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ALUMINUM TYPE DEOXIDIZER WEIGHTED  
TO SUBMERGE IT IN MOLTEN METAL  
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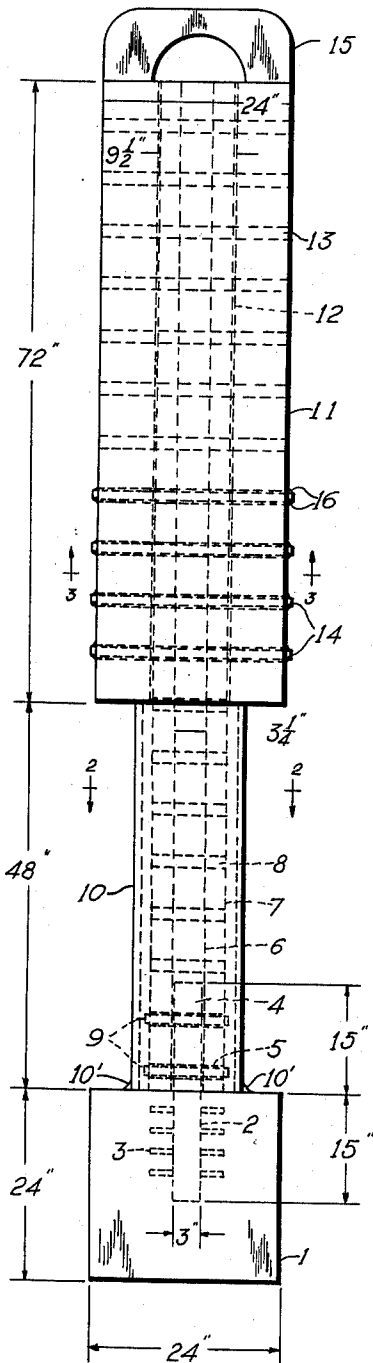


FIG. 1

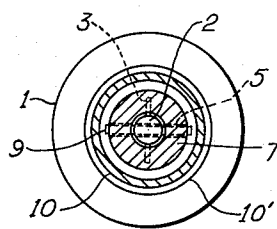


FIG. 2

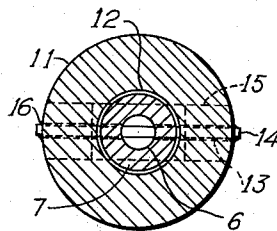


FIG. 3

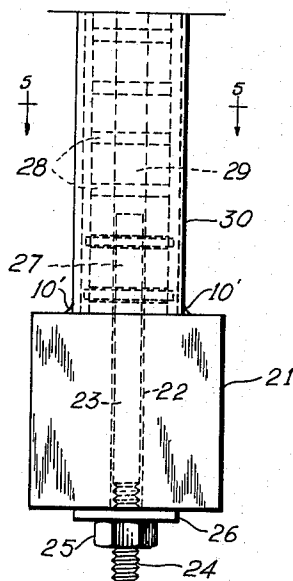


FIG. 4

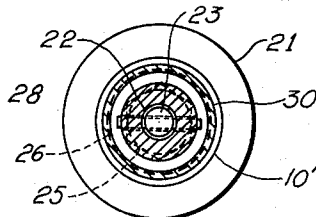


FIG. 5

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## ALUMINUM TYPE DEOXIDIZER WEIGHTED TO SUBMERGE IT IN MOLTEN METAL

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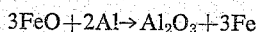
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14 Claims. (Cl. 266—34)

The present invention relates to an aluminum type deoxidizer for making steel of low iron oxide content (ferrous oxide). It relates more particularly to an aluminum type deoxidizer for making low carbon steel. However, it is not confined to the latter. This may be employed in the open hearth, electric, and oxygen processes for making steel.

This application is a continuation-in-part of my application identified as Serial Number 211,542, filed on July 20, 1962, now abandoned, which in turn is a continuation-in-part of now abandoned application Serial No. 162,317, filed on February 22, 1961, in the U.S. Patent Office.

It has been common practice to eliminate the harmful effects of FeO in steel through the use of aluminum as a deoxidizing agent by the introduction of metallic aluminum into the molten furnace bath, holding ladle, or ingot molds. Aluminum chemically has a greater affinity for oxygen than iron, and will therefore take chemically found oxygen from the ferrous oxide. The following reaction takes place in the molten steel in removing the FeO:



At present there are three methods usually employed in deoxidizing steel, wherein metallic aluminum is employed. These will herewith be summarized.

(1) Shot aluminum, which is metallic aluminum in the form of small pellets approximately  $\frac{3}{8}$ " in diameter and having a density of 90–100 lbs. per cubic inch is added to the molten steel in the mold.

(2) Small aluminum ingots, commonly referred to as "notchbars," cast in units of 2–6 lbs. each in weight, is commonly added to the molten steel in the ladle, after it has been tapped from the furnace bath. It is generally added in groups of notchbar bundles, which bundles weigh approximately 50 lbs. per bundle. In this latter method, part of the total amount of notchbar aluminum is thrown into the ladle shortly after tapping the molten ferrous metal from the furnace bath. After the molten ferrous metal starts to rise in the ladle, the aluminum introduction is continued until all the necessary aluminum for the deoxidation is in the ladle. Occasionally, if the helper is slow in getting the aluminum into the ladle, there will have been some slag run into the ladle from the steel furnace and there is the possibility that the aluminum, because of its light weight will rise into the overlying slag and thereby be lost to the deoxidizing process. Thus, there is the risk of ending up with an unsatisfactory deoxidizing heat of steel, due to the error on the part of the worker.

(3) A third method of deoxidizing steel is the introduction of a larger unit than used in the aforesaid two methods, and to immerse it in the molten bath of the steel furnace. Such larger aluminum units, which range in weight from 15 to 50 lbs. are generally termed "boots." To use these "boots" of metallic aluminum, they are cast into suitable shapes that are customarily circular, rectangular or sometimes diamond in cross-section, having a tapered cylindrical hole through the center of each cast unit; a steel bar is then driven into the hole until the bar is so tightly held to the aluminum that the furnace helper can place the object through the furnace door, thus introducing the fabricated deoxidizer through the slags of the furnace bath into the molten metal underneath. He customarily moves the aluminum "boots" around until the aluminum dissolves, then removes the rod. The true pur-

pose of the steel bar is to make use of its specific gravity, whereby the aluminum is maintained immersed in the molten steel in the furnace, and to prevent its rising through molten ferrous metal and slag, floating on the surface of the bath.

The third of the aforesaid methods has been used in the production of "killed" steels which usually contain more than 0.20% carbon. Another grade or type of aluminum "killed" steels has a low carbon content; it contains from 0.04% to 0.08% carbon. Because of its very nature, it is likely to be highly oxidized and to have a high concentration of ferrous oxide, and for this reason this grade requires strong deoxidation practice. This grade of "killed" steel is largely used in the manufacture of deep stamping steel parts for automobile and other difficult stampings.

It has been the practice over the years to employ 4 to 6 lbs. of aluminum per ton of steel to accomplish the desired end in the manufacture of this low carbon, aluminum deoxidized (killed) steel; this is because, as the carbon content of the steel increases, the percentage of FeO (ferrous oxide) decreases. The relation between carbon and oxygen in the open hearth steel is shown in Fig. 175 of page 471 of the textbook "The Making, Shaping, and Treating of Steel," 6th edition by J. M. Camp and C. B. Francis. Thus it will be seen that to make 200 tons of low carbon, aluminum deoxidized, "killed" steel, it will require approximately 800–1200 lbs. of aluminum ingots; or in terms of aluminum ingots, termed "boots" of the third method above presented, 20 to 30 ingots each weighing 40 lbs. will be needed to substantially completely deoxidize the steel in 200 tons drawn from the furnace. Furthermore, it can be easily seen that such a method or practice would require an inordinate length of time and trouble, and would cause confusion. Such a practice does not fit into the scheme of things commercially. And furthermore, it would be awkward to handle 20–30 aluminum ingots of 40 lbs. each, also the same number of steel rods of 15–20 feet in length, and approximately  $1\frac{1}{4}$  to 1 $\frac{3}{4}$  inches in diameter, which rods would have to be driven into these aluminum ingots.

Commercially, at present, the second method, wherein the notchbar aluminum is added to the ladle, is employed to deoxidize low carbon steel, and if deoxidation in the ladle is incomplete, aluminum, such as shot, is added thereafter to the molds.

On page 390 of the same textbook referred to supra, "Making, Shaping, and Treating of Steel," the 6th edition by J. M. Camp and C. B. Francis, under the heading "Deoxidation of Bessemer Steel," topic "Aluminum Deoxidation," after the mention of addition of aluminum to the ladle, there appears these statements: "Various methods have been used for adding aluminum to steel. The development of a superior method for making this addition would be desirable."

The present invention is a weighted aluminum type deoxidizer for ferrous metal of molten condition in the ladle and would not be used in the steel furnace. It consists broadly of a substantially solid, large aluminum ingot, above it a steel ingot of even larger size and having several times the weight of the aluminum ingot, a steel rod which is firmly affixed to the aluminum ingot, a substantial portion of which extends above the aluminum ingot, a hollow steel billet attached to the steel rod; the steel billet projects into a vertical passageway in the previously mentioned steel ingot, and is attached to the steel billet. It is preferred to encase the said billet, thus also the steel rod, by a clay refractory sleeve to protect the steel rod and billet from attack by the hot molten steel. When the said sleeve is employed, a steel rod much smaller than when it is not used, such as 3 inches in diameter can be employed. It

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is essential that the steel parts of the combined deoxidizer unit be at least several times the weight of the aluminum ingot which is to be immersed in the molten steel. The total weight of the steel parts must be sufficient that the large aluminum ingot will, due to the great weight of the steel in the structure, mostly in the steel ingot, be readily immersed in the molten steel, and remain submerged until the aluminum ingot has dissolved therein. Based on the theoretical weights, the steel parts will usually weigh in the ratio of about 8,500 lbs. as against the aluminum ingot's weight of about 1,000 lbs. However, this ratio can be varied provided the objective just stated is attained by the excess weight of the steel.

In the aluminum type deoxidizer of my invention, an aluminum ingot may be cast in one unit around the lower portion of a studded steel bar. The purpose of the studs on the steel rod is to enable the steel rod to be securely held to the aluminum ingot, which customarily weighs 200-1,000 lbs. or even somewhat more, and furthermore to be suspended by the steel rod in the deoxidation process of the molten steel. The studded steel rod should be well embedded vertically, i.e., a suitable distance, in order that it will not become dislodged from the aluminum ingot. Instead of studs other anchoring adjustments in association with the steel rod may be employed to securely fasten or hold the steel rod to the aluminum ingot. Or the aluminum ingot may be affixed to a steel rod by having a vertical hole in the former, through which the steel rod extends. In this arrangement the steel rod would be threaded at its lower extremity, and a nut screwed against a washer placed around the steel rod, which washer in turn firmly presses against the underside of the aluminum ingot. Or the washer can be used without any nut, and with no need for the said steel rod having screw threads cuts therein at its lower extremity, by welding the washer directly to the steel rod, where it emerges from the hole in the ingot on the bottom side of the latter.

The aluminum ingot may be cylindrical, or be a parallelepiped or a cube. Even other geometric configurations could be utilized too.

Above the top surface of the aluminum ingot, the steel rod has a series of horizontal holes approximately equally spaced from each other vertically. It is preferred that the distance between each of the said holes be about equal. These holes can be about 1-1/4 inches in diameter, the size not being particularly critical. The purpose of these holes will shortly be explained. A suitable construction for the embedded or inserted steel rod is for it to extend about the same distance above the upper surface of the aluminum ingot as it is embedded in it or 3/4 the height of the said ingot.

Above the upper surface of the aluminum ingot and even seated upon, it there is a steel billet whose inside diameter is a little greater than the diameter or thickness of the afore-mentioned steel rod. This steel billet has a hole that extends vertically the length of the said billet. This vertical hole receives the upper half length of the steel rod referred to supra. To illustrate, if the diameter of the steel rod is 3", the inside diameter of the steel billet can conveniently be 3 1/2". The steel billet is usually cylindrical in shape, but it could be square or rectangular in cross-section, there being centrally positioned, vertical passageway therein to accommodate the steel rod. The outside diameter of the said billet can be an inch or several inches greater than the diameter or thickness dimension of the steel rod. When no refractory clay sleeve is used to protect the steel rod, also the billet; the steel rod would be of several inches greater diameter or thickness than when the said sleeve is employed, even as much as 9".

The steel billet contains horizontal holes or passages spaced preferably equi-distance from the adjacent holes, throughout the length of the said billet. The horizontal holes can be 1-1/4" in diameter but the size is not exactly critical. The said holes are spaced about 6" apart, and

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this distance is not a necessity, for a greater number or even a lesser number of holes could be used, too. That portion of the steel rod which extends above the upper surface of the aluminum ingot projects a distance inside the vertical passageway in the steel billet. The horizontal holes in the steel rod are caused to be in alignment with the horizontal holes in the lower portion of the billet; and steel keys are fitted through these aligned holes, whereby the steel billet is secured to the steel rod. Other means of attaching the non-embedded or non-encased portion of the steel rod to the steel billet having a vertical passageway could be used, but the use of a plurality of keys, each fitted into the aligned holes in the steel rod and the steel billet is considered preferable, and is simple.

As stated previously, it is preferred to encase the steel billet and steel rod with a clay refractory sleeve. It extends from the top surface of the aluminum ingot to or about to the lower surface of the steel ingot. The clay refractory sleeve is cemented to the upper surface of the aluminum ingot in a thorough manner, so that the hot, molten steel can not contact, hence attack directly or indirectly, the steel rod or the steel billet.

In the upper half, approximately of the structure of my invention, there is a large steel ingot, larger in surface area than the aluminum ingot. This steel ingot may be cylindrical or be a parallelepiped, or even of another geometric configuration, including a cube. This large steel ingot is obviously of much greater weight than the aluminum ingot previously described. The steel ingot has a vertical hole extending centrally thereof the entire height of the steel ingot, and a diameter just slightly greater than the exterior diameter of the steel billet to which reference has been made. There are a series of horizontally positioned holes drilled in the steel ingot, preferably equally spaced from one another vertically over the entire height of the steel ingot. These holes mesh or are in alignment with the series of holes in the steel billet, i.e., comparing one particular hole in the steel billet at a time with the hole in the steel ingot. These holes in the steel ingot are of the same diameter as the holes in the steel billet, namely about 1" to 1 1/8" in diameter, and spaced about 6" apart, vertically. These diameters and distances apart are not however, critical. A series of steel keys of a size to fit snugly in or have a close fit with the holes aligned in the steel ingot and the steel billet are put in place. These steel keys secure the large steel ingot to the steel billet. Reference is here being made to the series of keys stuck in the holes of the steel ingot in alignment with the holes in the steel billet. Looking at the immersion structure, the holes are aligned in a straight line from the uppermost holes in the steel ingot to the lowermost holes in the steel billet.

At the upper end of the large steel ingot there is a structure means to hang the steel ingot, and therefore the entire aluminum deoxidizer immersion unit, on the cranehook from the auxiliary hoist.

To hold the steel keys in place they are tack welded to the steel ingot or to the steel billet, depending upon their location on the structure. One of the primary reasons for providing holes through the aforesaid component parts of the immersion unit is that of economy and also convenience of assembly as well as operability. Particularly if no encasing protective clay refractory sleeve is used, when and if the lower end of the steel billet is melted off or eroded by the molten steel undergoing deoxidation, all that will be necessary will be to take the effected part to the shop and there cut off the defective part; and the result will be, of the last operation, to reduce the length of the steel billet that is inserted in the steel ingot; this operation will enable the same billet to be used again in the deoxidation unit of the present invention.

The studded steel rod that is firmly secured in the aluminum ingot, or the steel rod encased in the aluminum in-

got, both previously referred to, must of course be sufficiently strong to support the weight of the aluminum ingot, when suspended during the entire deoxidation of the ferrous metal. Also, the steel rod should be thick enough to resist melting under the conditions in which it is employed in the molten steel in the ladle, which has a temperature of about 2750° F. to 2900° F. before the aluminum that surrounds the steel rod has melted and become assimilated in the molten steel. The aluminum melts at approximately 1225° F., and the low carbon steel melts at about 2700° F., and the steel bath in the ladle has a temperature somewhat higher. When a clay refractory sleeve is employed, the steel rod can be 3" in thickness, but if not employed twice or more that thickness even.

It is my purpose to employ aluminum ingot of not less than approximately 200 lbs. in weight. Preferably, a size greater than 200 lbs., such as 400 lbs., or more in weight is used. Such a size would avoid some difficulties attending the use of ingots of 25-50 lbs. in weight, referred to in the third method, near the outset, of deoxidation of aluminum, i.e., use of "boots." It is known that the amount of aluminum in the range of 4 to 6 lbs. per ton of low carbon steel is employed in the steel manufacturing industry. Hence, for 200 tons of steel, the amount of aluminum would be 800 to 1,200 lbs. So, when aluminum ingot of 400 lbs. is used in my fabricated deoxidizer, it would be necessary to employ 2-3 such weight aluminum ingots for proper deoxidation of the low carbon steel. Or one ingot of 800-1,200 lbs. could be used.

The aluminum type deoxidizer of my invention can be immersed in the molten ferrous metal in the ladle, in fact that is where it is intended to be used. The mechanical equipment to accomplish the immersion of my deoxidizer can be positioned above or in the proximity to the ladle, working cooperatively with the ladle. The aluminum ingot can be mechanically put in the ladle and fixed in place prior to tapping the heat or it may be put in the ladle after the molten steel starts to rise in the ladle and then held there in place. The aluminum ingot, which accomplishes the deoxidation of the ferrous metal in the ladle, is caused to remain in the molten metal until all of the aluminum which surrounds the steel rod has melted and gone into solution in the molten steel, whereupon the steel rod is removed. A suitable mechanical device at the upper end of the steel ingot of my deoxidizer unit functions both in the introduction and the removal of the aluminum ingot just set out, since the steel ingot and therefore the entire deoxidation unit would be suspending from the arm of the mechanical equipment that accomplishes the moving of the entire unit of my invention.

For a better understanding of my invention, reference is made to the drawing, which illustrates two embodiments of the present invention.

FIGURE 1 is a front plan view of my invention in the first embodiment.

FIGURE 2 is a cross-section of FIGURE 1, taken along line 2-2 indicated thereon.

FIGURE 3 is a cross-sectional view, taken along line 3-3 thereof.

FIGURE 4 is a front plan view of the lower portion of another embodiment of my invention.

FIGURE 5 is a cross-sectional view of FIG. 4, taken along line 5-5 thereof.

It will be perceived that the embodiment in FIGURES 4 and 5 is the same as the embodiment in FIGURES 1, 2 and 3, except that the steel rod is not provided with studs and embedded in the aluminum ingot, but the rod is inserted in the hole of the said ingot and is fastened firmly to the ingot as shown. On FIGURE 1 of the drawing, numeral 1 designates the aluminum ingot which is a cylinder of 24" diameter and 24" height. In this aluminum cylinder, there is firmly anchored (casting operation)

a 3" diameter steel rod, numbered 2, to which there are attached a plurality of studs on all sides of it, numbered 3. This steel rod is circular in cross-section. That portion of this steel rod which extends above the upper surface of the aluminum ingot is designated by the numeral 4. As seen from the drawing there are a series of horizontal holes, numbered 5, in this portion of the steel rod. This portion of steel rod 4 projects for a distance of 15" into the vertical hole 6 of the cylindrical steel billet 7. This is substantially the same distance that the steel rod is imbedded in the aluminum ingot.

The cylindrical steel billet has an over-all length of 120", an external diameter of 9" and an internal diameter of 3 3/4". There are a series of horizontal holes 8, vertically spaced equi-distant throughout the length of the steel billet. In the lower portion of this billet 7, the horizontal holes therein are in alignment with the holes in the studded steel rod 4. A suitable size of these holes in both the steel rod and the steel billet is 1 1/2", and they are spaced 6" apart vertically. Steel keys, designated by the numeral 9 fit closely into these holes to hold the rod 4 to the steel billet 7.

Encasing the steel billet is a clay refractory sleeve bearing the numeral 10. Its inside diameter is somewhat greater than the outside diameter of the steel billet, so that it also surrounds the steel keys 9; its inside diameter can be 9 1/2" to 10". As seen from FIG. 1 of the drawing, the length of the clay refractory sleeve is 48". It is cemented at its bottom edge at 10' to the top surface of the aluminum ingot 1.

Above the upper end of the clay refractory sleeve 10 there is a large cylindrical steel ingot, bearing the numeral 11, having a length of 72" and a diameter of 24" (exterior). It has a vertical hole 12 therein, whose diameter is 9 1/2". The billet 7 extends the entire distance of 72" through the said vertical hole 12. There are drilled 6" apart a series of horizontal holes numbered 13 through the thickness of the steel ingot, and extending on both sides of the said vertical hole, i.e., each horizontal hole corresponds to a diameter distance of the steel ingot by taking into consideration the diameter measurement of the vertical hole. These holes 13 have a diameter of 1 1/2", and are in alignment with the holes 8 in the steel billet. Keys numbered 14 are inserted in each of the holes in the large steel ingot, whereby the latter is fixed to the billet. It is obvious that the length of the steel keys 14 that extend through the steel ingot is much greater than the length of the keys 9 that extend through the billet 7 previously mentioned. For the steel ingot has a diameter of 24", whereas the billet has an exterior diameter of about one-third of that. At the very top of the steel ingot there is a hooking member 15 forming an eye by which the steel ingot, therefore the entire deoxidizer unit, may be affixed to the hoisting mechanism.

Steel keys 9 and 14 have each tack weld, numbered 16, to securely fasten them to the surface of the steel ingot and the steel billet respectively.

The over-all height of the weighted aluminum deoxidizing unit shown in the drawing is 144", namely, 12 feet, of which the aluminum ingot is 24" or 2 feet. The height of the steel ingot is 6 ft.

From the respective dimensions of the parts, particularly those of the steel and aluminum ingots respectively, it is obvious that the ratio of the weight of the steel in this unit is many times the weight of the aluminum ingot, which latter is the chemically functioning deoxidizer for the molten ferrous metal. This must be true in order to submerge and maintain submerged the aluminum ingot in the molten steel in the ladle, because of the specific gravities of the two substances.

In the second embodiment which is shown in FIGURES 4 and 5, in the aluminum ingot 21, there is a vertical hole or passageway 22, into which there has been inserted steel rod, numbered 23. This steel rod is circular in cross-section, and has cut into it screw threads num-

bered 24. This rod is secured at its lower end to the aluminum ingot by nut 25, tightened against washer 26, which abuts the aluminum ingot 21. That portion of the steel rod which extends above the upper surface of the aluminum ingot is designated by the numeral 27. And in it there are a series of horizontal holes 28 in this portion of the steel rod. This portion projects for a distance of 15" in the vertical hole 29 of the cylindrical billet 30.

The rest of the structure of this embodiment, about half of which is to be found in FIGS. 4 and 5, is the same as shown in FIGURES 1, 2 and 3. The sole difference of the second embodiment over the first resides in the steel rod and the manner in which it is affixed to the aluminum ingot.

For an aluminum ingot in the form of a parallelopiped, there are set out below the weights, dimensions, and the volumes of several aluminum ingots. These dimensions are based on aluminum weighing 0.09757 pound per cubic inch.

| Aluminum Ingot Weight | Aluminum Ingot Dimensions | Aluminum Ingot Volume cu. in. |
|-----------------------|---------------------------|-------------------------------|
| 600 lbs.              | 12" x 12" x 12"           | 6,048                         |
| 600 lbs.              | 15" x 15" x 27"           | 6,075                         |
| 600 lbs.              | 18" x 18" x 19"           | 6,056                         |
| 800 lbs.              | 15" x 15" x 36"           | 8,100                         |
| 800 lbs.              | 18" x 18" x 25"           | 8,000                         |
| 1,000 lbs.            | 15" x 15" x 48"           | 10,125                        |
| 1,000 lbs.            | 18" x 18" x 32"           | 10,368                        |
| 1,000 lbs.            | 20" x 20" x 26"           | 10,400                        |
| 1,200 lbs.            | 18" x 18" x 38"           | 12,312                        |
| 1,200 lbs.            | 20" x 20" x 31"           | 12,400                        |

There are various advantages in the use of this weighted aluminum type deoxidizer to submerge the aluminum ingot in the molten steel in the ladle, for making steel of low iron oxide content, and more particularly low carbon steels. Some specific advantages are herewith set forth. There is more complete deoxidation of the steel because the aluminum, which is an ingot, is in more positive contact with the molten metal due to immersion therein. Also there is closer control in the use, due to the efficiency of the introduction of aluminum into the molten ferrous metal. In the older method the aluminum tends to float on the molten ferrous metal, and therefore is only partially dissolved in the molten metal (steel). This is particularly true where control of the residual aluminum is desired in the finished steel or is a part of the steel specification. A third advantage is that the use of it saves time, and the deoxidation can be done at a time and in a place where the entire heat is available for such treatment. And the latter factors make for a more uniform specification of the steel. Fourth, the closer control of the use of and efficiency of the introduction of the aluminum makes quality of the end product much more subject to the desires of the supervisors. To make this last clearer, it shall be pointed out, that in the normal practice where aluminum is added to the ladle by throwing groups of (50 lbs. approximately) 2-6 lbs. notchbars individual weight, a great deal of the efficiency of the effort depends upon the skill of the helper who throws the aluminum into the ladle; if he is too late, the steel may be so high in the ladle as to cause the notchbars to float and finally get into the slag that comes into the ladle at the end of the tapping process; in this situation, the aluminum in the slag is a complete waste. This condition cannot occur where the aluminum ingot is submerged in the molten ferrous metal and held there by the weight of the steel in the component parts of the unit, namely the steel ingot, the steel billet in addition to the steel rod.

I have described two specific embodiments of the immersion unit of aluminum type deoxidizer of my invention. However, it will be evident to those skilled in the art that different embodiments of this invention may be made without departing from the spirit thereof. Conse-

quently, I do not limit myself other than by the scope of the invention as defined in the appended claims.

I claim as my invention:

1. A weighted aluminum type deoxidizer to submerge the aluminum in the molten ferrous metal to be deoxidized, comprising a solid aluminum ingot firmly secured to a steel rod, a substantial portion of this said rod extending above the surface of the aluminum ingot and pierced by a series of horizontal holes at spaced vertical distances, a steel billet extending above the upper surface of the aluminum ingot, which billet has a vertical opening centrally positioned throughout its length and into which the said steel rod projects, and extending through the thickness of the said billet there are horizontally positioned holes vertically spaced from one another, at least the lower series of horizontal holes in said billet being capable of being brought into alignment with the holes in the steel rod, keys inserted through several aligned holes in the billet and in the steel rod for holding the aluminum ingot to the said steel billet, means on the respective keys to prevent their disengagement, a steel ingot larger in total surface area than the said aluminum ingot and being several times the weight of the latter and positioned in the approximate upper half of the entire deoxidizer structure, the steel ingot having a vertical passageway centrally positioned and extending throughout its height, there being a plurality of horizontally positioned, vertically spaced holes extending the entire thickness of the steel ingot, the billet extending up into the said vertical passageway of the steel ingot, metal keys extending through a plurality of the horizontal holes in the steel ingot and the aligned horizontal holes in the billet for securing the billet to the steel ingot, means on these respective keys to prevent their disengagement, mechanical means at the top of and affixed to the steel ingot for fastening it to a hoisting mechanism, whereby the entire unit of the structural parts recited can be lifted and moved.

2. A weighted aluminum type deoxidizer to submerge the aluminum in the molten ferrous metal to be deoxidized, comprising a solid aluminum ingot firmly secured to a steel rod, a substantial portion of this said steel rod extending above the surface of the aluminum ingot and pierced by a series of horizontal holes at spaced vertical distances, a steel billet extending above the upper surface of the aluminum ingot, which billet has a vertical opening centrally positioned throughout its length and into which the said steel rod projects, and extending through the thickness of the said billet there are horizontally positioned holes vertically spaced from one another, at least the lower series of horizontal holes in said billet being capable of being brought into alignment with the holes in the said steel rod, keys inserted through several aligned holes in the billet and in the steel rod for holding the aluminum ingot to the said steel billet, means on the respective keys to prevent their disengagement, a clay refractory sleeve surrounding the said steel rod, steel billet and the means which prevent disengagement, joined to the upper surface of the aluminum ingot to prevent the molten metal from seeping into the steel rod, a steel ingot larger in surface area than the said aluminum ingot and being several times the weight of the latter and positioned above the upper end of the clay refractory sleeve, the steel ingot having a vertical passageway centrally positioned and extending throughout its height, there being a plurality of horizontally positioned, vertically spaced holes extending the entire thickness of the steel ingot, metal keys extending through a plurality of the horizontal holes in the steel ingot and the aligned horizontal holes in the billet for securing the billet to the steel ingot, means on these respective keys to prevent the disengagement, mechanical means at the top of and affixed to the steel ingot for fastening it to a hoisting mechanism, whereby the entire unit of the structural parts recited can be lifted and moved.

3. A weighted aluminum ingot as set out in claim 1,

wherein the steel rod is imbedded in the aluminum ingot and is held firm to it by means attached to the steel rod.

4. A weighted aluminum ingot as set out in claim 2, wherein the steel rod is imbedded in the aluminum ingot and is held firm to it by means attached to the steel rod.

5. A weighted aluminum ingot as set out in claim 1, wherein the aluminum ingot has a centrally positioned vertical hole therein, through which the steel rod extends, and which rod is secured to the base of the said aluminum ingot.

6. A weighted aluminum ingot as set out in claim 2, wherein the aluminum ingot has a centrally positioned vertical hole therein, through which the steel rod extends, and which rod is secured to the base of the said aluminum ingot.

7. A weighted aluminum ingot as set out in claim 1, wherein the means on the keys to prevent their disengagement is a tack weld.

8. A weighted aluminum type deoxidizer to submerge the aluminum in the ladle in the molten ferrous metal to be deoxidized, comprising a solid aluminum ingot firmly secured to a steel rod, a substantial portion of this rod extending above the upper surface of the aluminum ingot, a steel billet extending above the upper surface of the aluminum ingot, which billet has a vertical opening centrally positioned throughout its length and into which the said steel rod projects, means to secure the said steel rod to the said billet, a clay refractory sleeve surrounding the steel rod, billet and said securing means, and joined to the upper surface of the aluminum ingot to prevent molten metal from seeping in to the steel rod, a steel ingot larger in surface area than the said aluminum ingot and being several times the weight of the latter and positioned above the upper end of the clay refractory pipe, the steel ingot having a vertical passageway centrally positioned and extending throughout its height, the steel billet extending up into the said vertical passageway in the steel ingot, means for securing the said billet to the steel ingot, mechanical means at the top of and affixed to the steel ingot for fastening the latter to a hoisting mechanism, whereby the entire unit of the structural parts recited can be lifted and moved.

9. A weighted aluminum type deoxidizer to submerge the aluminum in the molten ferrous metal to be deoxidized, comprising a solid aluminum ingot firmly secured to a steel rod, a substantial portion of this rod extending above the surface of the aluminum ingot, a steel billet extending above the upper surface of the

aluminum ingot, which billet has a vertical opening positioned throughout its length and into which the said steel rod projects, means to secure the said steel rod to the billet, a steel ingot larger in surface area than the said aluminum ingot and being several times the weight of the latter and positioned in the approximate upper half of the entire deoxidizer structure, the steel ingot having a vertical passageway centrally positioned and extending throughout its height, the steel billet extending up into the said vertical passageway in the steel ingot, means for securing the said billet to the steel ingot, mechanical means at the top of and affixed to the steel ingot for fastening the latter to a hoisting mechanism, whereby the entire unit of the structural parts recited can be lifted.

10. A weighted aluminum ingot as set out in claim 8, wherein the steel rod is imbedded in the aluminum ingot and is held firm to it by means attached to the steel rod.

11. A weighted aluminum ingot as set out in claim 9, wherein the steel rod is imbedded in the aluminum ingot and held firm to it by means attached to the steel rod.

12. A weighted aluminum ingot as set out in claim 1, wherein the aluminum ingot has a centrally positioned vertical hole therein through which the steel rod extends and which rod is secured to the base of the said aluminum ingot.

13. A weighted aluminum ingot as set out in claim 2, wherein the aluminum ingot has a centrally positioned vertical hole therein, through which the steel rod extends, and which rod is secured to the base of the said aluminum ingot.

14. A weighted aluminum ingot as set out in claim 2, wherein the means on the keys to prevent their disengagement is a tack weld.

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