May 14, 1968 L. M. MALONE 3,382,911

CASTING FERROALLOYS

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FIG. 3.

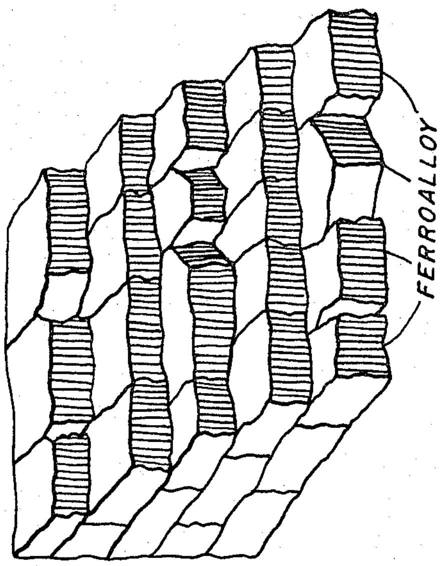


FIG. 1.

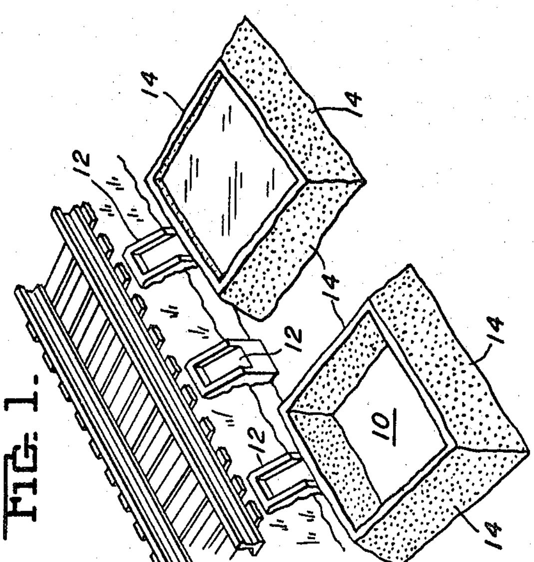
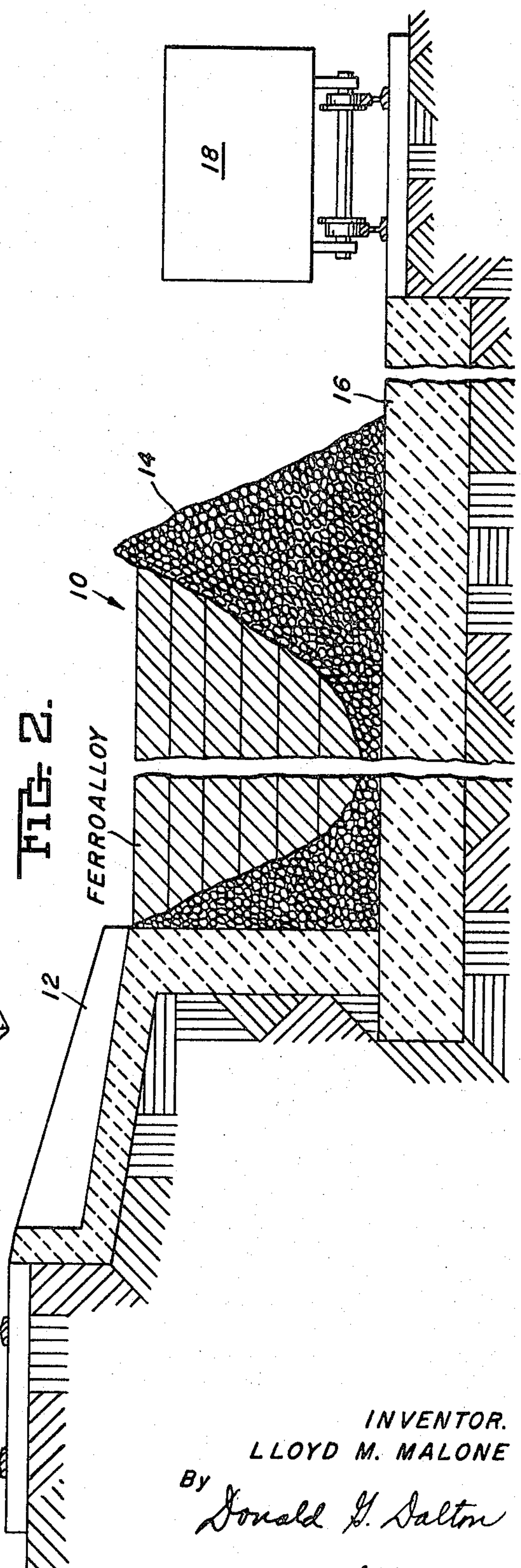


FIG. 2.



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1

3,382,911
CASTING FERROALLOYS

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Continuation-in-part of application Ser. No. 540,702, Apr. 6, 1966. This application July 3, 1967, Ser. No. 650,845
9 Claims. (Cl. 164—70)

ABSTRACT OF THE DISCLOSURE

A method of casting ferroalloys such as ferromanganese or ferrosilicon by pouring molten ferroalloy into a confined area in a plurality of layers with each layer being solidified before pouring a succeeding layer. The last and uppermost layer of ferroalloy is water cooled and, when solidified, the cast ferroalloy may be removed as sized pieces.

This application is a continuation-in-part of application Ser. No. 540,702, filed Apr. 6, 1966, now abandoned.

This invention relates to the production of ferroalloys. More particularly, the invention relates to a method of producing sized pieces of ferroalloys such as ferromanganese and ferrosilicon without crushing and screening. Still more particularly, the invention relates to a new method of casting and handling ferromanganese and ferrosilicon.

Several different methods of handling ferroalloys have been used in the past. One technique comprises casting a ferroalloy, e.g. ferromanganese, from the furnace directly to boxes on railroad flat cars. After solidifying, the ferromanganese is crushed and screened to desired sizes. This approach is generally unsatisfactory because of the danger of hot metal breaking out of the boxes on the railroad cars and because of the high maintenance costs of equipment and high cost of crushing and screening.

A safer, although still relatively expensive technique which has been used, is to cast the ferromanganese into pigs. In this method, the ferromanganese is cast into ladles and poured into a pig casting machine which casts pigs continuously. The cast pigs may then be further processed by crushing and screening to size.

Still another approach, which is described in U.S. Patent No. 2,917,798, is to cast ferromanganese into a divided pit, the inner walls of which are coated in such a manner as to allow removal of the cast material. However, the cast slabs produced in this manner still must generally be crushed or broken before use.

It is an object of this invention to provide a relatively low-cost method of producing sized pieces of ferroalloys without the necessity of crushing and screening.

It is another object of the invention to provide a method of casting ferroalloys such as ferrosilicon and ferromanganese so that upon solidification the ferroalloy self-fractures.

Still another object of the invention is to provide a method of producing sized fragments of ferromanganese and ferrosilicon substantially cubically shaped and substantially of predetermined size.

According to the invention, a ferroalloy is cast into a confined area in such a manner that upon solidification the cast ferromanganese breaks up into pieces of controlled size. The method comprises pouring a plurality of layers of ferromanganese into a confined area, solidifying the surface of each preceding layer prior to pouring the succeeding layer to allow layering without substantial fusion between layers, water cooling the last and uppermost layer to solidify and fracture the surface of same and removing cast ferromanganese from the confined area in fragments substantially cubically shaped and approximately equal to layer thickness. In the preferred embodiment, a molten ferroalloy is poured in successive layers as described into a casting pit enclosed with walls of loosely piled pieces of the same ferroalloy which are easily removed. After layering to the desired depth, one or more of the walls is taken away to provide access for recovering the ferroalloy in the pit.

2

The invention will be further described by reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of a plurality of casting pits suitable for use in accordance with the invention;

FIGURE 2 is a view in elevation, partly in section, of one of the casting pits described in FIGURE 1; and

FIGURE 3 is a perspective view of a portion of a plurality of layers of ferroalloy as would appear in the interior of the casting pit after removal of the confining walls.

The perspective view in FIGURE 1 shows a plurality of casting pits and troughs leading thereto as it would be constructed at a site near a ferroalloy supply, e.g. a ferromanganese or ferrosilicon furnace. As an example, ferromanganese is produced in a blast furnace and can be cast into ladle cars which are transported on rails from the blast furnace. The pits may also be constructed near blast furnaces in such a manner that ferromanganese can be cast directly into the pits from the furnaces. Casting pits as illustrated in FIGURE 1 can be easily constructed at a point adjacent the tracks on which the ladle cars are transported, or alternatively, the tracks can be elevated. As can be seen, it is only necessary to excavate an area for the casting pit and pouring trough or, as in the preferred embodiment, the casting pit may be formed by piles of refractory material capable of containing the molten ferroalloy, e.g. ferromanganese, when it is poured into the casting pit.

The following description of casting ferromanganese will illustrate the practice of the invention. However, it is apparent that substantially the same practice will apply to other ferroalloys.

As can be seen in the perspective view shown in FIGURE 1, the casting pit **10** is a confined area adapted to receive molten ferromanganese from a hot metal ladle car via a pouring trough **12**. The hot metal ladle car **11** shown in FIGURE 2 is representative of the ladle cars into which ferromanganese is cast from the blast furnace. The ladle cars are conveniently transported on rails to the casting pit area.

The casting pit itself may be constructed in any suitable manner so long as it is able to receive and contain molten ferromanganese from the ladle car. One preferred construction consists of walls **14** of loose piled ferromanganese on a refractory lining or pad **16**. The trough **12** is preferably also constructed of a suitable refractory material and supported on a refractory bed.

Removable walls 14 are provided for access to the cast layers of ferromanganese in the confined area of the pit. When the desired layering depth has been achieved, the ferromanganese may be easily removed by removing one or more of the walls so that mechanical handling equipment may be brought in to recover the ferromanganese and load it into cars **18** for shipment.

The layering of ferromanganese in the casting pit is shown in FIGURE 3. As can be seen, there is a clean separation between each of the layers. The ferromanganese in each layer is fragmented and the ferromanganese can be recovered in pieces of controlled size ready for loading by mechanical equipment onto transportation cars.

In operation, molten ferromanganese is poured from a ladle car into a trough from which it flows into the casting pit. Preferably, the casting pit is constructed of a size which permits it to receive a full pour from the ladle. After the cast, the surface of the layer of ferromanganese is solidified either by air cooling or by water cooling and then a subsequent layer is cast onto the previous one. Any number of layers may be cast and the thickness of each layer may vary considerably, depending on the desired size of ferromanganese pieces.

Control of the size of pieces of ferroalloy is achieved by controlling the layer thickness because the ferroalloy pieces produced are generally cubically shaped and approximately equal in size to the layer thickness. In a presently preferred embodiment, for example in casting ferromanganese, the practice is to cast the alloy to a depth of about 48 inches in 6 layers, each about 8 inches thick. By solidifying the surface of each layer, such as by air cooling, prior to pouring succeeding layers, it is possible to minimize fusion between the layers and thus produce a clean separation between layers. The rapid change in temperature following solidification, e.g. by contact after cooling with a succeeding molten layer or in solidifying the surface by water cooling (as in the case of the uppermost surface), creates stresses in the layers which cause or induce the formation of fracture cleavages that result in fragmentation of the layer. After the last and uppermost layer is poured, it is water cooled to achieve fracturing comparable to the lower layers. It has been found that merely air cooling the uppermost layer is not always sufficient to obtain satisfactory fracturing. If the top layer is not water cooled after casting, it may break up into undesirably large pieces.

A flowing trough for transferring the molten metal into the casting pit area is desirable to provide a gentle flowing action of the molten metal onto a surface of solidified ferroalloy. In order to maintain the integrity of each layer, it is desirable to pour succeeding layers in such a manner as to minimize the possibility of the molten metal washing into the lower layer and to thereby preclude substantial intermixing and fusion between layers. If multiple layers are to be poured in rapid succession, it would be advantageous first to water cool each layer to solidify its surface prior to each subsequent pour. In general, however, water cooling each layer results in somewhat smaller fragments of ferroalloy and it is presently preferred to construct the casting pit of a sufficient size to permit a full pour as a single layer. The use of loose or fine ferroalloy similar to the material being cast for the pit walls makes pit size adjustment relatively quick and simple. With controlled layer thickness and cooling, the fragment size can also be controlled and relatively few fines will be produced.

To remove the ferroalloy fragments after the removable wall is taken away, any mechanical handling equipment may be used. The use of more than one removable wall facilitates speedy recovery of the ferroalloy. The product is immediately ready for loading and transportation. Any number of casting pits may be used to accommodate the amount of ferroalloy available for casting. The use of a sufficiently long trough to permit the molten metal to flow instead of falling into the pit is desirable. If desired, loose ferroalloy of similar composition may be spread over the bottom of the pit prior to casting. This serves the purpose of protecting the pit bottom from thermal shock. This loose bottom layer also facilitates easier removal by mobile equipment.

It is apparent from the above that various changes and modifications may be made without departing from the invention. Accordingly, the scope of the invention should not be limited to the foregoing description and drawings.

I claim:

1. A method of producing sized pieces of ferroalloy without crushing and screening by casting ferroalloy in a confined area so that said cast ferroalloy fractures into pieces of controlled size comprising the steps of pouring a plurality of layers of molten ferroalloy into said confined area, solidifying each preceding layer prior to pouring the succeeding layer to allow layering without substantial fusion between layers and so as to allow the creation of stresses in the layer which induce fragmentation, water cooling the last and uppermost layer to solidify and fracture the surface of same, and removing cast ferroalloy from said confined area in pieces substantially cubically shaped and approximately equal to the layer thickness.

2. A method according to claim **1** wherein said ferroalloy is ferromanganese.

3. A method according to claim **1** wherein said ferroalloy is ferrosilicon.

4. A method of producing sized pieces of ferroalloy without crushing and screening by casting ferroalloy in a confined area having at least one removable wall so that said cast ferroalloy fractures into pieces of controlled size comprising the steps of pouring a plurality of layers of molten ferroalloy into said confined area, solidifying the surface of each preceding layer prior to pouring the succeeding layer to allow layering without substantial fusion between layers, water cooling the last and uppermost layer to solidify and fracture the surface of same, withdrawing said removable wall to provide access to the ferroalloy within said confined area, and removing cast ferroalloy from said confined area in pieces substantially cubically shaped and approximately equal to the layer thickness.

5. A method according to claim **4** wherein said ferroalloy is ferromanganese.

6. A method according to claim **4** wherein said ferroalloy is ferrosilicon.

7. A method according to claim **4** including the step of forming said confined area by disposing piles of particulate ferromanganese continuously therearound.

8. A method according to claim **4** including the step of forming said confined area by disposing piles of particulate ferrosilicon continuously therearound.

9. A method of producing sized pieces of ferromanganese without crushing and screening by casting ferromanganese in a confined area so that said cast ferromanganese fractures into pieces of controlled size comprising the steps of pouring a first layer of molten ferromanganese into said confined area, pouring a plurality of successive layers onto said first layer, solidifying the surface of each preceding layer prior to pouring the succeeding layer to allow layering without substantial fusion between layers, each of said successive layers being poured onto the preceding layer by gently flowing same to preclude substantial intermixing and fusion between layers, water cooling the last and uppermost layer to solidify and fracture its surface, and removing cast ferromanganese from said confined area in pieces substantially cubically shaped and approximately equal to the layer thickness.

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