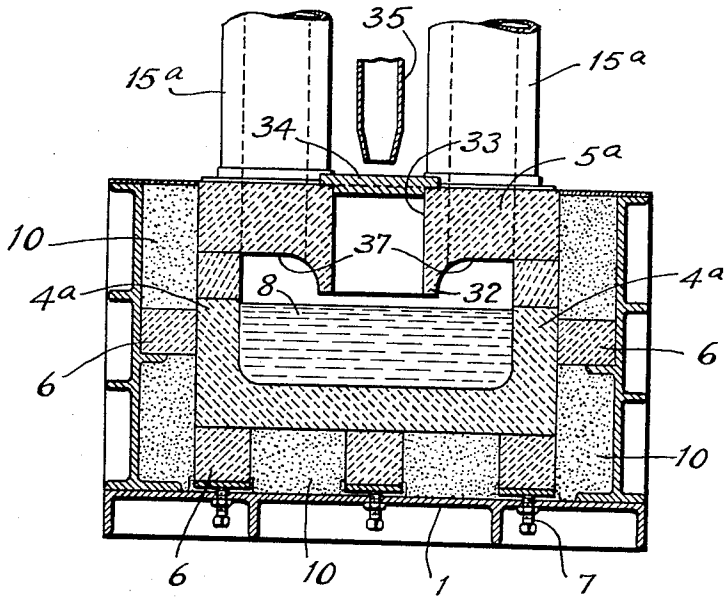
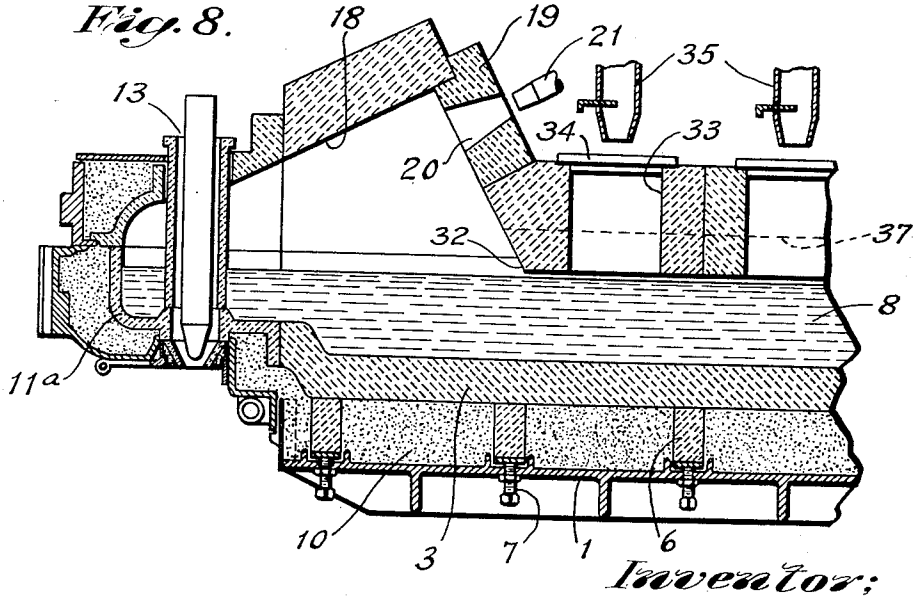


Fig. 8.



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FOREHEARTH FOR MOLTEN GLASS

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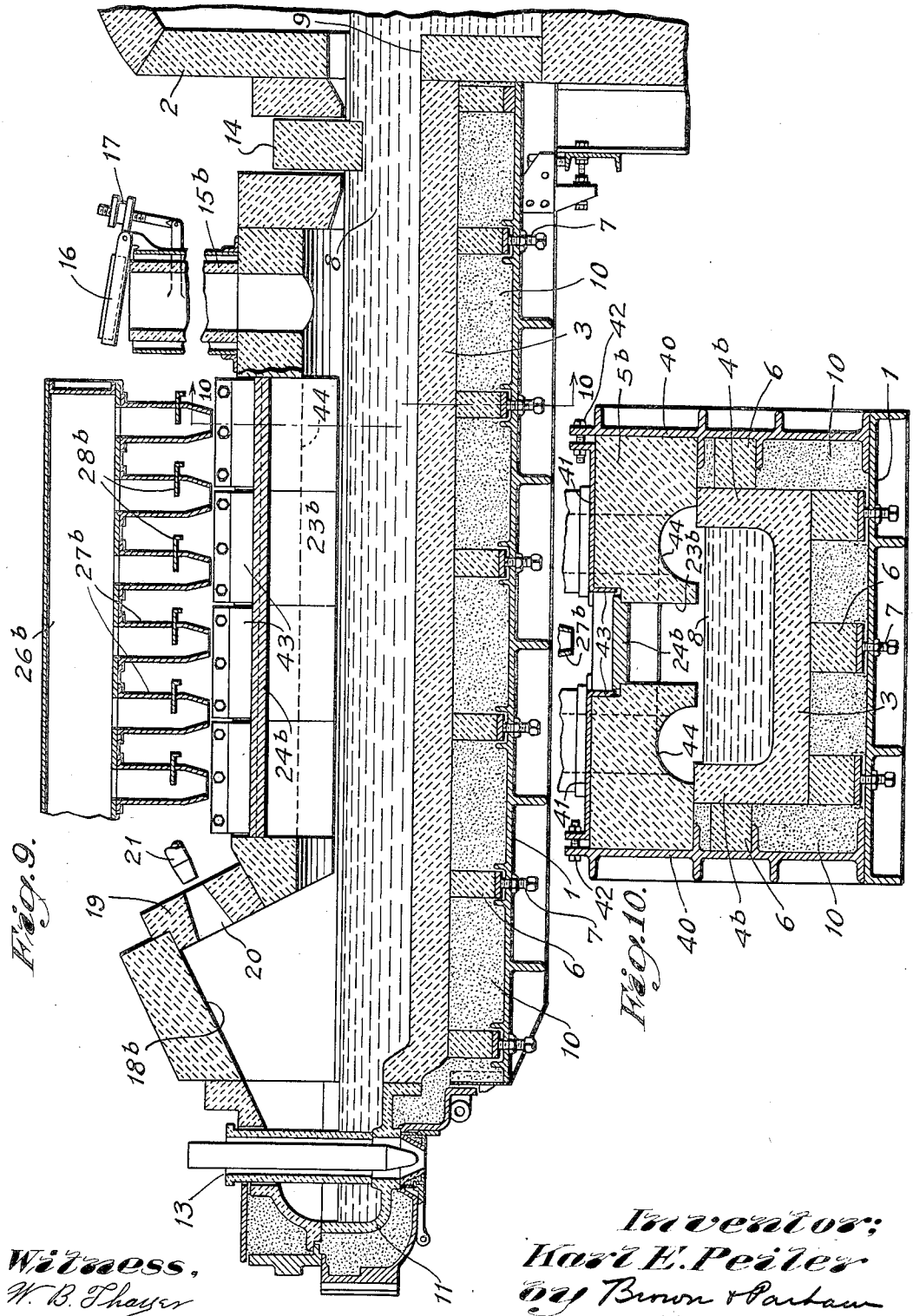


Fig. 9.

Fig. 10.

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FOREHEARTH FOR MOLTEN GLASS

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Fig. 11.

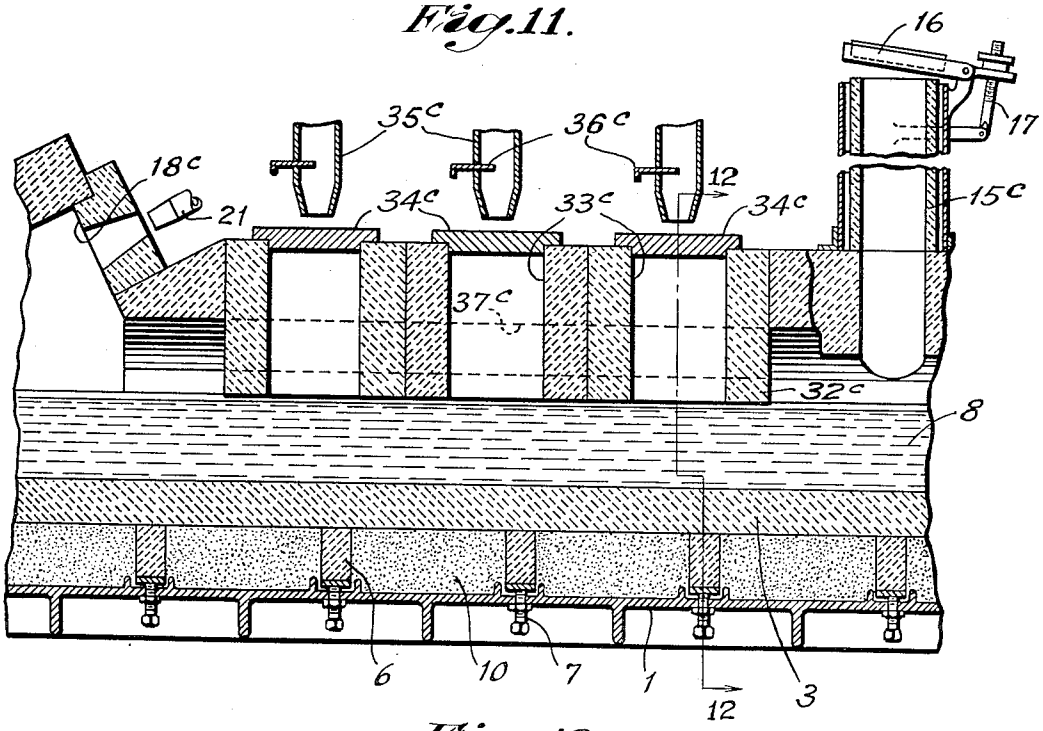
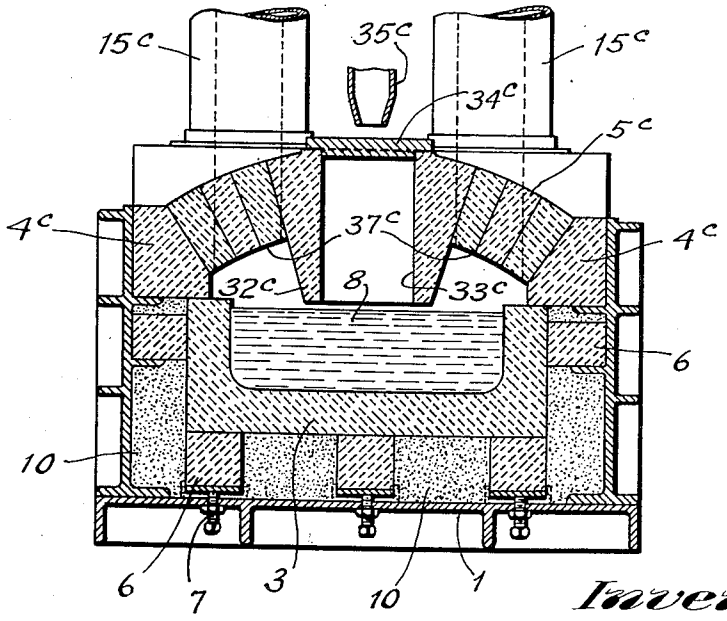


Fig. 12.



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FOREHEARTH FOR MOLTEN GLASS

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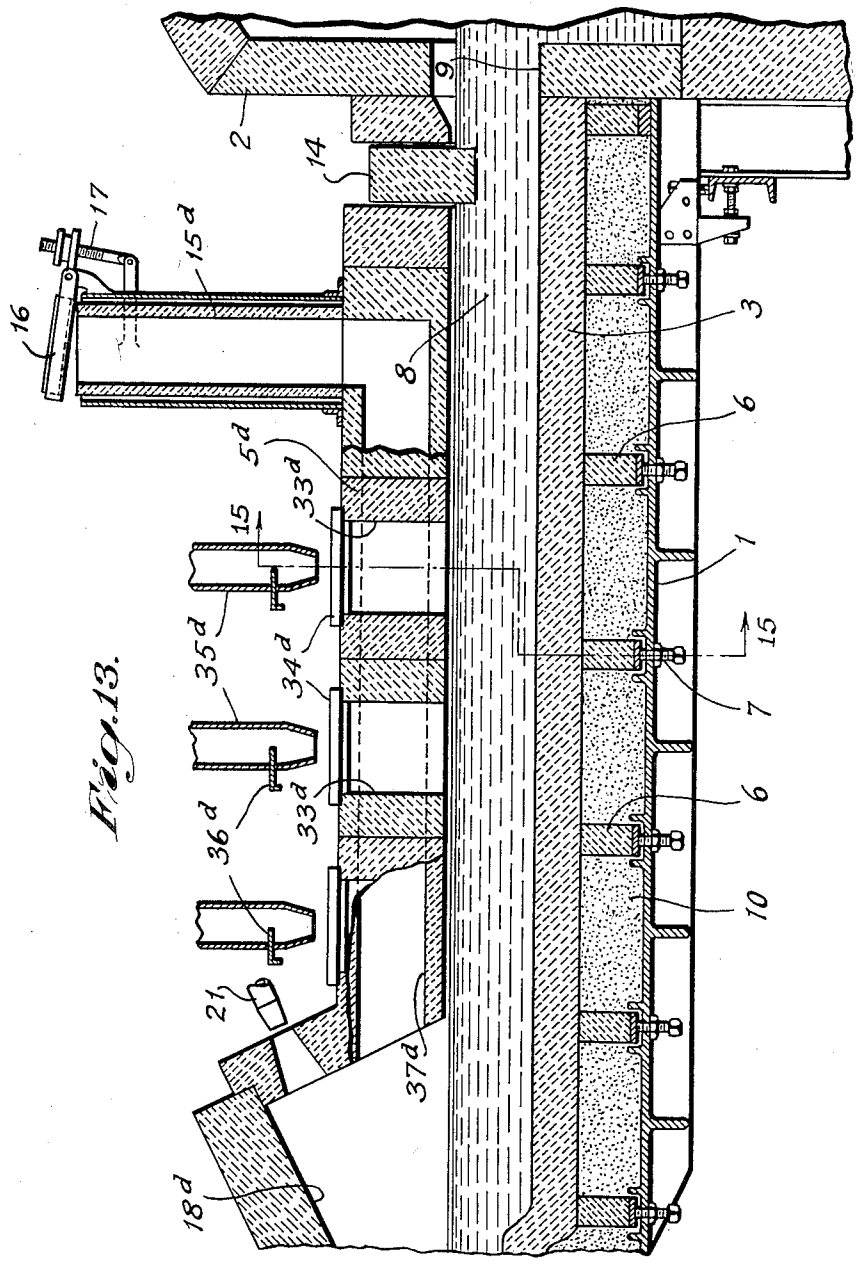


Fig. 13.

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Jan. 3, 1933. K. E. PEILER 1,893,061

FOREHEARTH FOR MOLTEN GLASS

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Fig. 14.

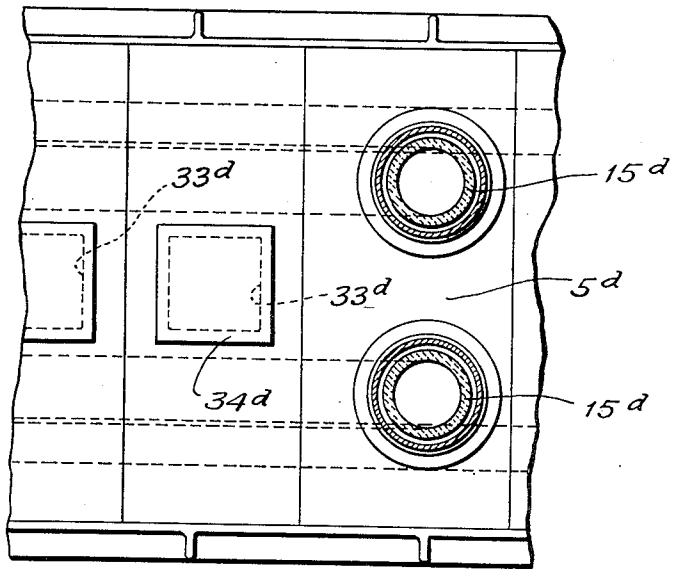
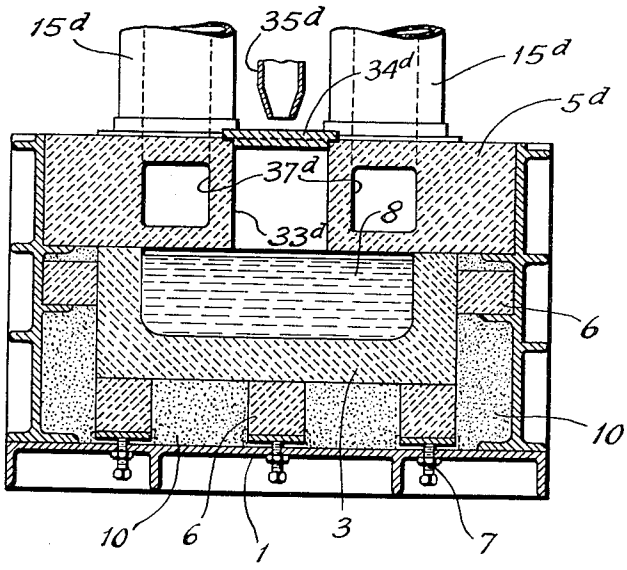


Fig. 15.



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Patented Jan. 3, 1933 1,893,061

UNITED STATES PATENT OFFICE

KARL E. PEILER, OF WEST HARTFORD, CONNECTICUT, ASSIGNOR TO HARTFORD-EMPIRE COMPANY, OF HARTFORD, CONNECTICUT, A CORPORATION OF DELAWARE

FOREHEARTH FOR MOLTEN GLASS

Application filed September 19, 1929. Serial No. 393,680.

This invention relates to improvements in forehearths for receiving molten glass from a melting furnace and for conducting such glass to a feed spout, basin, or other supply chamber from which glass is to be fed, gathered, drawn or otherwise removed.

It is usual in taking glass from a melting furnace or tank to provide a forehearth or extension, having a channel along which molten glass flows from the furnace or tank to a place at which glass is to be fed in mold charges, gathered by suction in a gathering receptacle, or otherwise removed. Glass flowing along a channel of a forehearth or extension tends to lag or flow more slowly and to become relatively cool at the sides of the channel while hotter glass will flow at a relatively high velocity along the longitudinal median portion of the channel, thus producing the condition known as "channeling". This condition is objectionable in that the glass entering the chamber or place of delivery or removal of glass at the outer end of the forehearth or extension is not uniform in viscosity, temperature and condition. In some instances, the relatively cool and stagnant glass at the sides of the forehearth channel may become "cordy" or partially devitrified and portions thereof may be entrained with the relatively hot and more swiftly flowing glass at the longitudinal median portion of the forehearth and may seriously interfere with the feeding or removal of glass at the delivery end of the forehearth.

It has been proposed prior to the present invention to effect cooling of the glass at the longitudinal median portion of the forehearth channel with a view to reducing the temperature and velocity of flow of such glass to coincide more nearly with the temperature and velocity of flow of glass at the side portions of the forehearth channel. Patent No. 1,656,869, granted to me January 17, 1928, illustrates and discloses means for and methods of cooling the glass at the longitudinal median portion of the tank by providing an opening or openings in the top of the forehearth above the longitudinal median portion thereof and regulating the effective size and character of such opening or openings to effect regulable accelerated cooling of the glass at the middle of the forehearth channel. The construction and methods of such patent obviate many of the objectionable features of forehearths provided prior thereto. However, the opening or openings at the top of the forehearth tend to influence draft and firing conditions within the forehearth and, in some circumstances, it may be desirable to obviate such influence on draft and firing conditions.

It also has been proposed to effect local cooling of part of the glass in a forehearth by passing a cooling medium through a member adjacent to such glass. In some instances, the member through which the cooling medium is to be passed is a refractory wall of the glass conducting channel. Such local cooling, if effective to lower the temperature and reduce the velocity of flow of any portion of glass in the forehearth, probably also would tend to lower the temperature and rate of flow of the remaining glass in the forehearth and thus might prevent the delivery at the outer end of the forehearth of glass at a desirably high temperature. Moreover, such local cooling of relatively hot glass in the forehearth would not obviate the objectionable features which result from the presence of the cooler and more slowly moving or stagnant glass at the sides of the forehearth.

An object of the present invention is to provide for the conditioning of glass during its passage along the flow channel of a forehearth or like extension from a melting furnace or other source of supply of molten glass to a feed spout, gathering basin or other place of delivery of glass at the outer end of the forehearth so that the glass passing to such place of delivery will be of uniform temperature, viscosity and condition throughout and of proper temperature, viscosity and condition for use in the manner desired.

A further object of the invention is to produce an even flow of the glass in the channel of a forehearth throughout the cross section of such glass by causing a relatively greater radiation of heat from the glass at the longitudinal median portion of the fore-

hearth without causing any interference with or influence on the draft and firing conditions within the forehearth and by distributing the temperature within the space above the glass in the forehearth so that the heating of the glass in the side portions of the channel of the forehearth will be intensified as required to produce a condition of uniform viscosity and temperature throughout the cross section of the glass in the channel.

A further object of the invention is the provision of improved means for and improved method of cooling glass in the longitudinal median portion of a forehearth by radiation alone while preventing drafts or flow of cold air at the cooling place.

A further object of the invention is to provide improved means for causing independently regulable flow of heating media longitudinally of the forehearth above the glass in the side portions of the glass flow channel.

The invention, generally described, contemplates the provision of a forehearth having a glass conducting channel provided with refractory walls. The forehearth channel will be suitably insulated at the places at which it is desired to restrict or practically prevent radiation of heat from the glass. The influence on the glass within the forehearth of temperature and draft conditions above the glass in the furnace is practically prevented by closing communication between the space above the glass in the forehearth and the space above the glass in the furnace. Conditioning and control of the temperature and viscosity of the glass in the forehearth are effected by regulating the temperature and draft conditions in the forehearth to control the distribution transversely of the forehearth of the currents of heating media which move longitudinally of the forehearth above the glass therein, as by causing the heated gases to pass longitudinally of the forehearth mainly or entirely at the side portions thereof, and by causing relatively greater radiation of heat from the glass at the longitudinal medium portion of the forehearth without opening the space above such glass to the atmosphere and therefore without influencing or altering draft or firing conditions in the forehearth.

A desirable arrangement for effecting conditioning of glass in the forehearth and distribution of heat therein comprises a source of heat, such as a burner, located so as to discharge a heating blast downwardly and forwardly into the outer end portion of the forehearth and means, such as stacks having dampers therein, in communication with the rear or inner portion of the space above the glass in the forehearth at opposite sides of the longitudinal median line thereof for inducing drafts rearwardly in the forehearth above the glass in the side portions of the glass conducting channel of the forehearth whereby the heating of the glass in the side portions of the forehearth will be relatively great. In conjunction with this local heating of the glass in the side portions of the forehearth, the invention provides for regulably controlled relatively great radiation of heat from the longitudinal median portion of the forehearth, by cutting away part of the refractory top of the glass conducting channel along the longitudinal median line thereof and covering the cut away portion of such refractory top by a metallic cover through which a relatively large volume of heat will be radiated. This radiation of heat through the metallic cover may be regulated and influenced by local cooling of such covers. The character and amount of heat projected into the front or outer end portion of the forehearth and the velocity and heating characteristics of the heating media passing rearwardly above the glass in the side portions of the forehearth may be regulated by regulating the intensity and volume of flame from the burner and/or regulating the draft inducing action of the stacks at the rear of the forehearth.

In the drawings:

Figure 1 is a generally longitudinal vertical section through a forehearth embodying the invention and shown appurtenant to a portion of a glass melting tank, the section line on which the view is taken extending centrally of the forehearth from the outer end of the forehearth for part of the length thereof and then being offset laterally to extend nearer to one side of the forehearth for the remainder of the length of the latter;

Fig. 2 is a transverse vertical section to the forehearth, substantially along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary vertical section through a portion of the top of the forehearth embodying the invention, showing a removable refractory block in position to reduce or prevent heat radiation from a portion of the heat radiating metallic cover section of the top of the forehearth;

Fig. 4 is a view similar to Fig. 3 but showing a modified form of top structure of a forehearth embodying the invention and illustrating a method of preventing radiation of heat through part or all of the metallic cover plate of the top by placing a removable refractory block or blocks beneath part or all of such metallic cover plate.

Fig. 5 is a fragmentary longitudinal vertical section through a modified forehearth structure, generally similar to that shown in Fig. 1 but provided at its outer end with a gathering basin and means for regulating the draft conditions thereover;

Fig. 6 is a view similar to Fig. 1 but showing a forehearth having a basin for a gathering pool at its outer end and provided with a modified form of heat radiation controlling

top structure and with a modified construction for controlling the transverse distribution of heat within the space above the glass in the forehearth;

Fig. 7 is a transverse section through the forehearth structure of Fig. 6, taken substantially along the line 7—7 of Fig. 6;

Fig. 8 is a fragmentary longitudinal vertical section through a forehearth generally similar to that shown in Fig. 6 but provided at its outer end with a spout for the feeding of glass through a submerged outlet;

Fig. 9 is a view generally similar to Fig. 1 but showing another form of forehearth structure embodying the invention;

Fig. 10 is a transverse section through the forehearth structure of Fig. 9, the view being taken substantially along the line 10—10 of Fig. 9;

Fig. 11 is a fragmentary longitudinal vertical section through still another form of forehearth embodying the invention;

Fig. 12 is a transverse vertical section along the line 12—12 of Fig. 11;

Fig. 13 is a view similar to Fig. 11, showing still another form of forehearth structure for carrying out the invention;

Fig. 14 is a fragmentary plan view, partly in section, showing a portion of the forehearth structure of Fig. 13; and

Fig. 15 is a transverse vertical section substantially along the line 15—15 of Fig. 13.

The forehearth structure shown in Figs. 1 and 2 comprises a metallic frame work 1 connected with the frame structure of a melting tank 2, Fig. 1, so as to permit independent expansion and contraction of the walls of the forehearth and of the melting furnace. The glass conducting channel of the forehearth is supported by the metallic frame structure and comprises a refractory bottom, side and top walls respectively indicated generally at 3, 4 and 5. The walls of the forehearth channel are spaced from the metallic frame work structure by suitable refractory spacing members, such as indicated at 6 and adjusting mechanism, such as those indicated at 7, whereby the forehearth channel will be supported by the metallic casing and may be adjusted relatively thereto according to particular requirements or conditions and as required to receive molten glass 8 from the furnace outlet 9 to the best advantage. The refractory glass conducting walls of the forehearth channel may be insulated, as by insulation such as indicated at 10, at the bottom, sides and for part of the top thereof to prevent or minimize radiation of heat from the glass through such portions of the forehearth. A suitably insulated refractory feed spout 11 is provided at the outer end of the glass conducting channel, Fig. 1. This feed spout is shown as having a discharge outlet 12 in its base, below the glass level, through which molten glass may be discharged under the control of the glass feeding mechanism generally indicated at 13.

A refractory separator block 14 extends transversely of the glass conducting channel adjacent to the furnace outlet and dips into the glass so as to prevent communication between the space above the glass in the furnace and the space above the glass in the forehearth.

The structure shown is suitable for the feeding of glass in mold charges and as described so far is generally similar in construction to that of the forehearth structure of the well-known Hartford single feeder, a disclosure of which may be found in my copending application, Serial No. 683,576, filed December 31, 1923.

A pair of stacks 15 communicate with the space above the glass at the inner or rear portion of the forehearth at opposite sides of the longitudinal median line of the forehearth channel. Each of these stacks is provided with a damper 16 and with suitable mechanism 17 for adjusting the damper to vary the effective draft outlet of the stack.

The space above the glass adjacent to the feed spout 11 is enlarged upwardly to provide a firing chamber 18. The walls of the firing chamber 18 are formed of suitable refractory material and, so far as practicable, preferably are provided on their outer surfaces with heat insulating material. The rear wall of such firing chamber preferably is inclined forwardly and upwardly and constitutes a burner block, indicated at 19, provided with an inwardly enlarging opening 20 through which flame from a burner 21 may be projected forwardly and downwardly in the firing chamber. The top wall of the firing chamber preferably is inclined downwardly and forwardly, as indicated at 22, so that the flame and heat from the burner 21 will be deflected downwardly and forwardly into the feed spout and against the glass therein, the inner walls of the feed spout being formed to cause a return or rearward movement of the heated gases close to the glass in the forehearth channel.

With this arrangement, the flame and heat from the burner not only will locally heat the glass passing into the feed spout and in the latter but will be constrained to pass rearwardly along the surface of the glass in opposite side portions of the forehearth channel to the stacks 15 and thence through the latter to the atmosphere. The effective heating action and velocity of movement of the heated gases above the glass in the side portions of the forehearth channel may be regulated by adjusting the dampers 16, by controlling the volume and character of flame from the burner 21, or by a combination of these adjustments. As a result of the passage of the heated gases above the glass in the side portions of the forehearth channel, the glass

which otherwise would tend to become colder and more viscous and to flow more slowly than the glass at the longitudinal median portion of the forehearth channel is heated more intensely than the middle glass, thus tending to cause more uniform velocity of flow and temperature and viscosity conditions in the glass throughout the cross section of the glass conducting channel.

In addition to the control of the distribution of heat transversely of the forehearth, a further control of the temperature and viscosity conditions throughout the cross section of the forehearth is effected by means which will now be described. The longitudinal median portion of the refractory top 5 of the glass conducting channel of the forehearth is cut away, as indicated at 23, to provide an opening of predetermined length and width above the glass at the longitudinal median line of the forehearth. A metallic cover plate 24 is arranged to cover the opening 23. The cover plate 24 preferably is an arched member, as shown, having supporting flanges at its marginal edges insulated from the refractory top wall of the forehearth by suitable heat insulating material, such as indicated at 25. This metallic cover plate 24 should have high heat resisting qualities. A metal known commercially as Q-alloy has been found to be satisfactory for the purpose. The insulation on the refractory top of the glass conducting channel of the forehearth may extend flush with the crown of the cover member 24, as shown in Figs. 1 and 2.

A cooling pipe 26 for blowing air or other cooling media on the metallic member 24 may be disposed above the latter and may be provided with longitudinally spaced downwardly turned discharge nozzles 27, each provided with an independently controllable valve 28, whereby the member 24 may be locally cooled to different extents at different places along its length.

The operation of the embodiment of the invention just described may be substantially as follows:

Molten glass from the tank 2 will flow through the tank outlet 9 beneath the refractory separator or gate member 14 into the flow channel of the forehearth. Tendency of the glass in the side portions of the flow channel to lag behind the glass in the longitudinal median portion of the flow channel and to become cooler and more viscous may be minimized or practically prevented by reason of the relatively intense and greater local heating of the glass in the side portions of the forehearth by the heated gases which are conducted in clearly defined channels from the firing chamber 18 rearwardly along the side walls of the forehearth channel to the stacks 15. At the same time, the temperature of the glass at the longitudinal median portion of the forehearth channel may be reduced by reason of the relatively greater radiation of heat through the metallic heat radiating plate 24 and thus substantially uniform and desirable condition, viscosity, temperature and velocity of flow of glass throughout the cross section of the glass at the forward end of the channel may be obtained. The glass supplied to the feed spout 11 therefore will be homogeneous and of uniform and desirable temperature, viscosity and condition.

It may be desirable at times to shut off the relatively greater radiation of heat from the longitudinal median portion of the forehearth through the metallic plate 24 or through a portion thereof. This may be done by placing a refractory block 29 on the metallic member 24 or on any portion of the latter, as shown in Fig. 3. If desired, the metallic cooling member may extend above the heat insulation on the refractory top 5*a* of the forehearth channel, as illustrated in Fig. 4, in which the metallic cooling member is designated generally at 24*a*. In such construction, the metallic cover member may include hinged side sections 30, each of which may be swung outwardly and upwardly to permit a refractory cover block 31 to be placed within the metallic member 24*a* so as to close the portion of the cooling opening 23*a* and thus to prevent radiation through a portion of the metallic member 24*a*. The entire opening 23*a* may be covered by refractory members in this manner or different longitudinally spaced portions thereof may be covered to vary the heat radiation at different places along the top of the forehearth.

The modified forehearth construction partially shown in Fig. 5 may be identical in all essential respects with the construction of Fig. 1 as hereinbefore described except that the feed spout 11 and associate feeding mechanism 13 of the construction of Fig. 1 are replaced in the construction of Fig. 5 by a basin 38 for holding a pool of moten glass from which glass may be removed by suction molds or other gathering receptacles. The firing space of the construction shown in Fig. 5 is indicated at 18*a* and the front wall thereof may comprise a vertically adjustable refractory baffle 39 which depends close to the glass and is adjustable to vary the exchange of heat permitted between the space in the firing chamber and the space above the glass in the gathering basin. Suitable glass circulating means, not shown, may be provided for use in connection with the glass gathering pool in the basin 38. The basin construction of the form of forehearth shown in Fig. 5 comprises features which are disclosed and claimed in my copending prior application, Serial No. 387,285, filed August 21, 1929, and which therefore need not be described herein as they are not being claimed in this application. The same reference characters have been usel to designate like parts of the con-

structions of Figs. 1 and 5 and the operation of the construction shown in Fig. 5 will be understood from the hereinbefore given statement of the operation of the construction of Fig. 1 supplemented by the brief description above given of the construction of Fig. 5.

In the construction shown in Figs. 6 and 7, the refractory top 5*b* of the forehearth channel comprises blocks which extend transversely across such channel and have central portions thereof depending downwardly to provide a longitudinal baffle 32. The top 5*a* is formed with a series of longitudinally spaced openings 33, each of which may be formed in one of the component blocks of the top 5*a*. Each opening 33 extends downwardly through the baffle portion 32 of the refractory top of the channel and is covered at its upper end by a metallic heat radiating cover member 34. An individual blow nozzle 35, provided with a regulating valve 36, may be provided above each of the cover plates 34 for projecting a regulable volume of air or other cooling media against the plate 34. The baffle 32 depends close enough to the glass level practically to prevent passage of any appreciable volume of heated gases along the longitudinal median portion of the glass in the forehearth and the side walls of the baffle 32 cooperate with the adjacent portions of the side walls 4*a* of the glass conducting channel of the forehearth and of the refractory top 5*a* to define passages, indicated at 37, above the side portions of the forehearth channel through which heated gases and products of combustion pass from the firing chamber 18*a*, at the front of the forehearth rearwardly to the stacks 15*a*. Each of the stacks 15*a* is provided with a damper 16 and with damper adjusting mechanism 17. The particular forehearth structure shown in Fig. 6 has the front or outer end portion thereof formed as a basin 38, as in Fig. 5, for holding a pool of molten glass from which glass may be removed by suction in molds or other gathering receptacles. In order to control draft and temperature conditions over the glass in the gathering basin, the front or outer wall of the firing chamber 18*a* may comprise the vertically adjustable refractory baffle 39 which depends close to the glass but can be adjusted with respect to the glass level to vary the exchange of heat between the space in the firing chamber and the space above the glass in the gathering basin.

The glass conducting channel of the forehearth construction of Fig. 6 may correspond in all other essential respects with the construction shown in Fig. 1 and heretofore described. Consequently parts of the construction of Fig. 6 which are identical or not essentially different from corresponding parts of Fig. 1 will not be described but are designated by the same reference characters as have been used for the corresponding parts of the construction of Fig. 1.

The construction shown in Fig. 8 differs from that shown in Fig. 6 in that a feed spout 11*a* and glass feeding mechanism 13 are provided, as in Fig. 1, at the outer end of the forehearth in lieu of the gathering basin 38 of Fig. 6. Otherwise, the construction shown in Fig. 8 conforms in all essential respects with the construction shown in Fig. 6.

In Figs. 9 and 10, the refractory top of the glass conducting channel is designated 5*b* and may be said to be of the cantilever type of construction. This top wall comprises longitudinal series of cantilever blocks having their outer portions supported on the side walls 4*b* of the forehearth channel structure and on portions of the side members of the metallic casing, as best seen in Fig. 10, such blocks being clamped securely in place by the metallic side frame members 40, the metallic top plate 41 and the adjustable connections 42 between the metallic top and side frame members. The cantilever blocks of the refractory top of the glass conducting channel have portions spaced apart above the longitudinal median portion of the forehearth channel to provide the opening 23*b*. A metallic cover plate 24*b* covers the opening 23*b* and may be retained in place by the clamp members 43. The cantilever blocks have cutaway portions at their bottoms to provide the central baffle 32*b* and the side passages 44 for conducting heated gases from the firing chamber 18*b* to the stacks 15*b*. A cooling pipe 26*b* having the separate nozzles 27*b* arranged to discharge against longitudinally spaced portions of the metallic plate 24*b* may be provided for locally applying cooling air or other cooling media to the plates 24*b*, if desired. Each of the nozzles 27*b* may be provided with a separate regulating valve 28*b*. The remaining parts of the construction shown in Figs. 9 and 10 are substantially identical with corresponding parts of the construction shown in Fig. 1 and have been designated by the same reference characters.

In Figs. 11 and 12, the refractory top of the forehearth channel is designated generally at 5*c* and is of the arched type of construction. The component blocks of this arched refractory top member of the forehearth channel are supported on the refractory side walls 4*c* of the channel structure, as best seen in Fig. 12, and include crown or key blocks having depending lower portions formed to provide a baffle 32*c* above the longitudinal median portion of the forehearth channel for part of the length of the latter and the side passages 37*c* for the passage of heated gases from the firing chamber 18*c* to the lower end of the stacks 15*c*. The blocks at the longitudinal median portion of the top structure 5*c* are provided with longitudinally spaced openings 33*c*, each of which extends through

the baffle 32*c*, and is covered at its upper end by a heat radiating metallic plate 34*c*. An individual blow nozzle 35*c* provided with a separate valve 36*c* may be provided above each of the plates 34*c* for discharging air or cooling media thereon. The remaining parts of the forehearth structure of Figs. 11 and 12 are not essentially different from like parts of the construction of Fig. 1 and have been designated by the same reference characters.

The forehearth construction of Figs. 13 to 15 inclusive has a refractory top designated 5*d*, comprising refractory blocks so formed and so disposed as to provide longitudinally spaced vertical openings 33*d* above the longitudinal median portion of the glass in the forehearth and the muffled longitudinally extending side passages 37*d* for conducting heated gases from the front firing chamber 18*d* to the lower ends of the stacks 15*d*. As clearly shown in Fig. 15, the blocks of the refractory top 15*d* have their lower surfaces close to the glass level and the heating of the glass in the side portions of the glass conducting channel is effected by radiant heat imparted from the gases passing through flues or muffled passages 37*d* through the bottoms of such passages to the glass therebeneath. Each of the openings 33*d* is covered at its upper end by a metallic heat radiating plate 34*d*. Such openings may be square in cross-sectional configuration as shown in Fig. 14. A separate blow nozzle 35*d*, controlled by a valve 36*d*, may be provided above each of the metallic plates 34*d*, for discharging air or other cooling medium thereagainst when desired.

The remaining portions of the construction shown in Figs. 13 to 15, inclusive, are designated by the same reference characters as generally corresponding parts of the construction shown in Fig. 1.

In the use of each of the specifically different constructions hereinbefore described and illustrated in the respective views of the drawings, conditioning of the glass in the forehearth may be regularly controlled by the conjoint action of the means which controls the distribution of temperature and draft conditions within the forehearth and the means which permits relatively greater radiation of heat from the glass at the longitudinal median portion of the forehearth so that the glass passing to a feed spout, glass gathering basin, or other supply chamber at the outer end of the forehearth will be uniform in temperature, viscosity and condition and will be of desired predetermined regulable condition, temperature and viscosity for use as required for a particular service. The regulation and control of the temperature and condition of the glass within the forehearth may be entirely independent of draft and temperature conditions within the space above the glass in the furnace and is effected while the top of the forehearth is closed to the atmosphere, thus obviating any objectionable interference with desirable control of firing and draft conditions in the forehearth.

I claim:

1. The combination with a glass melting furnace of a forehearth having a channel along which glass may flow from said furnace, means for introducing a heating medium into the space above the glass adjacent to the outer end of the channel and separate draft inducing means respectively communicating at opposite sides of the longitudinal median line of the forehearth with the space above the glass adjacent to the inner end of said channel for causing the path of movement of heat from the outer end of the channel to be mainly above the side portions of the glass in said channel.

2. The combination with a glass melting furnace of a forehearth having an enclosed channel along which molten glass may flow from the furnace, means for introducing a heating medium into the space above the glass adjacent to the outer end of said channel, and a pair of stacks respectively communicating at opposite sides of the longitudinal median line of the channel with the space above the glass adjacent to the inner end of the channel for causing the heated gases at the outer end of the channel to pass longitudinally of the channel above the glass in the side portions of said channel.

3. The combination with a glass melting furnace of a forehearth projecting therefrom and having a flow channel for receiving molten glass from the furnace, said forehearth having a firing chamber above the glass adjacent to the outer end of the channel and having separate draft inducing means respectively in communication at opposite sides of the longitudinal median line of the channel with the space above the glass adjacent to the inner end of the channel, and means for projecting a heating mixture in combustion downwardly and forwardly in said firing chamber above the longitudinal median line of said channel.

4. The combination with a glass melting furnace of a forehearth projecting therefrom and having a channel along which glass may flow from the furnace, means for separating the space above the glass in the forehearth from the space above the glass in the furnace, means for introducing a heating medium into the space above the glass in said channel adjacent to one end of the latter to cause heating of the glass in the forehearth independently of heat from the furnace, means, including separate draft inducing means, respectively communicating with the space above the glass in the channel at opposite sides of the longitudinal median line thereof, for causing the heated gases in the forehearth to travel lon-

gitudinally of said channel, mainly above the glass in the side portions of the channel, and imperforate means for causing a relatively greater radiation of heat from glass at the longitudinal median portion of said channel than from the glass in the side portions of said channel.

5. The combination with a glass melting furnace of a forehearth projecting therefrom and having a channel along which glass may flow from the furnace, means for introducing a heating medium into the space above the glass adjacent to the outer end of the channel, a cover structure for said channel having an imperforate metallic portion located above the glass in the longitudinal median portion of said channel to cause a relatively greater radiation of heat from part of the glass at the longitudinal median portion of the channel than from the glass in the side portions of the channel, said metallic portion having its outer surface exposed at the top of said cover structure, means for causing heated gases within the forehearth to travel longitudinally of the channel mainly above the glass in the side portions of said channel and means for insulating the glass conducting channel of the forehearth at the bottom and sides thereof.

6. The combination with a glass melting furnace of a forehearth having a refractory channel along which glass may flow from the forehearth, means separating the space above the glass in the forehearth from the space above the glass in the furnace, means for introducing a heating medium into the space above the glass in the forehearth, means for controlling the distribution of flow of heated gases within the forehearth to cause said heated gases to travel mainly above the glass in the side portions of said channel, and imperforate metallic means above part of the glass at the longitudinal median portion of said channel for causing a relatively greater radiation of heat from the glass at the longitudinal median portion of the channel than from the glass in the side portions of the flow channel, said imperforate metallic means having its inner surface exposed to heat from the underlying glass and its outer surface exposed at the outer side of the forehearth.

7. The combination with a glass melting furnace of a forehearth having a refractory channel along which glass may flow from the furnace, means separating the space above the glass in the forehearth from the space above the glass in the furnace, means for introducing a heating medium into the space above the glass in the forehearth, means for controlling the distribution of flow of heated gases within the forehearth to cause said heated gases to travel mainly above the glass in the side portions of said channel, imperforate metallic means above part of the glass at the longitudinal median portion of said channel for causing a relatively greater radiation of heat from the glass at the longitudinal median portion of the channel than from the glass in the side portions of said channel, said imperforate metallic means being in direct heat communicating relation with both the space within the forehearth and the atmosphere outside of the forehearth, and means for locally cooling said imperforate heat radiating means.

8. The combination with a glass melting furnace of a forehearth having a refractory channel along which glass may flow from the forehearth, means separating the space above the glass in the forehearth from the space above the glass in the furnace, means for introducing a heating medium into the space above the glass in the forehearth, means for controlling the distribution of flow of heated gases within the forehearth to cause said heated gases to travel mainly above the glass in the side portions of said channel, imperforate metallic means above part of the glass at the longitudinal median portion of said channel for causing a relatively greater radiation of heat from the glass at the longitudinal median portion of the channel than from the glass in the side portions of the channel, and means for locally cooling said imperforate heat radiating means, said cooling means being adjustable to vary the cooling of said imperforate metallic means independently at a plurality of different places above the longitudinal median line of the forehearth.

9. The combination with a glass melting furnace of a forehearth projecting therefrom and having a channel along which glass may flow from the furnace, said channel having refractory bottom, side and top walls, said refractory top wall being spaced from the glass in the channel, refractory means separating the space above the glass in the channel from the space above the glass in the furnace, said refractory top wall having a vertical opening formed therein above the longitudinal median line of the channel, a metallic member completely closing the upper end of said opening to cause a relatively greater radiation of heat from the glass below said metallic member than from the glass in the side portions of said channel, means for introducing a heating medium into the space above the glass adjacent to one end of said channel, and means for controlling the distribution of flow of heated gases above the glass in the channel to cause said heated gases to travel longitudinally of the forehearth mainly above the glass in the side portions of said channel and laterally of the space beneath said metallic heat radiating member.

10. The combination with a glass melting furnace of a forehearth projecting therefrom and having a channel along which glass may flow from the furnace, said channel having refractory bottom, side and top walls, said

refractory top wall being spaced from the glass in the channel, refractory means separating the space above the glass in the channel from the space above the glass in the furnace, said refractory top wall having a vertical opening formed therein above the longitudinal median line of the channel, a metallic member completely closing the upper end of said opening in the refractory top wall of the channel to cause a relatively greater radiation of heat from the glass below said metallic member than from the glass in the side portions of said channel, means for introducing a heating medium into the space above the glass adjacent to one end of said channel, and means for controlling the distribution of flow of heated gases above the glass in the channel to cause said heated gases to travel longitudinally of the forehearth mainly above the glass in the side portions of said channel and laterally of the space beneath said metallic heat radiating member, said heat radiating member being formed to permit removable refractory blocks to be placed in position to shut off said relatively great radiation of heat through a regulable portion or all of said opening in the refractory top member.

11. The combination with a glass melting furnace of a forehearth projecting therefrom and having an enclosed channel along which glass may flow from the furnace, said forehearth being formed to provide side passages above the glass in the side portions of said channel for conducting heated gases longitudinally of the forehearth, means separating the space above the glass in the forehearth from the space above the glass in the furnace, means for introducing a heating medium into the space above the glass in the channel adjacent to one end of each of said side passages, and separate means in communication with the space above the glass in the channel at the opposite end of each of said side passages for causing a draft in each side passage, whereby the heated gases in said channel will travel mainly through said side passages, and imperforate means located above the space between said side passages for causing a relatively greater radiation of heat from the glass at the longitudinal median portion of the channel than from the glass below said side passages.

12. The combination with a glass melting furnace of a forehearth projecting therefrom and having a channel along which molten glass may flow from the furnace, said channel having refractory bottom, side and top walls, the refractory top wall of the channel having a vertical opening therein above the longitudinal median line of the glass in the channel, and an imperforate metallic closure for the upper end of said opening for causing a relatively greater radiation of heat from glass at the longitudinal median portion of the channel than from the glass in the side portions of said channel.

13. The combination with a glass melting furnace of a forehearth projecting therefrom and having a channel along which glass may flow from the furnace, said channel having a top structure formed with a relatively thin imperforate portion above the glass in the longitudinal median portion of the channel to cause a relativeily greater radiation of heat from the longitudinal median portion of the glass in the channel than from the glass in the side portions of said channel, the inner and outer surfaces of said imperforate portion of the top structure respectively being exposed to heat from the underlying glass and to a cooling medium above the forehearth.

14. The combination with a glass melting furnace of a forehearth having a covered channel along which glass may flow from said furnace, means for introducing a mixture in combustion into a firing space above the glass in the channel adjacent to one end of the latter, and separate independently regulable draft inducing means communicating at opposite sides of the longitudinal median line of the channel top for causing independently regulable flow of heated gases from said firing space longitudinally of the channel above the glass in the side portions of said channel.

15. The combination with a glass melting furnace of a forehearth having a channel along which glass may flow from said furnace, a cover enclosing said channel, said cover having a longitudinally-extending chamber with a bottom opening communicating with the space above the longitudinal median portion of the glass in the channel, and means for absorbing heat from said chamber while the top of said chamber is closed to the atmosphere.

16. The combination with a glass melting furnace of a forehearth having a channel along which glass may flow from said furnace, a cover enclosing said channel, chamber means disposed in said cover for providing a heat column above the median portion of the glass in the channel higher than the heat column above the side portions of said channel and means for absorbing heat from said chamber while the top of said chamber is closed to the atmosphere.

Signed at Hartford, Connecticut, this 17th day of September, 1929.

KARL E. PEILER.