(No Model.) 2 Sheets—Sheet 1.

H. SCHULZE-BERGE.

GLASS MELTING FURNACE.

No. 296,227. Patented Apr. 1, 1884.

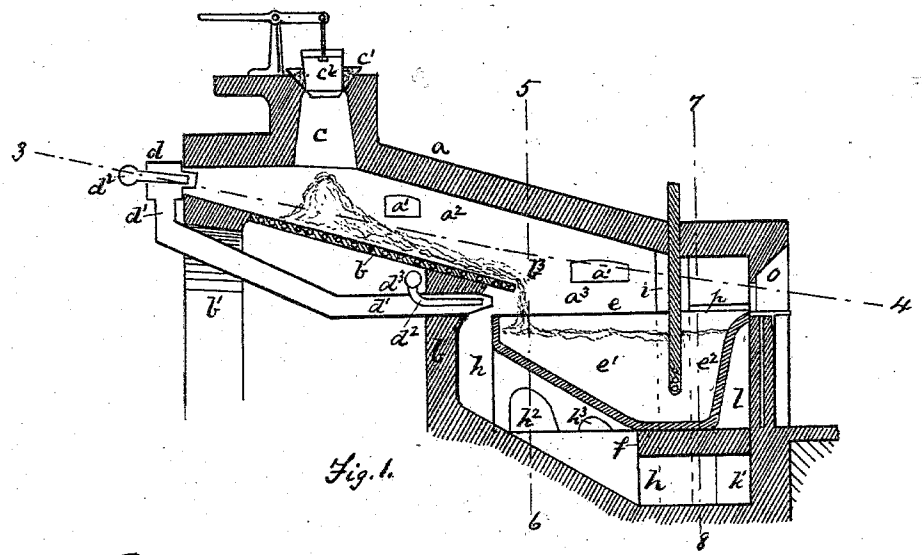


Fig. 1.

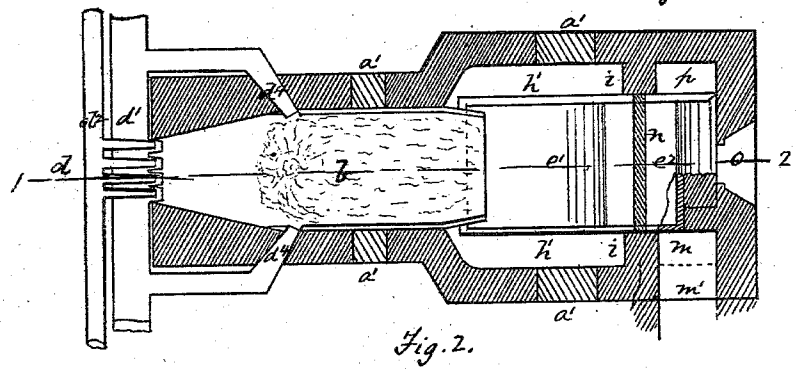


Fig. 2.

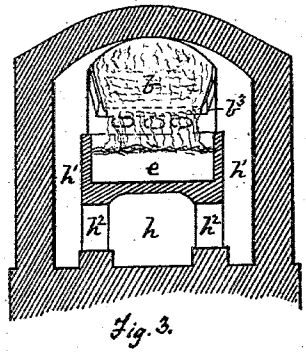


Fig. 3.

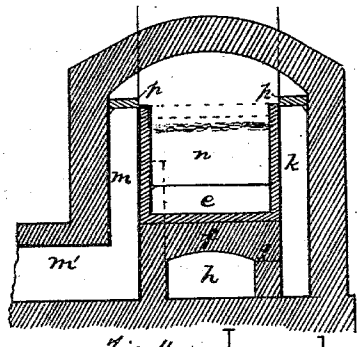


Fig. 4.

Witnesses.
Jno. K. Smith
R. C. Goldeu

Inventor.
Hermann Schulze-Berge
by his attys
Bakewell & Kerr

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

H. SCHULZE-BERGE.

GLASS MELTING FURNACE.

No. 296,227. Patented Apr. 1, 1884.

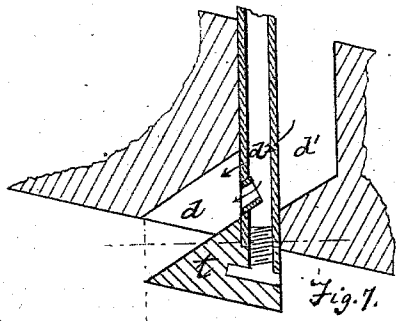


Fig. 7.

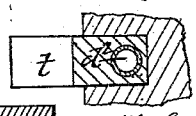


Fig. 8.

Fig. 5.

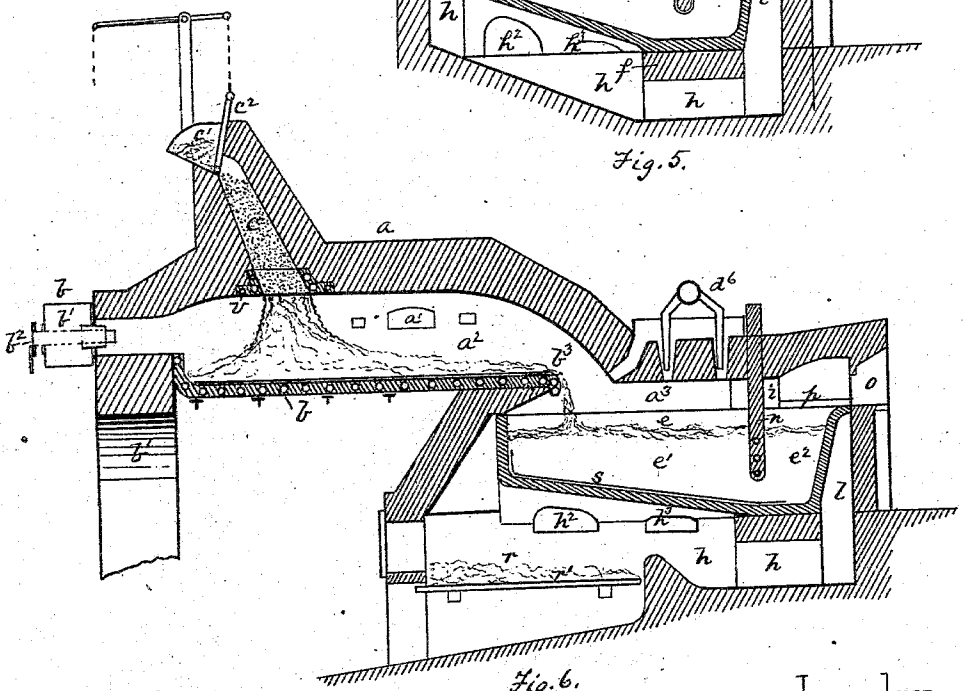


Fig. 6.

Witnesses—
Jno. K. Smith
R. C. Goldsborough

Inventor
Hermann Schulze-Berge
by his attys
Bakewell & Kerr

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

HERMANN SCHULZE-BERGE, OF ROCHESTER, PENNSYLVANIA.

GLASS-MELTING FURNACE.

SPECIFICATION forming part of Letters Patent No. 296,227, dated April 1, 1884.

Application filed January 16, 1884. (No model.)

To all whom it may concern:

Be it known that I, HERMANN SCHULZE-BERGE, of Rochester, in the county of Beaver and State of Pennsylvania, have invented a new and useful Improvement in Glass-Melting Furnaces; and I do hereby declare the following to be a full, clear, and exact description thereof.

In the manufacture of glass from sand and its other ingredients quite a variety of furnaces is used for melting the batch. The most common forms are crucible or pot furnaces and hearth-furnaces. The hearth-furnace is better adapted to the first portion of the melting operation, in which the solid ingredients are fused, for the reason that this part of the operation is better performed at a very high temperature, which has the effect of eliminating the volatilizing-acids—such as carbonic or sulphurous acid—so rapidly that it causes the contents of the pots to rise and flow over their edges. Consequently where pot-furnaces are used this step is performed at a lower temperature, and requires a much longer time than would be necessary in a hearth-furnace. The remaining steps of the operation may then be proceeded with at a lower temperature than is necessary or desirable in the fusing of the ingredients.

My improved furnace is designed to combine the advantages of the hearth and pot furnaces.

To enable others skilled in the art to make and use the same, I will now describe it by reference to the accompanying drawings, in which—

Figure 1 is a vertical section of my improvement on the line 1 2 of Fig. 2. Fig. 2 is a section on the line 3 4 of Fig. 1. Fig. 3 is a vertical cross-section on the line 5 6 of Figs. 1 and 2. Fig. 4 is a vertical cross-section on the line 7 8 of Figs. 1 and 2. Figs. 5 and 6 are vertical longitudinal sections of modified forms, and Figs. 7 and 8 are sectional views of an improved tuyere.

Like letters of reference indicate like parts in each.

The furnace *a* is provided with a metallic or other suitable melting-floor, *b*, which is preserved from the heat or kept cool by water, air, or other cooling-fluid passing through coils of pipe formed in it. This floor is supported by suitable walls, *b'*, Fig. 1, or by means of metallic beams of angle, T, or other suitable shape, as illustrated in Figs. 5 and 6. The end of the melting-floor projects beyond the edge of the inner supporting-wall, *b''*, so as to form a precipice, b^3. In the top of the furnace, above the floor *b*, is a charging-hole, *c*, which may be fitted with a hopper, *c'*, and stopper c^2. The ingredients are fed to the floor through this hole. At the end or side of the floor, back of the charging-hole *c*, is a tuyere or tuyeres, *d*, consisting of a gas-pipe, *d'*, and air-pipe d^2.

Arranged below the precipice or discharging edge b^3 of the floor *b* is a pot or receptacle, *e*, which rests upon a supporting-bench, *f*, and is further sustained by side walls, *g*, which also support the bench *f*. The space between the side walls of the furnace and the pot *e* is divided vertically on one side into chambers or flues *h'* and *k*, and at the other into separate chambers or flues *h''* and *m* by vertical walls *i*. Extending down from the edge of the pot, under the precipice b^3 and under the bench *f*, is a flue or passage, *h*. The side chambers or flues, *h'*, communicate with the passage *h* by means of openings h^2 h^3, through skirt of the pot or through the walls *g*. At its forward end the passage *h* communicates with the vertical flue or chamber *k* by means of a lateral opening, *k'*, through one of the walls *g*, and in front of the pot is a lateral passage, *l*, which leads to the vertical flue *m* on the side opposite to the chamber *k*, and the flue *m* communicates with the stack-flue *m'*. The course of the products of combustion from the floor *b* is by the passage *h* and passages *h'*, through openings h^2 h^3, into the passage *h*, thence by opening *k'* into passage *k*, thence by passages *l*, *m*, and *m'*, to the stack. By this arrangement the heated products of combustion are caused to pass over and around the pot *e*. Extending through the inner supporting-wall of the floor, just below the precipice *b*, so as to discharge upon or through a stream of glass which falls over the precipice, is a second tuyere or tuyeres, d^3. By this arrangement the glass which falls over the precipice *b* is exposed to the direct action of a second heating and melting blast. Inserted through the top of the furnace, between the lateral walls *i*, is an intercepting-trap or dam-plate, *n*, formed of

refractory material, with coils of pipe extending through it, so that it may be preserved from the destructive action of the heat by means of air, steam, or other cooling medium passing through the pipes. This trap *n*, extending down into the pot *e*, practically divides its interior into two chambers, *e' e²*, which communicate at the bottom, in the first of which the melting and mixing operation of the batch is completed, and out of the latter of which the glass is taken through a work-hole, *o*, as it is needed for use. In the sides of the furnace, opposite the floor *b* and chamber *e'*, are holes *a'*, usually closed by suitable bricks, tiles, or doors, through which tools may be inserted to facilitate the working and mixing of the batch. The metallic floor *b* may be protected by a thin layer of refractory material; or there may be melted on this floor a layer of very silicious glass, which sticks to it, and as such layer is kept cool by the cooling agent passing through the pipes, it serves as a bottom upon which the easier-fusible glass is melted, and thus prevents the oxidizing ingredients of the batch from acting upon the metallic bottom.

Thus constructed, the operation of my improvement is as follows: The ingredients of the batch, being first properly mixed, are fed through the charging-hole *c* onto the floor *b*, where they are acted upon by the heat produced and sustained by the gaseous fuel from the tuyeres *d*. As the ingredients become fused, they flow down over the inclined surface of the floor and drop in the form of a cascade from the precipice b^3. Usually the condition of the batch, when sufficiently fused to flow, is stringy. As it is falling from the edge b^3, it is not only exposed to the heat in the lower chamber, but also to the flame from the second set of tuyeres, d^3, which acts upon it while it hangs suspended or is falling from the edge b^3, so that the second melting-flame is applied to the half-molten glass under the very best possible conditions, and has the effect of bringing it quickly to a fluid state. When the glass reaches the chamber *e'* of the pot *e*, it is further acted upon by the heat, which, as before stated, circulates over the top of and all around the pot, and the volatilizing-gases still remaining in it are rapidly evolved and given off without an injurious degree of ebullition. The glass flows under the trap *n*, and when sufficiently cooled for working can be taken out through the work-hole *o*.

The upper ends of the chambers or passages *k* and *m* are closed by tiles or slabs *p* on a level with the edge of the pot *e*, Figs. 1 and 4, to prevent access of the flame to that portion of the furnace commanded by the work-hole *o*.

If desired, a third set of tuyeres, d^4, may enter the sides of the furnace, Fig. 2, and play on the pile of ingredients placed on floor *b*.

In Fig. 5 I show a modification of the furnace. Here tuyeres d^5 are placed in the top of the furnace, to play down upon the top of the glass batch, and the precipice b^3 is formed of a separate water-cooled piece placed at the lower end of the floor *b*. Arranged across the furnace, below the precipice b^3, is a bridge or arch, *q*, so that the glass from the floor *b* falls thereon, and then falls therefrom into the pot *e*, being thereby retarded and kept longer in the action of the heated gases in the furnace. Thus two cascades are formed, and the half-molten glass is more thoroughly exposed to the action of the blast from the tuyeres d^3 and the heat in the furnace. The force of the blast from the tuyeres d^3, acting against the glass on the bridge *q*, which is preferably inclined in a reverse direction, retards its descent, and hence retains it longer under the influence of the flame. The bridge is formed of fire-brick or other refractory material; but as such material will not withstand the dissolving action of silica at the temperature attained in the furnace, the upper surface of the bridge is covered with a thin foil, *q'*, of platinum or kindred metal. The platinum not melting at this temperature and not being acted upon by the melting glass, unless metals or sulphides or phosphides are present to form alloys with the platinum, protects the bridge, so that it will stand any temperature attainable in the furnace. For the same reason the intercepting-trap *n* is covered with a thin protecting-foil, *n'*, of platinum or kindred metal, such as iridium, ruthenium, palladium, osmium, or alloys of these metals. Other parts of the pot subjected to the dissolving action of the fluid glass may be protected in the same way.

In Fig. 6 I show another modification. Here the floor *b* is level instead of inclined, as in Figs. 1 and 5; and a fire-chamber, *r*, with grate-bars *r'*, or other special fire, is provided, to heat the pot *e* from beneath. To render the bottom of the pot better able to withstand the dissolving action of the fluid glass, it is lined inside, as at *s*, with a layer of carbonaceous matter—preferably graphite clay, such as is used for graphite crucibles—formed, dried, and baked thereon when the pot is made. The molten glass does not act upon graphite, and the graphite lining prevents, to a considerable degree, the dissolving action of the already molten glass, provided that it does not contain oxidizing substances—such as nitrates of alkalies, binoxide of manganese, litharge, &c.—such oxidizing agents having performed their function by melting together with and acting upon the ingredients of the glass upon the floor *b* and before reaching the bottom of the pot.

In Fig. 6 gas-tuyeres d^6 are arranged in the top of the furnace, to play upon the surface of the glass in the pot *e*.

In Figs. 7 and 8 I show an improved construction of tuyere, having a stopper, *t*, for regulating the size without changing the direction of the blast.

The discharge end b^3 of the floor *b* may be provided with a dam or rib, for the purpose of forming a pool of molten glass thereon, where it is subjected to intense heat.

Placed across the upper chamber, a^2, of the furnace, at or near the precipice b^3, is a skimmer, *u*, Fig. 5, which is so arranged as to prevent unmelted material which may float down on the surface of the molten glass from being carried over the precipice b^3 into the pot *e*. This skimmer need not stand above the precipice, but may be arranged beyond it, but must be so near as to skim off the said unmelted ingredients, if any there be, from the top of the stream of molten glass. In this connection I will state that for the edge b^3 may be substituted a slot or series of holes or openings through the projecting edge of the floor *b*, and the molten glass may flow down through them and drop into the pot *e* in a series of streams. Such an arrangement would be simply a modification of the precipice, and would accomplish the purpose of the skimmer, as only the molten glass would go through.

In Figs. 5 and 6 I show the charging-hole surrounded by a water-cooled casting, *v*, so that the ingredients may be allowed to stand up in the charging-tube and descend as the base of the pile melts. The casting *v* is used, because the melting glass, if in contact with the brick top of the furnace, would melt it away. The advantage consists in placing a considerable quantity of material in the furnace without danger to it, so that the operation may be carried on without frequent charging.

When the crude ingredients contain substances—such as sulphides or phosphides of metals—capable of fusing the platinum or similar lining, it can be used only during the second period of the melting operation. These substances will be oxidized to such an extent during the first period of the operation as to be practically harmless to the lining of the bridge or other part in the second chamber; but where the ingredients do not contain such substances, or where old glass is remelted, such lining may be used indiscriminately in any part of the furnace.

The pot *e* is supported by the bench *f* only below the working-compartment e^2, so that the heat has access to the bottom below the melting-compartment e' either by means of the passage *h*, Fig. 1, or the furnace *r*, Fig. 6. Thus the working-chamber e^2 is better fitted for reducing the temperature of the glass. So far as I know, I am the first to apply heat to the bottom of a melting-pot, which can be done with advantage wherever the materials melted are not of a character to waste the sides of the pot, such as old glass or glass previously fused in a preliminary melting-chamber, as in this case.

If desired, the preliminary melting floor or chamber may be caused to discharge into several pots, and one pot be cooling while others are being filled, and so the working out of the furnace goes on continuously.

The floor *b* may, if desired, be made of refractory tile or other suitable material, provided with the passages, channels, or chambers for the passage of the cooling medium, which floor may be protected, as before stated, by a thin layer of very silicious glass or other refractory material. The channels or chambers for the passage of the cooling medium may be of any desired form, and are provided with suitable supply and discharge pipes, as will be understood.

As shown, the height of fall from the precipice b^3 to the pot *e* is comparatively small; but I do not limit myself to any particular height. The distance may be made very great, in order that the falling glass may be subjected longer to the action of the heat in the chamber a^3 in its passage from the precipice to the pot.

By the term "disconnected from the side walls," used in the claims, I mean a discharging-point which is away from and at a lower level transversely than the point where the floor or bed connects with the side walls of the furnace, so that the molten glass shall flow from the other parts of the floor or chamber to such discharging-point, and then drop sheer through the heated gases, and, without contact with any downward-conducting surface, into the pot or receptacle below.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A glass-melting furnace having a fusing floor or chamber for fusing the batch, a projecting edge or precipice disconnected from the side walls, over which the melted batch falls, a vertical free space through which the melted batch falls freely, and in which it is exposed to the action of the heated gases during its fall, a pot or receptacle arranged on a lower level directly under the precipice, so as to receive the freely-falling glass for further treatment, to clear it and complete the melting operation, and a working-chamber separated from the clearing-chamber by a dependent trap, the lower end of which is immersed in the glass, substantially as and for the purpose described.

2. A glass-melting furnace having a fusing chamber or floor, with a discharging end or precipice disconnected from the side walls, projecting over a vertical space in the furnace, so that the molten batch flowing over the same from the fusing-floor shall have a free fall through the heated gases of the furnace into a pot or receptacle arranged in the furnace at a lower level, substantially as and for the purpose described.

3. A glass-melting furnace provided with a fusing-floor, a pot or receptacle arranged below the fusing-floor, a projecting precipice from which the molten glass falls through the heated air of the furnace into the pot, and means for projecting a supplemental flame on the glass as it falls through the space, substantially as and for the purpose described.

4. The combination, in a glass-melting furnace, of a fusing-floor having a precipice or discharging end cooled by water or other suitable medium, with a pot or receptacle arranged under the precipice to receive the glass

falling therefrom for further treatment, substantially as and for the purposes described.

5. A glass-melting furnace having a fusing floor or chamber provided with a discharging edge or precipice projecting into a vertical space in the furnace, so that the molten glass may have a free fall therefrom, a pot or receptacle arranged below it, so as to receive the falling glass, and a bridge, break, or arch arranged across the chamber below the precipice and above the pot, so as to intercept, retard, or break the fall of the glass, substantially as and for the purpose described.

6. The combination, in a glass-melting furnace, of a fusing-floor having a precipice, and a pot or receptacle arranged under the precipice, with a reversely-inclined bridge or arch, and tuyeres arranged to blow against the downward flow of glass on the bridge, substantially as and for the purposes described.

7. The combination, in a glass-melting furnace, of a fusing-floor having a precipice, with a trap or dam-plate arranged over it, at or near its edge, to prevent the unfused ingredients from being carried over the precipice with the molten glass, substantially as and for the purposes described.

8. A glass-melting furnace having a feed-hole arranged over the fusing-floor, provided with channels or pipes for the passage of a cooling medium, substantially as and for the purposes described.

9. The combination of a glass fusing floor or chamber with a glass pot or furnace lined with graphite for receiving the molten glass from the fusing-floor, substantially as and for the purposes described.

10. The method of melting glass, consisting of fusing the ingredients in a suitable chamber or floor, whence it falls to a second chamber, pot, or receptacle for further treatment, and in its descent is subjected to the action of a supplementary blast of heated gas or flame projected against or through it, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 22d day of December, A. D. 1883.

HERMANN SCHULZE-BERGE.

Witnesses:
THOMAS B. KERR,
W. B. CORWIN.