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G. H. MCINTYRE ET AL

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APPARATUS FOR SMELTING

Filed May 11, 1937

2 Sheets-Sheet 1

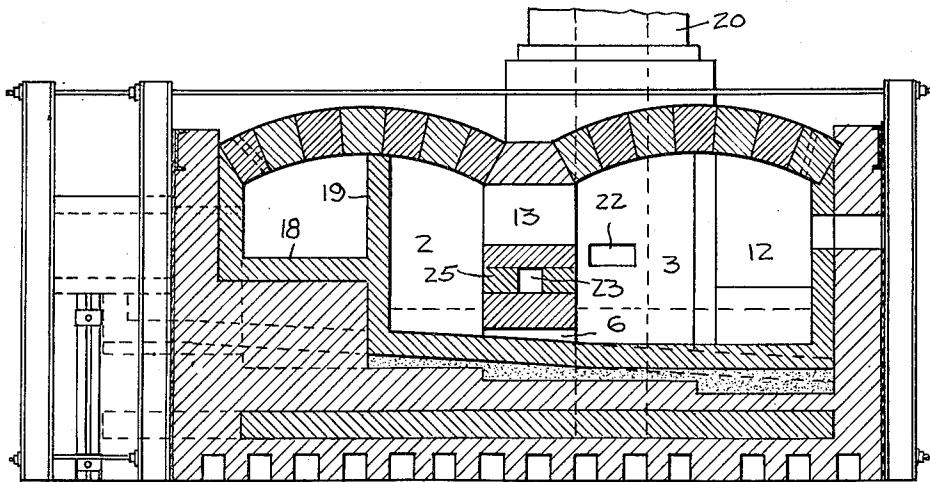
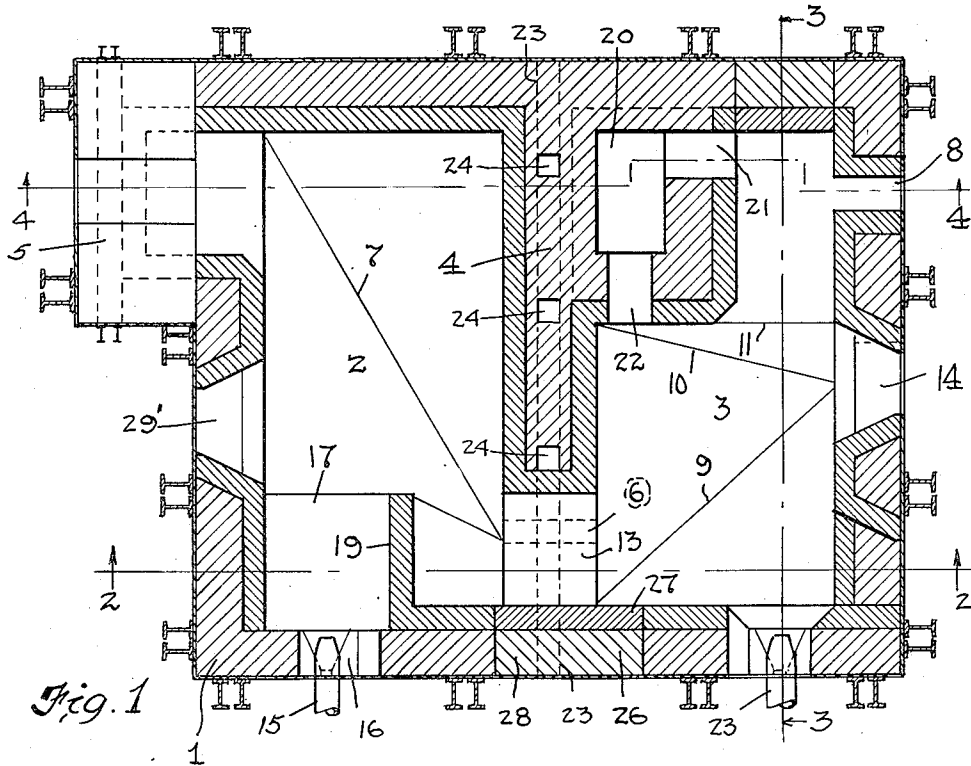


Fig. 2

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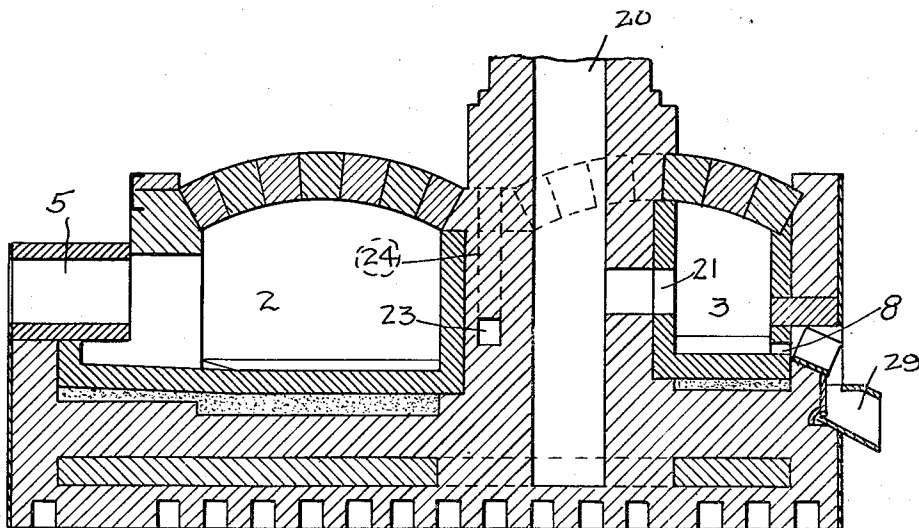


Fig. 4

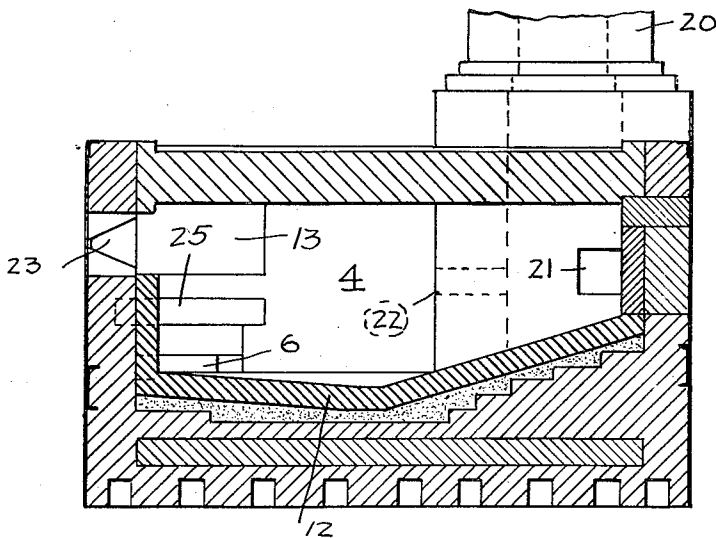


Fig. 3

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UNITED STATES PATENT OFFICE

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APPARATUS FOR SMELTING

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7 Claims. (Cl. 49—54)

This invention relates as indicated to method of and apparatus for smelting and more particularly to the smelting of the raw materials used in the manufacture of glass and porcelain enamel.

The method and apparatus of our invention is designed particularly for the production of porcelain enamel frit, since certain problems encountered in the manufacture of such material are not present in the manufacture of plain glass.

It is the principal object of our invention to provide a method of and apparatus for smelting raw materials for the manufacture of products of the character described characterized by the fact that the smelting operation is carried on continuously and in such a way and by means which insure the more economical production of a superior product.

Other objects of our invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the annexed drawings and the following description setting forth in detail certain means and one mode illustrating, however, but one of the various ways in which the principle of the invention may be used.

In said annexed drawings:—

Fig. 1 is a horizontal sectional view through a smelter constructed in accordance with the principles of our invention and adapted to carry out the process comprising our invention; Fig. 2 is a transverse sectional view of the apparatus illustrated in Fig. 1 taken on a plane substantially indicated by the line 2—2; Fig. 3 is another sectional view through the apparatus illustrated in Fig. 1 taken on a plane substantially indicated by the line 3—3; and Fig. 4 is a transverse sectional view of the smelter illustrated in Fig. 1 taken on a plane substantially indicated by the line 4—4.

Referring now more specifically to the drawings and more especially to Fig. 1, the smelter here illustrated in horizontal cross-section as one embodiment of the apparatus comprising our invention is generally rectangular in form and constructed of the usual refractory materials employed in structures of this type which are subject to high temperatures. The general rectangular smelter 1 is roughly divided into two compartments or chambers 2 and 3 by a substantially centrally located dividing wall or partition 4.

The chamber 2 will throughout the ensuing description be referred to as the melting chamber, since therein substantially all of the raw materials used in the production of the finished product are melted or reduced to a fluid state. The chamber 3 will throughout the ensuing description be referred to as the fining chamber for the reason that therein the material previously melted in chamber 2 is refined by being subjected to an elevated temperature for a predetermined length of time to remove all "seeds" and the like from the material before it is discharged.

The raw material to be smelted is fed to the melting chamber 2 by means of a suitable screw conveyor or the like (not shown) located in a conventional "dog house" 5 positioned at the upper lefthand corner of the melting chamber as viewed in Fig. 1. The hearth of the melting chamber 2 is inclined towards an opening 6 which, as most clearly illustrated in Fig. 2, extends through the central dividing wall 4 from the melting chamber to the fining chamber.

The line 7 shows the approximate direction of flow of the melting materials as determined by the slope of the hearth 2. After the melted material enters the fining chamber 3 from the passage 6, it flows towards the discharge opening 8, this direction of flow being, of course, determined by the slope of the hearth of the fining chamber 3 and such slope is roughly indicated by the lines 9, 10 and 11. It will be noted, however, from an inspection of Fig. 3, that the actual slope of the hearth in the fining chamber may be more clearly determined.

As most clearly illustrated in Fig. 3, the hearth 12 of the fining chamber slopes downwardly away from the opening 6 through which the melted material is admitted to the fining chamber. The hearth, however, at substantially the central part of the fining chamber 3 again slopes upwardly towards the discharge opening 8, so that the elevation of this discharge opening is higher than the top of the passage 6 but lower than the bottom of the opening 13 in the wall 4 above the glass passage 6 through which the gases flow from the chamber 2 to chamber 3 in the manner hereinafter more fully explained. This elevation of the discharge opening 8, therefore, determines the depth of the bath of melted material in the smelter at all times.

Directly opposite the intersection of the lines 9 and 10, i. e., at the very lowest point in the fining chamber 3, there is provided a drain port 14. This drain port 14 is normally closed and is opened merely for the purpose of draining the

material in the smelter if it should be desired to discontinue the smelting operation or if it should be desired to change the formula of the material passing through the smelter.

5 The heating of the materials in the apparatus comprising our invention is accomplished by means of hydrocarbon burners utilizing either gaseous or liquid fuel such as natural gas or fuel oil. The primary burner 15 is positioned in a
10 port 16 formed in the outside wall of the melting chamber 2 at the same end of such chamber as the passages 6 and 13 formed in the dividing wall 4 and through which the melted material and burning gases respectively flow.

15 The burner 15 has a firing shelf or combustion chamber generally indicated at 17 associated therewith. This firing shelf or combustion chamber consists of an elevated hearth portion 18 and a partial partition 19. The provision of this firing shelf 17 has several advantages. In the first
20 place, it, by being positioned within the melting chamber 2, eliminates what would otherwise be a dead corner of the bath in the melting chamber. The partition 19 directs the flame from the burner
25 15 so as to more fully insure the production of a loop in the flame which is essential for the carrying on of our process for the reasons herein-after more fully explained. The firing shelf or more specifically the elevated hearth portion 18
30 thereof, catches drippings from the hydrocarbon burner which would otherwise fall into the bath and contaminate the same. These drippings, due to the temperature of the hearth 18 are, of course, volatilized and burned. We have found that
35 when employing fuel oil in the burner 15, the hearth 18 should extend for a distance of approximately three feet beyond the end of the burner.

The flame produced by the burner 15 forms a
40 loop in the melting chamber 2 from the time it issues from the burner 15 to the time when it passes through the opening 13 into the fining chamber 3. The forward end of this loop and in which area the highest temperature in the melt-
45 ing chamber is secured is directly opposite the point of charging of the raw material through the "dog house". Thus the materials fed to the smelter are immediately brought to an elevated temperature at least sufficiently to prevent separation
50 of constituents of the raw material mass which might occur if the raw materials were brought to an elevated temperature more slowly. The righthand leg of the fire loop in the melting chamber 2 of course extends into the area between
55 the partition 19 and the opening 13. This is in effect a restricted passage so that here again the chamber of the bath is elevated, thus insuring that there will be no freezing of the material as it passes through the opening 6 into the fining
60 chamber.

We have found that projecting the flame from the burner 15 in a loop through the melting chamber 2 in the manner just described unexpectedly increases the efficiency of operation of
65 such melting chamber. Not only is the melting rate considerably increased and accordingly the production for a given size unit increased, but furthermore, there is a more efficient interchange
70 of heat between the burning gases and the bath so that the melting operation is carried on economically.

The stack 20 for carrying away the products of combustion is located in one corner of the
75 fining chamber 3. The passage to the main flue

in the stack is by means of branched openings 21 and 22.

The hot gases passing into the main flue of the stack through the branched opening 21 are led across and through the area directly in front
5 of the continuous discharge opening 8. This insures that the melted material in this area is always maintained at the proper temperature. The heated gases passing through the branched opening 22 keep the area of the bath adjacent the
10 back wall fully heated so that there is a uniformity of temperature over the entire bath area.

It is within the contemplation of our invention to provide a damper in one or both of the branched passages 21 and 22. A main damper
15 in the main flue of the stack may be, of course, also advantageously employed either separately or in conjunction with the auxiliary dampers in the branched passages. In this way the temperature of the various areas of the bath in the
20 fining chamber may be accurately controlled as desired.

As a further means for controlling and augmenting the temperature in the fining chamber 3, an auxiliary burner 23 may be advantageously
25 employed.

It should be observed that the bottom of the continuous discharge opening 8, as most clearly illustrated in Fig. 3 is level with the hearth of the
30 fining chamber 3, thus reducing to a minimum the erosion which normally occurs when the melted material in a highly heated state flows over a supporting wall.

Likewise the arrangement of the discharge opening 8 on a level with the hearth eliminates
35 entirely all objectionable dead pockets in the bath adjacent the discharge opening.

The central wall 4 dividing the smelter 1 into the two compartments is interiorly cooled by being provided with a longitudinally extending
40 passage 23 adjacent the bottom thereof and vertically extending passages 24 opening out of the top of the furnace and at their lower ends in communication with the passage 23. Thus, a natural draft of air is established into the pas-
45 sage 23 and upwardly through and out of the passages 24, effectively cooling the dividing wall or partition 4.

In order to facilitate repair of the skimmer arch 25 between the gas passage 13 and the
50 melted material passage 6, the wall section 26 in the outside wall of the smelter directly opposite the skimmer arch is constructed so as to be readily removable. This may be accomplished by leaving an opening equivalent to the size of the
55 section 26 in the side wall of the furnace as such wall is originally constructed and then closing in such opening by means of a refractory lining, the element 27 and an outer brick wall 28, after the entire outer wall has been finished. In this way, when erosion of the skimmer arch 25 has deteriorated the same so as to require replacement,
60 the section 26 may merely be removed and the skimmer arch replaced without otherwise disturbing the structure of the furnace.

The smelter will, of course, be provided with an inspection opening 29, if desired, as well as the usual number of conventional pyrometer openings, all of which, since they form no part of the present invention, have not been more fully
70 illustrated and thus will not be particularly described.

It will be observed that when employing the apparatus comprising our invention, the raw materials from which the finished glass or more
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particularly the porcelain enamel frit is to be produced, are fed into the melting chamber where they are quickly and efficiently reduced to a molten state for discharge to the fining chamber 3 and in the fining chamber there is such a control of temperature and direction of flow of the melted material as to insure the discharge of a uniform product at the continuous discharge opening 8.

When manufacturing porcelain enamel frit by our improved smelter, the continuous discharge opening 8 will have a discharge spout 29, associated therewith, which will discharge the melted material into a water bath as is customary in the production of enamel frit.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

We, therefore, particularly point out and distinctly claim as our invention:—

1. A melting furnace comprising laterally contiguous melting and fining chambers respectively provided with a charging opening for the raw material and a discharge opening for the melted material, separate passages respectively for burning gases and melted material connecting said chambers, a burner arranged in one wall of said melting chamber in the same end of said furnace as said passage for burning gases whereby a heating flame in the form of a loop may be projected through said melting chamber and then through said burning gas passage into said fining chamber and a flue opening in said fining chamber.

2. A melting furnace comprising laterally contiguous melting and fining chambers respectively provided with a charging opening for the raw material and a discharge opening for the melted material, separate passages respectively for burning gases and melted material connecting said chambers, a burner arranged in one wall of said melting chamber in the same end of said furnace as said passage for burning gases whereby a heating flame in the form of a loop may be projected through said melting chamber and then through said burning gas passage into said fining chamber, an auxiliary burner in said fining chamber and a flue opening in said fining chamber.

3. A melting furnace comprising laterally contiguous melting and fining chambers respectively provided with a charging opening for the raw material and a discharge opening for the melted material, separate passages respectively for burning gases and melted material connecting said chambers, said melted material passage and said charging and discharge openings so arranged with respect to each other that the work material flows in loop fashion through the furnace, a burner arranged in one wall of said melting chamber in the same end of said furnace as said gas passage whereby a flame in the form

of a loop may be projected through said melting chamber and then into said fining chamber and a flue opening in said fining chamber.

4. A melting furnace comprising laterally contiguous melting and fining chambers separated by a common wall and respectively provided with a charging opening for the raw material and a discharge opening for the melted material, separate passages through said common wall for the flow of burning gases and melted material from said melting chamber to said fining chamber, a burner arranged in the wall of said melting chamber in the same end of said furnace as said gas passage whereby a heating flame in looped fashion may be projected through said melting chamber and then into said fining chamber and a flue opening in said fining chamber.

5. A melting furnace comprising laterally contiguous melting and fining chambers respectively provided with a charging opening for the raw material and a discharge opening for the melted material, separate passages respectively for burning gases and melted material extending from said melting chamber to said fining chamber, a burner arranged in one wall of said melting chamber adjacent said gas passage for projecting a heating flame in looped fashion through said melting chamber and into said fining chamber, a flue opening in said fining chamber and a partition in said melting chamber extending between said gas passage and the area directly in front of said burner.

6. A melting furnace comprising laterally contiguous melting and fining chambers respectively provided with a charging opening for the raw material and a discharge opening for the melted material, separate passages respectively for burning gases and melted material extending from said melting chamber to said fining chamber, a burner arranged in one wall of said melting chamber adjacent said gas passage for projecting a heating flame in looped fashion through said melting chamber and into said fining chamber, a flue opening in said fining chamber, and a firing shelf in said melting chamber in the area directly in front of said burner.

7. A melting furnace comprising laterally contiguous melting and fining chambers respectively provided with an opening for charging raw material and an opening for the discharge of the melted material, passages between said chambers for the flow of burning gases and melted material, a burner in said melting chamber in the same end thereof as said passage for gas whereby a flame in the form of a loop may be projected into the same and then through said gas passage into said fining chamber, a flue opening in the same end of said fining chamber as said discharge opening and a plurality of openings from said fining chamber into said flue, one of said last-named openings being opposite to said discharge opening for melted materials.

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