Sept. 30, 1941. H. T. SMYTH 2,257,136

PRODUCTION OF CAST REFRACTORIES

Filed Dec. 7, 1939

Fig. 1.

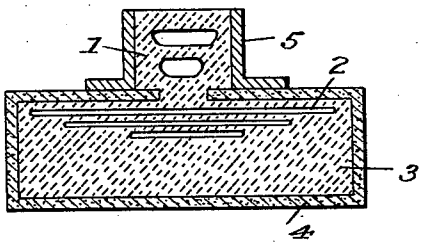


Fig. 2.

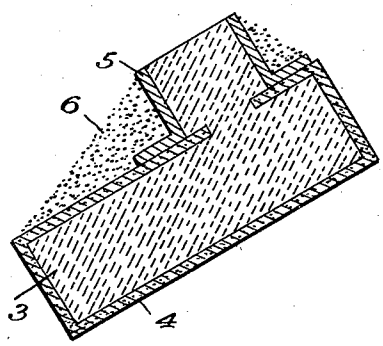


Fig. 3.

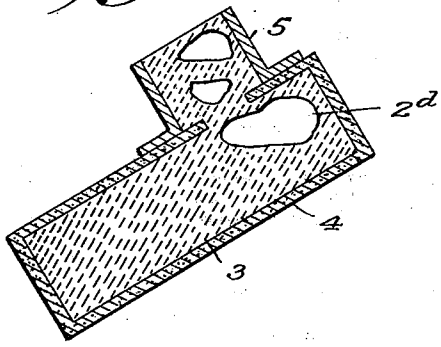


Fig. 4.

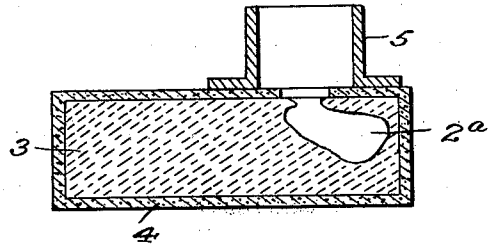
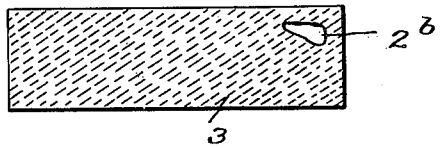


Fig. 5.



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PRODUCTION OF CAST REFRACTORIES

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Application December 7, 1939, Serial No. 308,062

6 Claims. (Cl. 49—79)

Useful refractories can be made by electrically melting refractory compositions and casting to shape in suitable molds. During the subsequent cooling, the liquid resolidifies to a non-porous highly crystalline refractory, the crystallization proceeding gradually inward from each mold surface in proportion to the latent heat dissipated from that surface. Since however the volume of any crystalline refractory material is less than the volume occupied when melted, a pipe will be produced if the mold is just filled. This internal flaw in a casting is obviously objectionable for any refractory which is required to resist failure by corrosion, as, for example, glass refractories.

It is the purpose of this invention to provide an economical method of decreasing the size of this pipe or of increasing the useful thickness of refractory material surrounding it.

One method of decreasing the pipe is to supply additional molten material from a font reservoir above the gate which additional material can drain into the casting after partial solidification has occurred. This technique is limited by the fact that the font casting is also freezing at substantially the same rate as the main casting, so that in order for molten material to be available at the last stages of crystallization of the main casting, the font must be substantially as large as the casting itself. This is obviously uneconomical, and in practice a font with perhaps 10% of the volume of the casting is normally employed. This is relatively efficient however as the greatest volume of the block is in the outside shell which freezes relatively rapidly. In the case of a sphere for example, 7/8 of the volume has frozen when the diameter of the molten core is halved.

As the material frozen in the font itself is wasted, two or more small fonts may be poured successively. In practice only two fonts are ordinarily used because of the difficulty of breaking through the gate into the pipe to permit refilling. Metal thus poured into the pipe will itself decrease in volume upon freezing and leave a smaller pipe so that the defect is not entirely corrected.

An alternative attack on the problem of minimizing the danger of failure through the pipe is to change its location within the block to a positon where failure is not as likely to occur in the particular use to which the block is put. Thus, for a block designed for use in the sidewall of a glass tank, which is often made 18" wide, 12" thick and of a length depending on the depth of the glass, say 40", the logical place for the gate scar is on the outside 18" x 40" face, away from the glass. However, since the rate of corrosion decreases with the distance below the glass line, the safest place for the pipe would be near the 18" x 12" end on which the block stands. A gate scar on this end would be dangerous however as glass seeping beneath the block would need to eat through only a thin shell to enter the pipe and attack from all sides at once. In application Serial Number 166,155 by Fulcher are described various methods of changing the location of the pipe after casting the block in its usual position, as a result of subsequent tilting, rocking or turning of the casting. In the illustration cited above for example, the block would be cast on its 18" x 40" face to place the gate scar on the back of the block, and the casting then tilted after the font has drained, so that after partial contraction of volume occurs, the still molten material in the interior of the elevated end will drain down and fill the center of the block. The block in use would then stand on the end containing the pipe which however has a smooth and relatively thick shell which was frozen before the block was tilted.

I have now discovered that castings can be made combining the tilting technique with the refilling technique which are improved to an unanticipated degree in that the completeness of refilling is greater in a tilted block than in the usual horizontal casting.

Referring to the accompanying drawing in which corresponding parts are designated by similar marks of reference,

Figure 1 illustrates the present accepted practice of casting a block showing the character of the pipes resulting therefrom.

Figures 2, 3 and 4 illustrate successive steps in casting a block in accordance with this invention, and

Figure 5 is a section through a block cast in accordance with this invention.

The surprising results before referred to as resulting from this invention have been traced to the character of the pipe obtained in the two cases. For example, I refer to Figure 1 in which 1 represents the font shell after draining; 2 represents the pipe resulting from the contraction upon freezing; 3 represents the solidified area of the refractory; 4 the mold in which the block has been poured; and 5 the font mold used for refilling. In a rectangular side wall block such as here represented, say, 12" x 18" x 42" which is normally poured 12" deep, crystallization and

freezing will proceed inward from all sides as long as the font continues to drain. After the font has drained the level of the liquid drops on further contraction, to form the pipe, and crystallization proceeds from the sides and bottom and ends at rates depending on the insulation applied. The pipe produced in this horizontal casting is therefore relatively large in area but perhaps only an inch deep. Furthermore the pipe is generally not a uniform cavity but is likely to have cross fins and thin septa which may result either from slopping of the liquid as the casting is handled, or to some ununiformity in insulation or some freak of crystal growth. At any rate the passages within the pipe are narrow and devious.

Refractory material as melted in contact with unmelted batch is only slightly superheated above its freezing point and rapidly freezes on coming in contact with a colder surface. When such material is poured into the relatively thin pipe, 2, of Figure 1 of a casting poured in a horizontal position, this rapid congealing may clog the pasageways on a slow pour, or the molten material may trap air in pockets on a fast pour so that in either case the farthest recesses may be only incompletely filled. As the main purpose of the procedure is to extend the thickness of solid refractory and especially towards at least the end which will be used at the glass line, the purpose is to a certain extent thwarted by the continued presence of flaws in unknown positions.

On the other hand when such a casting is tilted in order to locate the pipe in one end, the area of the free liquid surface is distinctly decreased. Since the volume of the pipe will remain the same, the depth is necessarily greater resulting in a more readily filled pipe. When molten material is poured into the concentrated pipe resulting from cooling in a tilted position, the efficiency of refilling is significantly increased and no unfilled voids are left in the lower part of the original pipe. The resultant casting therefore not only has its final void in the least harmful position, but that void is significantly smaller than can be obtained by refilling a casting cooled in a horizontal position.

To illustrate my method in greater detail the procedure for casting a glass tank sidewall block will be described. The mold is placed with its long axis horizontal. The font mold instead of being placed in the center can be advantageously shifted toward the end which is to be elevated since the angle of tilt can be increased without preventing drainage of the font liquid. Without removing the font, the block is then tilted a few minutes later at such an angle, as illustrated in Fig. 2, that molten material can drain simultaneously from the font and from the elevated end of the block as contraction occurs. To prolong this font draining period and decrease the amount of material wasted by freezing in the font itself, it is advantageous to cover the font as well as the block with insulating powder 6 to retain the heat. After the interior of the block has largely solidified leaving the pipe, 2^a, in the position shown in Fig. 3, the font shell is broken off, the hole into the pipe enlarged by chipping with a bar, a font mold 5 placed in position around the hole and the pipe then filled with the casting in a horizontal position as shown in Fig. 4. In practice very little draining occurs from the second font and it need not be large. A few minutes are sufficient to freeze a sealing layer on the font thick enough to withstand the liquid pressure and the block is then placed again in a tilted position. Since the font drainage in this case need not be taken into consideration, the angle of tilt may be increased if desired. Final cooling in this position will give a small pipe, 2, in the position illustrated in Fig. 5. The weight of the block is an indication of the efficiency of refilling, and in practice it is found that heavier blocks are obtained by my procedure.

In general the method can be applied with good results whenever tilting significantly decreases the area of the free liquid surface of unfrozen material so that a more compact pipe results. As further examples of this general classification we may cite the following:

1. It is desired to manufacture a block to be placed lengthwise in the top course of a glass tank sidewall. Since the severest corrosion occurs at the glass line, the least harmful position for the pipe would be on the bottom outside edge. If the block is say 18" high, 12" thick, and 24" long it would be poured on the 18"x24" surface and the 18" axis then tilted up from the horizontal to concentrate the pipe along the raised 24" long edge. While the pipe would still be long, its width is materially decreased and its depth increased by the tilting so that a compact readily filled void is formed. The refilled casting is set in the tank with its gate scar out and the edge containing the pipe, down.

2. It is desired to manufacture a doghouse corner in one course. In this case the edge projecting into the tank is severely corroded by fresh batch and the least harmful position for the pipe is diagonally opposite and toward the bottom. If the block is say 18"x18" and 40" high it would be poured on an 18"x40" surface and then one corner of this surface would be raised. In this case the free surface area is decreased in length as well as width and leaves a compact pipe for refilling. The casting is set in the tank with the corner containing the pipe down and away from the glass.

What I claim is:

1. The method of producing a cast refractory comprising casting the block with font reservoir of insufficient volume to prevent pipe formation through an asymmetrically located font on top of the block, tilting the block to raise the font end thereof in respect to the opposite end after partial but before complete solidification, breaking through the crusts over the pipe and refilling the void left by the contraction of the first cast material.

2. The method of producing a cast refractory comprising casting the block with font reservoir of insufficient volume to prevent pipe formation through an asymmetrically located font on top of the block, tilting the block to raise the font end thereof in respect to the opposite end after partial but before complete solidification, breaking off the font shell left by the said casting operation and refilling the thereby exposed pipe resulting from the contraction of the originally cast meterial.

3. The method of producing a cast refractory comprising casting the block through an asymmetrically located font with the gate bearing surface horizontal, and with a font reservoir of insufficient volume to prevent pipe formation, tilting the block to raise the font end thereof in respect to the opposite end after partial but before complete solidification, exposing and turning the void left by the contraction of the

originally cast material to a position lower than the gate and refilling the void.

4. The method of producing a cast refractory comprising casting the block through an asymmetrically located font with the gate bearing surface horizontal, and with a font reservoir of insufficient volume to prevent pipe formation, tilting the block to raise the font end thereof in respect to the opposite end after partial but before complete solidification, breaking off the font shell left by said casting operation, thereby exposing the pipe, turning the void left by the originally cast material to a position lower than the gate and refilling the void.

5. The method of producing a cast refractory comprising casting the block through an asymmetrically located font with the gate bearing surface horizontal, and with a font reservoir of insufficient volume to prevent pipe formation, tilting the block to raise the font end thereof in respect to the opposite end after partial but before complete solidification, exposing and turning the void left by the contraction of the originally cast material to a position lower than the gate, refilling the void, allowing the surface of the added material to solidify and restoring the block to its first tilted position.

6. The method of producing a cast refractory comprising casting the block through an asymmetrically located font with the gate bearing surface horizontal, and with a font reservoir of insufficient volume to prevent pipe formation, tilting the block to raise the font end thereof in respect to the opposite end after partial but before complete solidification, breaking off the font shell left by said casting operation thereby exposing the pipe, turning the void resulting from the contraction of the originally cast material lower than the gate, refilling the void, allowing the surface of the added material to solidify and restoring the block to its first tilted position.

HAROLD T. SMYTH.