March 24, 1959 F. J. O. HURUM 2,879,156

METHODS FOR THE TREATMENT OF A MELT WITH BRIQUETTED SUBSTANCES

Filed June 7, 1956

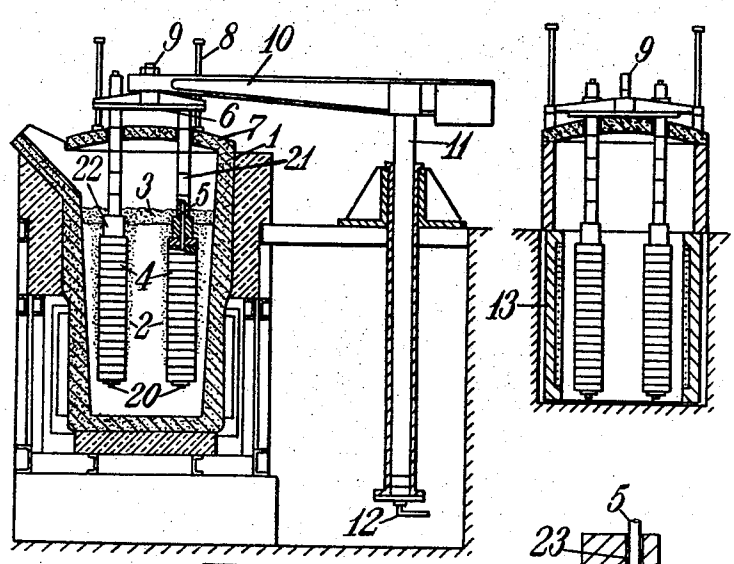


Fig. 1

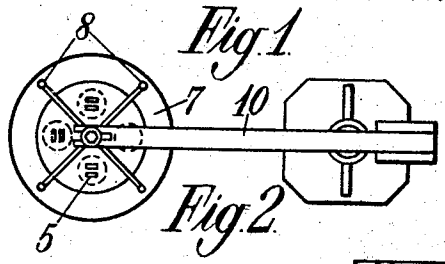


Fig. 2

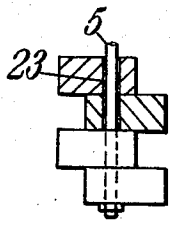


Fig. 5

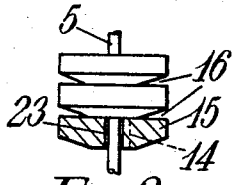


Fig. 3

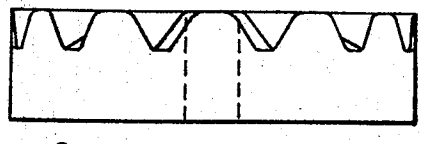


Fig. 6

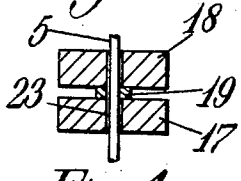


Fig. 4

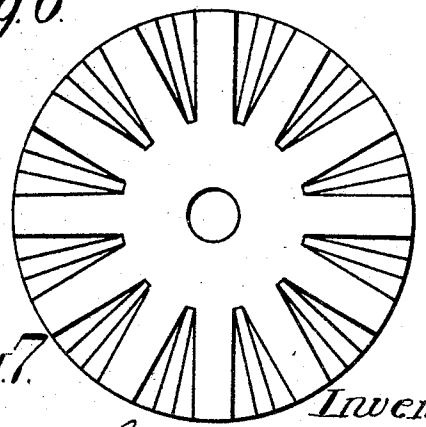


Fig. 7

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METHODS FOR THE TREATMENT OF A MELT WITH BRIQUETTED SUBSTANCES

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7 Claims. (Cl. 75—53)

The treatment of a molten metal, alloy or compound with another element, for the purpose of refining the material, is usually effected by placing the slag-forming substances in a loose form on the surface of the melt, without any previous reheating, and frequently also without any preparatory thorough mixing process, after which the substances flow together and melt, forming slag, which then reacts with the impurities of the melt.

In basic open-hearth furnaces the refining is normally done in such a way that pieces of iron ore, rolling scale, lime stone and fluor spar are dropped separately on the molten iron. When these substances slowly flow together and melt, a slag is formed, which reacts with the molten iron, and gradually and simultaneously increases its content of such products of chemical reactions as SiO_2, P_2O_5, MnO, and small quantities of other oxides, as the ferrous oxide content of the slag is reduced, so that it correspondingly loses its oxidising action. A considerable interval of time is therefore required before the slag in the open-hearth furnace becomes liquid and reacts with the melt. To this must be added the disadvantage that the reaction proceeds the slower, the more ferrous oxide is used in the slag, until the action of the oxygen ceases.

The present invention discloses a method for overcoming these difficulties, and consists in the substances which are to be admitted to the melt being mixed and moulded into briquettes, the briquettes having a hole therein. The briquettes are then stacked and fixed on a rod, which passes through these holes, so that the briquettes are clamped together and make contact on adjacent surfaces surrounding the hole, after which the briquettes are pushed by means of this rod into the melt. Thus an effective reaction between the metal melt and the additions is achieved, together with intimate contact between the melt and the briquettes, while the products of the reaction separate and pass to the surface of the melt, without interfering with the course of the reaction by getting mixed with the reacting substances.

It is the purpose of the present invention to accelerate considerably this process by employing also certain physical expedients which can be employed either separately or in conjunction, that is to say:

(1) By increasing the contact area between the melt and the briquettes,

(2) By passing a constant flow of briquettes into the melt,

(3) By covering the melt during the supply of briquettes,

(4) By preheating the briquettes.

These physical expedients, which are quite independent of each other, are factors having a cumulative effect, and interact with each other as the method is carried out.

Due to the fact that briquettes of different sizes can be arranged next to each other on the rod, it can be ensured that a considerable part of the surface of a large briquette is uncovered, and therefore makes contact with the melt. This effect can also be achieved by employing briquettes of the same size and shape, which are shaped so that the area of contact of two adjoining briquettes is smaller than the largest cross-sectional area of a briquette in a plane perpendicular to the axis of the hole.

A successfully accelerated reaction depends in many cases on the briquettes being admitted carefully and in a suitable way to the melt, where the melt must in many cases remain covered, to protect the surrounding area against the heat and spray. The stack or the charge of briquettes frequently occupies a fairly large space, which displaces the melt and moves its surface upwards. The invention is therefore also concerned with a special feeding device which enables the rod with the briquettes to be pushed continuously or for a considerable period into the melt, while the rate of feed can be chosen as desired to ensure that the briquettes are fed into the melt as they are being consumed.

The feeding device must be capable of being operated while the melt remains covered, and must therefore comprise a lid which enables this to be done.

The feeding device consists conveniently of a movable carrying device, which is pivoted and can be lifted or lowered, for instance, by hydraulic means, and supports the rod with the stack of briquettes and the lid which covers the melt. The suspension of the lid in the carrying device must be designed so that it can rest above the melt when it is fixed, while the stack of briquettes is being fed into the melt.

A further requirement, which must be satisfied if the reaction is to be speeded up, is the preheating of the briquetted substances in those cases where this is desirable. The preheating process could also comprise the drying of the briquettes. It is therefore a further purpose of the invention to design the feeding device in such a way that it can be used also in conjunction with the preheating furnace, on which the stack of briquettes and the lid can be arranged. Preheating is particularly desirable in cases where endothermic reactions occur, as, for instance, in the decarburization of liquid iron by means of iron oxides, such as F_2O_3 and Fe_3O_4.

If the preheating process is effected to a sufficient degree, it will not be necessary to shape the briquettes so as to obtain an increased surface for the reaction between the melt and the briquettes, and it will be sufficient to make do with the surface for reaction which is obtained by multiplying the circumference of the briquette with the height of the stack, that is to say, with a simple cylindrical outer surface, where the surface of contact between two briquettes has the same area as the cross-section in a plane perpendicular to the axis of the hole.

The invention is not limited in any way to the refining of an iron melt, which was quoted only as an example of its method of operation; the method can be used advantageously also for slag-forming reactions other than the oxidizing reaction of the refining process; these reactions include, for instance, the desulphurizing of a melt by means of salts or oxides of alkaline or alkaline earth metals, with the addition of the reducing substances for an endothermic reaction.

The method can be used advantageously also for certain thermal reactions involving metals, whose purpose is to obtain the metal from an oxygen compound, where the metal is immediately incorporated into the melt. Also, the invention is not confined to the metallurgy of iron, but can be used also for the refining and preparation of a large number of other metals. Moreover, the invention can be employed also for the treatment of a metal or alloy melt with substances which do not form slags, such as processes where the silicon content of cast iron or of a refined iron is to be increased.

Furthermore, the invention is not limited to a certain specific reaction, but is suitable also for carrying out a number of reactions in a desired sequence, by employ-

ing for this purpose a suitable number of stacks of briquettes of different properties, which produce selected reactions in the melt. The feeding device disclosed in the invention is particularly suitable for feeding accurately measured substances in rapid sequence to a melt.

The method is particularly suitable for use in conjunction with an induction furnace of high, medium, or low frequency. In furnaces of this kind the heat is developed inside the melt, while the slag is only heated to a moderate temperature. However, these furnaces are not very suitable for refining processes requiring a very hot or reactive slag. Such processes are therefore mostly carried out in arc furnaces, where the slag is heated to a higher temperature than the melt underneath it. In the present invention, the slag-forming reactions take place inside the melt or, more accurately, on the surface of the briquettes, which are quickly heated up, due to the motion of the melt, while the slag is immediately separated from the briquettes, as it is formed, and assumes the temperature of the melt. Since this slag separates out on the surface of the melt, it is cooled and the reactions of the slag become less fierce, so that it does not attack the lining of the furnace.

The fact that the method is employed in an inductive furnace must be regarded as part of the invention, as mentioned above.

In order that the invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawings, in which:

Figure 1 is a section through an installation with furnace, feeding device and preheating furnace,

Figure 2 shows a part of a feeding device, looking from above, and

Figures 3 to 7 show different shapes of briquettes.

In the drawings, there is shown a low-frequency furnace **1** without core, and the melt **2** in such furnace. The slag **3** floats on the melt **2**. Briquettes **4** of moulded additives are pushed on the rod **5** which is suspended in a vertically movable frame **6**. The rod **5** has an upset end or a welded plate **20**, which carries the stack of briquettes. A lid **7** covers the furnace **1**. The lid is carried by bolts **8**, supported by the frame **6**. These bolts **8** serve as guides for the frame **6** when the briquettes are lowered into the melt while the lid rests on the furnace. The frame **6** is fixed by means of a pin **9** to a pivoting arm **10** of an hydraulic piston **11**, whose vertical motion can be adjusted by throttling the oil drain pipe **12**. Thus the stack of briquettes can drop slowly under its own weight into the melt **2**.

A furnace **13** for preheating the briquettes is designed so that the arm **10** can be swung over it and back again, while the stack of preheated or dried briquettes is guided into the melt **2**, by lifting the stack from the furnace **13** and rotating the arm **10**. Fireproof pipes **21** or the like are employed to protect the rod **5** against heat and the molten metal.

In order to ensure that the area of contact between the briquettes and the melt is as large as possible, they could be made as shown in Figure 3, where they have a greater height along the dotted line **14** than shown at **15**. There is therefore an annular slot **16** and a correspondingly larger area of contact with the melt. The hole inside the briquettes is conveniently made of larger diameter than the rod **5**, so that a channel **23** for exhausting the gases formed during the reaction is obtained.

Figure 4 shows another example, which produces the same effect. Each alternate briquette **17** and **18** is, for instance, of the same size, while the intermediate briquettes **19** are of much smaller size, so that an annular space between the briquettes **17** and **18** is obtained, which increases the area of contact.

As shown in Figure 5, the briquettes may also have their approximately circular holes placed eccentrically.

The adjacent briquettes are then offset with respect to each other on the rod **5**.

But the briquettes can also be made of any non-cylindrical shape, and adjoining briquettes can be offset on the rod with respect to each other, so that while small areas of contact exist between any two briquettes, large areas of contact exist between the briquettes and the melt.

Figures 6 and 7 are side elevation and plan views respectively of yet another form of briquette, one end of which is formed with radial teeth in the manner of a crown such briquettes being stacked with their respective different ends adjoining so as substantially to increase the area of the briquettes in contact with the melt.

In Figure 1, there is also shown at **21** how the rod **5** is protected against the melt **2**, and at the same time strengthened so that it does not bend under the effect of the lift. This protection is conveniently achieved by means of fireproof cylindrical bricks having a through hole along the axis of the cylinder. Such bricks or tubes are employed at the same time to clamp the stack of briquettes to the rod **5**. A slightly heavier protection ring **22** is pushed on the rod in the plane of the slag, because at this point the rod **5** is particularly exposed to corrosion. This protection can be made of fireproof material, or it can be made as a slowly acting special briquette of a special size, which sticks to the rod **5**, so that the fireproof tubes **21** do not drop into the melt when treatment is completed.

In my copending application Serial No. 675,308, filed July 26, 1957, and which is a continuation-in-part of my applications Serial No. 322,394, filed November 25, 1952, now abandoned, and Serial No. 357,383, filed May 25, 1953, now abandoned, I have disclosed and claimed an invention, the allowed claims of which in this application are for an improvement.

I claim:

1. A method for accelerating the treatment of a metallurgical melt comprising the steps of forming a briquette with a hole therein, stacking a plurality of such briquettes on a rod passing through the holes in the briquettes so that the common surface of contact between any two juxtaposed briquettes is materially less than the total surface area of the non-contacting areas, and immersing the stack of briquettes into the metallurgical melt.

2. A method for accelerating the treatment of a metallurgical melt as set forth in claim 1 further including the step of forming a substantial annular space between the rod and each of the stacked briquettes to permit the escape of gases developed in the course of the treatment.

3. A method for accelerating the treatment of a metallurgical melt comprising the steps of forming briquettes of two different diameters, molding a hole in each briquette, stacking a plurality of the briquettes on a rod passing through the holes in the briquettes so that a briquette of smaller diameter is located between two briquettes of larger diameter whereby the common surface of contact between any two juxtaposed briquettes is materially less than the total surface area of the non-contacting areas, and immersing the stack of briquettes into the metallurgical melt.

4. A method for accelerating the treatment of a metallurgical melt comprising the steps of forming briquettes of circular form with a hole eccentrically placed in each briquette, stacking the briquettes in alternately offset positions on a rod passing through the holes so that the common surface of contact between any two juxtaposed briquettes is materially less than the total surface area of the non-contacting areas, and immersing the stack of briquettes into the metallurgical melt.

5. A method for accelerating the treatment of a metallurgical melt comprising the steps of forming briquettes with end surfaces of different area and a hole in each briquette, stacking a plurality of such briquettes on a rod so that the end surface of larger area of one briquette is opposite the end surface of smaller area of an adjacent

briquette whereby the common surface of contact between any two juxtaposed briquettes is materially less than the total surface area of the non-contacting areas, and immersing the stack of briquettes into the metallurgical melt.

6. A method for accelerating the treatment of a metallurgical melt as set forth in claim 5 further including forming one end surface of each briquette as a plane surface perpendicular to the axis of the hole therein and the other end surface as an at least partially frusto-conical surface of greater surface area than the first named end surface.

7. A method for accelerating the treatment of a metallurgical melt as set forth in claim 5 further including forming one end surface of each briquette as a plane surface perpendicular to the axis of the hole therein and the other end surface as a radial toothed surface of greater surface area than the first named end surface.

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