March 18, 1969 V. H. MONTGOMERY ET AL 3,433,283

METHOD OF REDUCING FRIABILITY OF FERRO-ALLOYS

Filed April 3, 1968

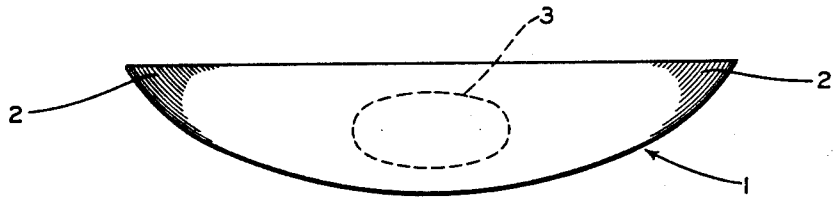

Fig. 1

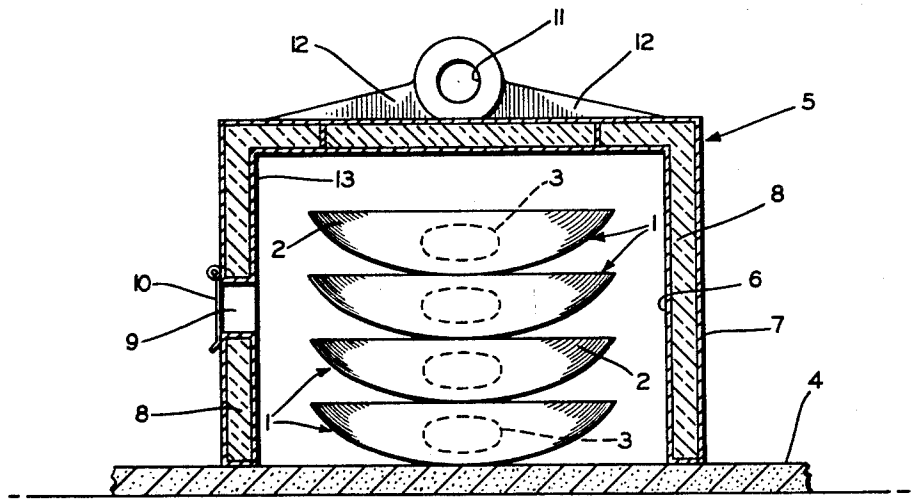

Fig. 2

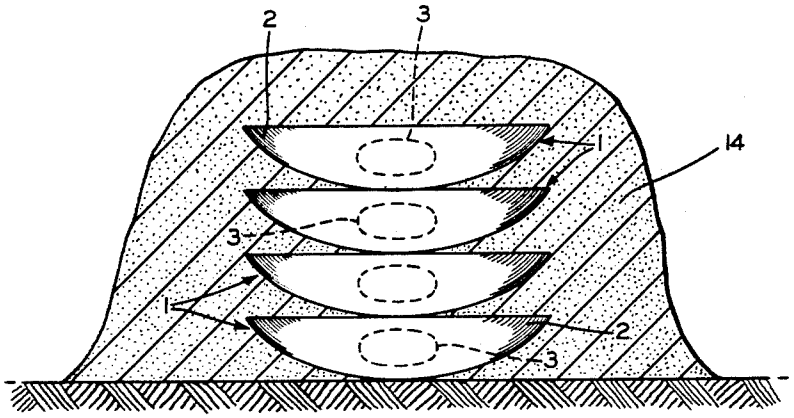

Fig. 3

INVENTORS.
Vernon H. Montgomery
and Roger N. McClure
BY
Frease & Bishop
ATTORNEYS

United States Patent Office 3,433,283
Patented Mar. 18, 1969

3,433,283

METHOD OF REDUCING FRIABILITY OF FERRO-ALLOYS

Vernon H. Montgomery and Roger N. McClure, Canton, Ohio, assignors to Ohio Ferro-Alloys Corporation, Canton, Ohio, a corporation of Ohio

Filed Apr. 3, 1968, Ser. No. 718,515
U.S. Cl. 164—69 11 Claims
Int. Cl. B22d *23/00, 27/04, 7/10*

ABSTRACT OF THE DISCLOSURE

A method for reducing the friability of ferro-alloys intended for use as ladle or furnace additions in steel making. The method consists in casting ingots of ferro-alloys such as ferro-silicon, silico manganese, magnesium ferro-silicon, ferro-manganese, iron-chromium-silicon alloy, and the like, removing the ingots from the chills or molds while the centers of the ingots are still molten, covering the hot ingots and permitting them to cool slowly to about 1200° F., then uncovering the ingots and permitting them to cool to room temperature, and then crushing the cold ingots to desired size for use as ladle or furnace additions.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to the production of ferro-alloys intended for use as ladle or furnace additions. Such ferro - alloys include ferro - silicon, silico manganese, magnesium ferro-silicon, ferro-maganese, iron chromium-silicon alloy, and the like. In the preparation of such ferro-alloy additions, it is customary that the metal be cast in cast iron, steel or copper chills, or carbon, graphite or refractory molds to form relatively large diameter shallow ingots. After cooling, these ingots are crushed into relatively small pieces for use as ladle or furnace additions.

Due to the friability of such ferro-alloys a considerable amount of fines is produced in the crushing operation. These fines are not suitable for use as ladle or furnace additions. Being too light in weight to sink into the molten metal bath and be dissolved, the fines float on the surface of the metal and are removed with the slag.

The only practical way of making use of the fines is to remelt them for casting future ingots. The larger the percentage of silicon in a ferro-alloy, the greater the friability thereof. In 50% ferro-silicon, that is containing about 50% by weight silicon, friability is at a maximum.

Under present practice, about 30% of the ingot shatters into fines which are not practical for use as ladle or furnace additions. In the crushing operation the fracture lines spread beyond the point of cleavage, or the metal breaks like onion peel. Subsequent handling or transporting of the crushed metal results in the production of further fines.

Description of the prior art

It is known that low silicon iron alloy ingots have been cooled slowly in order to make the metal more ductile

or soft, so that it may be forged or otherwise worked. However, it is not known that anyone has ever proposed the slow cooling of substantially large diameter shallow ingots of ferro-alloys to reduce friability, and then crushing the cold ingot for use as ladle or furnace additions.

SUMMARY OF THE INVENTION

In general terms the invention may be briefly described as comprising a method for reducing friability of ferro-alloys intended for use as ladle or furnace additions. This method consists in casting relatively large diameter shallow ingots of ferro-alloys such as ferro-silicon, ferro-manganese, silico manganese, magnesium ferro-silicon, iron-chromium-silicon alloys, and the like. These ingots are cast in shallow bowl-shaped cast iron, steel, or copper chills, or carbon, graphite or refractory molds.

While the centers of the hot ingots are still molten and the ingots are only starting to darken around the peripheral edges they are removed from the chills or molds and immediately covered. The cover may be formed of spaced metal shells with heat and cold insulating material, such as vermiculite or the like, therebetween. The hot ingots are stacked one upon another within the cover upon a pad of sand, or finely divided ferro-alloys.

For the purpose of reflecting the heat of the ingots the cover may be lined with polished stainless steel or the like, or it may be lined with refractory material to further retain the heat. The ingots are permitted to cool slowly within the cover for a period of thirty to thirty-six hours and should not be above 1200° F. when removed from the cover. The ingots are then permitted to cool down to room temperature after which they may be crushed by the conventional crusher into pieces suitable for use as ladle or furnace additions.

It is customary to set the crusher to break the ingots into pieces 2" x 5" or 4" x 8". Only about 15% of fines are produced during the crushing operation as compared with 30% of fines under standard practice. Also, it is pointed out that the untreated crushed material further shatters into fines by subsequent handling or transporting. The treated material will not be shattered into fines by subsequent handling or transporting.

As an alternative, instead of covering the stack of hot ingots with an insulated cover, as above described, the stack of hot ingots may be covered with fine granulated or powdered material such as sand, lime, metal fines, fine carbon, graphite or refractory material. The ingots remain covered until cooled down to 1200° F. or below when they are uncovered, and after cooling down to room temperature they are crushed in the manner above described.

A primary object of the invention is to reduce the friability of ferro-alloys intended for use as ladle or furnace additions.

Another object of the invention is to accomplish the above-named purpose by casting ingots of ferro-alloys, removing the hot ingots from the chills or molds in which they are cast while the centers of the ingots are still molten and immediately covering the hot ingots so that

they will cool slowly to about 1200° F., then uncovering the ingots and, after they have cooled to room temperature, crushing them into pieces of suitable size for use as ladle or furnace additions.

A further object of the invention is to use a cover for the slow cooling of the ingots, said cover comprising spaced metal shells with heat and cold insulation material therebetween.

The above objects together with others which will be apparent from the drawing and following description, or which may be later referred to, may be attained by performing the improved method of reducing friability of ferro-alloys, in the manner hereinafter described in detail and illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation of an ingot of ferro-alloy indicating the same in the condition as removed from the chill or mold and ready to be covered for slow cooling;

FIG. 2 is a vertical sectional view showing a stack of hot ingots covered by a removable cover comprising spaced metal shells with heat and cold insulating material therebetween; and

FIG. 3 is a sectional elevation of an alternate form of the method showing a stack of hot ingots covered by sand or other fine or granulated material.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 and 2, the ferro-alloy ingots indicated generally at **1** may be cast from ferro-silicon, silico manganese, magnesium ferro-silicon, ferro-manganese, iron-chromium-silicon alloy, or the like.

These ingots are preferably cast in shallow bowl-shaped iron, steel or copper chills, or carbon, graphite or refractory molds, producing an ingot of relatively large diameter and relatively low height or thickness.

When the hot ingot has just started to darken at the peripheral edges, as indicated at **2**, while still molten in the center, as indicated at **3**, and while it may be as hot as 2100° F., it is removed from the chill or mold and immediately covered so that the latent heat of fusion may act to raise the temperature of the entire ingot to a uniformly higher temperature, from which it will cool slowly.

As shown in FIG. 2, several of these hot ingots are stacked one upon another upon a pad **4** of sand or fines of ferro-alloys and covered by a cover indicated at **5**. This cover comprises inner and outer metal shells **6** and **7**, respectively, with heat and cold insulation material, such as vermiculite or the like therebetween, as indicated at **8**. A peephole **9** may be provided in one side of the cover to permit inspection of the ingots from the exterior of the cover, a hinged door **10** normally closing the same. An eye **11** is attached to the top of the cover **5** with reinforcing flanges **12** so that a crane hook or the like may be engaged therein for raising and lowering the cover.

The inner wall **13** of the cover may be of polished stainless steel or the like so as to reflect heat back onto the ingots or may have a refractory linging to further insulate the cover against heat and cold.

The ingots remain covered for from about thirty to thirty-six hours, or until they have cooled down to about 1200° F., after which the cover is removed and the ingots are permitted to cool naturally to room temperature.

After the ingots are cold they are crushed in a conventional manner into proper sized pieces for use as ladle or furnace additions. It has been found by experience that when treated in this manner, the ingots do not have the usual tendency to shatter when crushed. The amount of fines produced by crushing the treated ingots is only half that produced by crushing untreated ingots.

For example, 50% ferro-silicon (that is 50% by weight) was cast into ingots, and the ingots, while still molten in their centers, were placed under a cover, as above described and shown in FIG. 2. After slow cooling under the cover for nearly thirty-six hours, the ingots had cooled to 1200° F. The cover was then removed and the ingots were allowed to cool naturally to room temperature. After they were cold, the ingots were crushed in a crusher set to crush some of the ingots into pieces 2" x 5" and others of the ingots into pieces of 8" x 4". Only 15% of fines was produced in the crushing operation and no additional fines were produced by further handling or transporting of the crushed material.

It has been found that ingots slow cooled in this manner have fewer stress points and that when the metal breaks under pressure it doesn't have as much tendency to shatter as under ordinary practice, as the fracture lines of the material being crushed do not spread beyond the point of cleavage as in untreated ingots.

As an alternative, instead of placing the ingots under a removable cover as shown in FIG. 2, a stack of hot ingots **1**, the centers of which are still molten as indicated at **3**, may be covered with sand as indicated at **14** in FIG. 3. After the ingots have cooled to about 1200° F., the sand covering is removed and the ingots are permitted to cool naturally to room temperature. The cold ingots may then be crushed as described above for use as ladle or furnace additions.

Results have shown that for satisfactory annealing of the ferro-alloy ingots, the cooling rate should be under 30° F. per hour, although it need not be under 20° F. per hour. Satisfactory annealing is obtained with a 25° F. per hour cooling rate so long as the average temperature of the ingot is not above 1200° F. before subjecting it to air cooling.

In the foregoing description certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Moreover, the embodiments of the improved construction illustrated and described herein are by way of example, and the scope of the present invention is not limited to the exact details of construction.

Having now described the invention or discovery, the construction, the operation and use of preferred embodiments thereof, and the advantageous new and useful results obtained thereby; the new and useful construction, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

What is claimed is:

1. The method for reducing the friability of ferro-alloys intended for use as ladle or furnace additions, which consists in casting an ingot of such a ferro-alloy in a chill or mold, removing the hot ingot from the chill or mold while the center of the ingot is still molten and immediately covering the hot ingot so that it will cool slowly, keeping the ingot covered until it has cooled to about 1200° F., then uncovering the ingot and permitting it to cool to room temperature and then crushing the cold ingot into pieces of desired size for use as ladle or furnace additions.

2. The method as defined in claim **1** in which the ferro-alloy contains silicon.

3. The method as defined in claim **1** in which the ferro-alloy contains at least 15% silicon.

4. The method as defined in claim **1** in which the ferro-alloy is taken from a group consisting of ferro-silicon, ferro-manganese, silico-manganese, magnesium-ferro-silicon and iron-chromium-silicon alloy.

5. The method as defined in claim **1** in which the ferro-alloy is 50% ferro-silicon.

6. The method as defined in claim **1** in which the ingots are cast in shallow bowl-shaped chills or molds.

7. The method as defined in claim **1** in which as the hot ingots are removed from the chills or molds they are piled one upon another on sand and enclosed within a

cover comprising spaced metal shells having a heat and cold insulation material therebetween.

8. The method as defined in claim 1 in which the ingot remains covered from thirty hours to thirty-six hours.

9. The method as defined in claim 1 in which as the hot ingots are removed from the chills or molds they are piled one upon another and covered with sand.

10. The method as defined in claim 7 in which the ferro-alloy is 50% ferro-silicon, and in which the ingots remain covered from thirty hours to thirty-six hours and in which the cold ingots are crushed in a crusher set to produce minimum size pieces of two inches.

11. The method as defined in claim 1 in which as the hot ingots are removed from the chills or molds they are piled one upon another on fines of ferro-alloys and enclosed within a cover comprising spaced metal shells having a heat and cold insulation material therebetween.

References Cited

UNITED STATES PATENTS

1,555,557	9/1925	Darte	75—50 X
2,197,660	4/1940	Glunz et al.	164—136 X
2,452,613	11/1948	Taylor et al.	164—4 X
2,472,071	6/1949	Gathmann	249—111
2,485,492	10/1949	Hubbard et al.	164—4 X
3,197,828	8/1965	Cartoux et al.	164—72
3,221,559	12/1965	Miller et al.	164—4 X
3,236,103	2/1966	Kooken.	
3,323,899	6/1967	Forgeng	164—94 X
3,373,794	3/1968	Crago	164—127
3,382,911	5/1968	Malone.	

FOREIGN PATENTS

118,065	1/1944	Australia.

J. SPENCER OVERHOLSER, *Primary Examiner.*

V. K. RISING, *Assistant Examiner.*

U.S. Cl. X.R

164—122; 148—3