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Eichbaum et al.

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[54] **METHOD AND DEVICE FOR VARYING THE SUBSTANCE COMPOSITION IN METAL MELTS AND IN PARTICULAR FOR THE DESULFURIZING OF PIG IRON**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **C21c 7/02**

[58] **Field of Search** ..... 75/93, 61, 58, 135; 266/34 A, 34 PP

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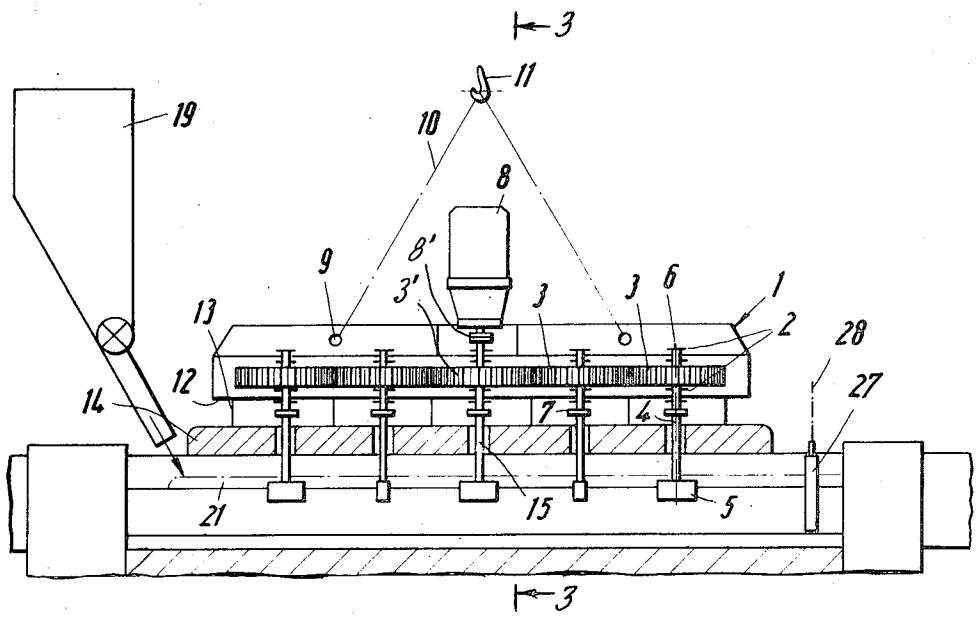
[57] **ABSTRACT**

A method for varying the substance composition in metal melts and in particular for desulfurizing pig iron where the contact surfaces of the reacting surfaces of the melt is enlarged by stirring, comprises producing a flow of metal and simultaneously stirring the flow to produce a plurality of eddies simultaneously at several locations along the flow path. The apparatus includes a housing mounting a plurality of rotatable stirrers with agitator elements at the lower end which are adapted to dip into the melt and be located between the slag layer and the melt in the bath. The apparatus includes a heat insulated cover which is adapted to overlie the trough and which includes openings for the passage of the stirrers therethrough to position them at spaced locations along the length of the flow path in the trough. The metallurgical melt system includes means for tapping the furnace at a plurality of locations for flow along troughs along which the agitator elements are positioned.

5 Claims, 4 Drawing Figures



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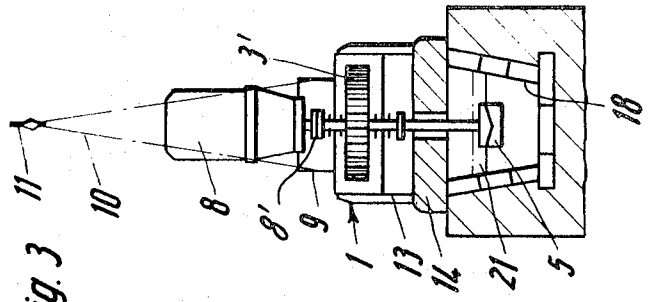

Fig. 3

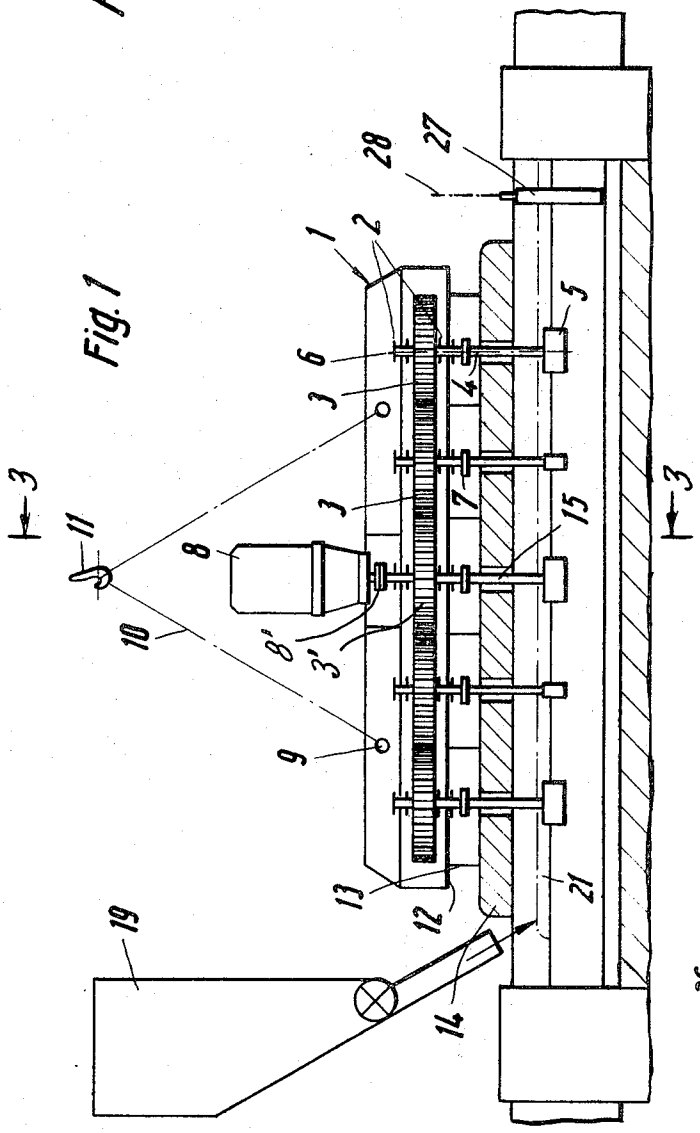

Fig. 1

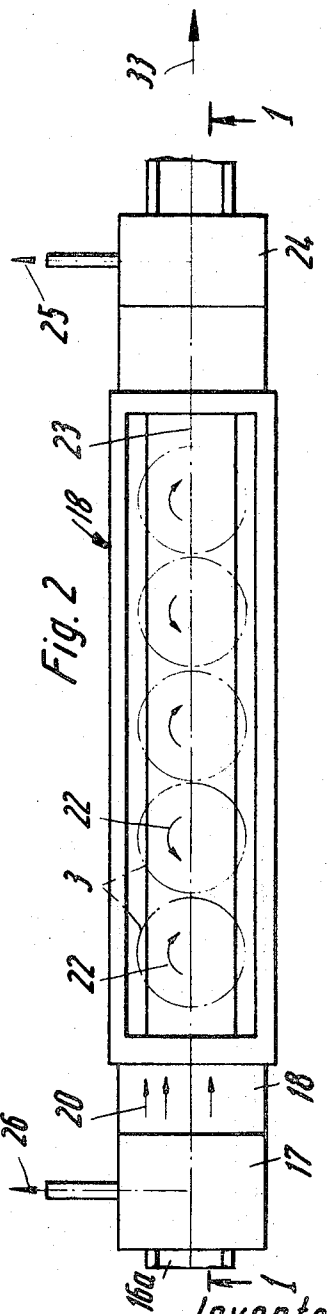

Fig. 2

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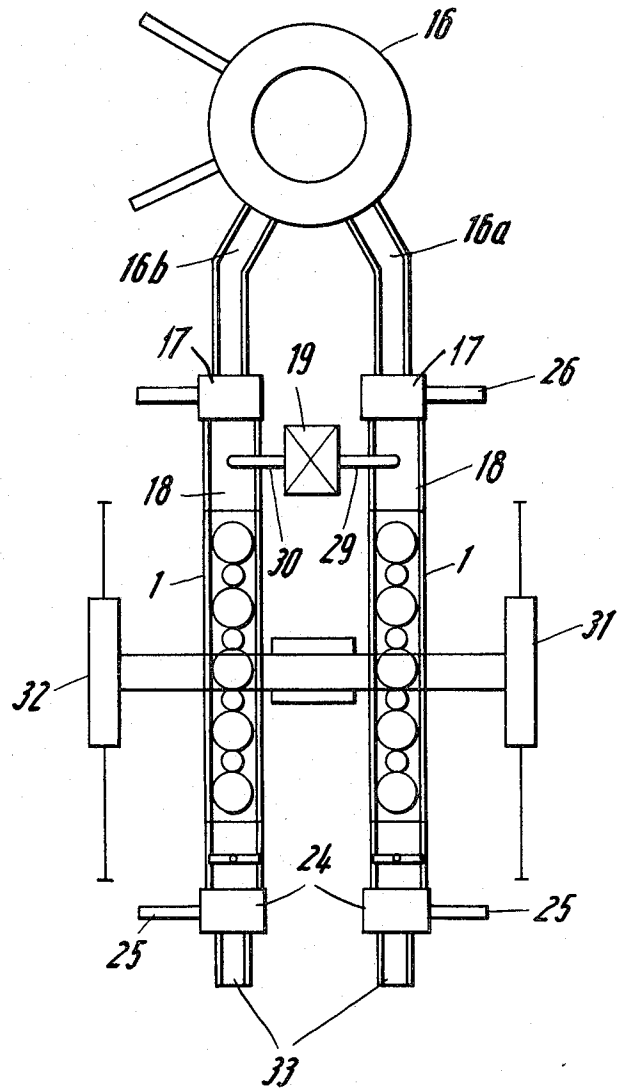
Fig. 4



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METHOD AND DEVICE FOR VARYING THE SUBSTANCE COMPOSITION IN METAL MELTS AND IN PARTICULAR FOR THE DESULFURIZING OF PIG IRON

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to a method and apparatus for treating metallurgical melts and, in particular, to a new and useful method and apparatus for varying the substance composition in metal melts by enlarging the contact surfaces between the various constituents by agitating the surfaces at the boundary layer and wherein a flow of the metal melt is first produced in a predetermined direction and a plurality of eddies are produced simultaneously along the flow at several locations and to an improved apparatus and metallurgical system in which this is done.

2. Description of the Prior Art

The present invention is particularly applicable for the desulfurizing of pig iron. Stirring methods have been proposed before for the purpose of desiliconizing, dephosphorizing and desulfurizing as well as for the admixing of alloy components. The stirring promotes the distribution of the substances to be admixed and increases the reactivity of substances which either operate as catalysts or are intended to take over undesired melt concomitants. The stirring of metal melts entails problems of heat loss and degree of utilization of the substances to be added. Both factors influence the economic efficiency of the method and the invariable composition or analysis of the solidified metal. At higher temperature levels, the reaction avidity of certain substances is greater than at lower levels, and another substance group is capable of dissolving out of the molecular structure of the particular metal or of becoming modified. In the practical application of the known methods, the temperature curve can be gone through only downwardly. One strives to keep the temperature drop small in order to provide for a processing of the metal which is favorable as to engineering and as to cost. Reactions must therefore proceed in a shorter period of time. After completion of the stirring process, the substance composition must remain within specified limits and also the end temperature must be adapted to the further processing. While the invention has particular application to the desulfurizing of pig iron, other metal treatment processes where stirring is of advantage are also included.

In one application of the invention, desulfurized pig iron is fed directly from the blast furnace and in another, the pig iron is stored in mixers and is processed to steel iron. The pig iron coming from the blast furnace shows high sulfur concentrations. In the mixer, the sulfur is distributed more and more so that while the average sulfur content is considerable, there are no extreme sulfur content fluxuations. The desulfurization of pig iron usually takes place on the basis of the mixer pig iron. This pig iron is suitable for being desulfurized by pouring onto a lime-soda powder in a casting ladle. More intensive desulfurization takes place when the melt is stirred.

The desulfurization agent is poured onto the surface of the melt bath and is distributed by means of stirrers. The action of the stirring extends in some measure to the mixing of the pig iron itself. At a certain speed of rotation, a suction follows the back of the agitator. The

desulfurization agent, as well as part of the liquid melt, get into the suction stream. If this speed is exactly maintained, a relative displacement takes place between the desulfurization agent and the liquid metal. A speed not correctly adjusted, however, either whirls up the desulfurization agent or creates no suction and hence no relative velocity. Experience from the practice and the test results that have been published show that good desulfurization results can be obtained in dependence on the given conditions but the utilization of the desulfurization agent leaves something to be desired. A better utilization of the desulfurization agent must necessarily bring with it an additional improvement of the results. The point of departure therefore is a method for desulfurizing pig iron where the desulfurization agent is only saturated and hence forms a slag layer which initially is able to absorb a part of this sulfur but later inhibits a higher degree of desulfurization.

SUMMARY OF THE INVENTION

In accordance with the present invention, the disadvantages of the prior art are overcome. With the invention, it is possible to treat liquid metals of irregular substance concentrations. Such inhomogeneous metal melts occur in particular immediately after melting. In accordance with the method of the invention, the melt is stirred at a plurality of locations along the path of metal flow after the flow is first begun. The stirring takes place along the flow path to produce a plurality of whirling eddies at several adjacent points. The stirring in the flow is much more effective because new melt is continuously admitted and removed without effecting the stirring. This stirring in another metal flow always conveys the slag with and counter to said flow and thereby intensifies the relative movement between the melt and the slag layer. In the stirring direction, which is opposite the flow direction, the melt dams up over the slag and continuously saturates the slat with new melt. The flow produced elsewhere is either a stirring flow of an adjacent stirrer or a flow produced by another force.

An outside flow, in addition to the flows produced by the individual stirrers, can be generated in different ways. A separate procedure, which is easily adapted to the needs of the metallurgical operation, is brought about by the use of a gradient in pressure temperature or height.

Large quantities of pig iron or any desired liquid metal to be desulfurized can be treated with a uniformly high efficiency by stirring at several points, one behind the other, in a stream of liquid in a flow direction. The stirring action can be rendered locally or more intensively at specific locations. For this purpose, the stirring movements must be effected with a different direction of rotation at several points. The stirring flows may extend in pairs opposite to the fundamental flow.

The invention can advantageously be employed in the continuous treating of metal melts. It is favorable to remove the slag continuously after the stirring with a movement adapted to the flow produced elsewhere and to execute it at the melt surface. The melt thus treated is ready for further processing without additional treatment.

While it is known to provide several rotatable agitators to stir on a larger melt bath surface, such an arrangement however, includes agitators which act inde-

pendently of each other and stir the liquid metal from below upwardly into or onto the slag layer. The agitator bodies are unsuitable for creating a horizontal fundamental flow in which the stirring is carried out as in the present invention. The great distance of the agitator bodies is unfavorable in terms of the drive.

In contrast to the known device which is placed on the casting ladle as a cover, the invention provides that for several agitators, one rotatable bearing is provided at a housing carrying the drive. Either a common driving motor for the agitators to be switched on and off singly or independently, or individual drives for each agitator are provided. The drive housing is thus independent of any vessel.

In order to avoid overheating due to heat radiation, the housing of the agitator may be cooled internally. The agitators advantageously have couplings or clutches to set adjacent agitators in rotation or to stop them. When one agitator is set to create a fundamental flow simultaneously for the adjacent one, it is advantageous to let the two agitators operate at different speeds. This can be achieved with independent drives or with an adapted transmission ratio of intermediate gears lodged in the drive housing.

It is also possible to manage without special cooling devices at the drive housing when a carrying frame for a heat shield with several openings for the drive shafts of the agitators is secured thereon. The carrying frame permits the arrangement of apertures through which the air circulates between the heat shield and the drive housing so that a simple cooling is provided.

According to a further feature of the invention, a fixed or movable lift means for the height adjustment of all agitators is provided. The lift means serve for the positioning, setting up, and the rapid release of the treatment vessel, and it facilitates the handling of the drive housing carrying the agitators. A movable lift means can also transport the drive housing between the workshop and the place of use. A continuous desulfurization operation for any metal treatment which does not take place in the vessel such as is customary, as a casting ladle, is advantageous for use with the invention. The invention provides for a continuous procedure and the agitators are arranged on a straight line and are located above a trough in which the basic flow of the liquid metal is produced. The trough is inclined and forms a natural gradient. The gradient provides a fundamental flow in which the stirring takes place according to the method. With several agitators lying one behind the other along the path of flow, all of the melt parts to be treated are reached with great certainty.

The trough of the invention advantageously connects with a blast furnace tap and with a slag discharge. A feed device for treatment means is arranged above the trough. The residual blast furnace slag is first removed from the slag discharge and thereafter the desulfurization slag is formed on the melt flow surface by additional substances such as lime and/or soda in powder form or by the addition of a liquid slag. A slag discharge for slag from the reaction with the treatment agents is also arranged behind the agitators in the direction of flow. The slag is drained at a point of the trough which is deep to calm the melt. The slag collects at the melt surface from whence it can be removed. The purified metal leaves the slag discharge through a lower outlet. It is a special advantage of the invention that the method and the device are suitable for continuous operation.

Accordingly, it is an object of the invention to provide a continuous method for varying the conditions in a metallurgical melt, which comprises producing a flow of the metal melt and stirring along the flow at a plurality of locations.

A further object of the invention is to provide an apparatus for treating metal melts which includes a plurality of rotatable stirrers rotatably mounted on a single housing and connected to a drive for rotating them either separately or in combination and which also includes a heat shield through which the stirrers project to cover the melt in order to position the housing in a location in which the stirrers contact the metal.

A further object of the invention is to provide a metallurgical melt treatment system which comprises a furnace having a cap with a trough in which a flow is produced and a housing for a stirrer mounted on a trough in a position in which a plurality of stirrers extend along the flow path for stirring the melt at various locations along the flow path.

A further object of the invention is to provide a metallurgical system and a metallurgical apparatus which are simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference should be had to the accompanying drawing and descriptive matter in which there are illustrated preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a section taken along the line 1—1 of FIG. 2;

FIG. 2 is a top plan view of the flow trough shown in FIG. 1;

FIG. 3 is a section taken along the line 3—3 of FIG. 1; and

FIG. 4 is a top plan view of a furnace system embodying the invention.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing in particular, the invention embodied therein comprises, an apparatus for stirring a liquid metallurgical melt at a plurality of locations along a flow path of the melt which includes a housing, generally designated **1**, having bearing means **2** for rotatably supporting individual gear shafts **6** of gears **3** and agitator shafts **4**. Each agitator shaft **4** carries a stirrer or agitator **5** at its lower end which is adapted to be positioned in the trough, generally designated **18**, which is located therebelow. A plurality of agitator shafts **4** with agitators **5** are secured to individual gears **3** and arranged rotatably in the housing **1** for rotation about individual vertical axes which are spaced in a longitudinal direction. Each agitator shaft **4** is connected to the associated gear shaft **6** by means of an engageable or disengageable coupling or clutch **7**. In the arrangement shown in the drawing in FIGS. **1** to **3**, only one driving motor **8** is provided which drives all of the

gears 3 through a main gear 3' which is carried on a motor shaft 8'.

In accordance with the invention, the housing 1 is transportable and it includes a cable lift 10, which is engaged in eyelets 9 of the housing 1, and which is adapted to be engaged by a crane hook 11 for transporting the device from one trough to the other. The crane hook 11 moves the housing 1 vertically and, on its usual crane path, it also moves it horizontally during the transporting of the housing.

In accordance with a feature of the construction, the carrying frame 13 is secured to the underside 12 of the housing and it carries a heat shield or cover 14 having individual openings 15 at longitudinally spaced locations for the passage of the individual stirrer shafts 4 therethrough. The openings 15 may have the contour of the cross-section of the agitator elements 5 so that they may be easily lifted upwardly through the openings if desired.

As shown in FIG. 4, a furnace system embodying the invention includes a melting furnace or blast furnace 16 having one or more taps 16*a* and 16*b* for the outflow of pig iron or other liquid metal through a slag discharge 17 into a trough 18. A device for feeding lime, soda or other treatment agent, generally designated 19, is located above the trough 18 and it provides a liquid slag on the melt. The formed slag layer 21 floats on the flow 20 of the liquid metal, as shown in FIG. 1. The agitators or stirrers 5 are located to extend partly into the slag layer 21 and partly into the liquid metal melt layer. When the stirrers are rotated in the direction of the arrows 22, shown in FIG. 3, rotational eddies are generated at respective opposite rotational directions as indicated. The rotational directions are chosen as shown in the drawing in FIG. 2, and the direction of the slag flow is indicated at 20. The slag 21 can finally migrate off and in so doing, the slag gets into the zone of the next agitator 5. This cycle is repeated several times.

It is important that the length of the agitators 5 exerts a corresponding influence on the slag conduction. Therefore, the specialist can choose agitators 5 of unequal length and act on the relative movements between slag 21 and flow 20 by the form of the agitator 5 which is employed.

The stirring device with the housing 1, constructed in accordance with the invention, is arranged on a trough 18. Accordingly, the agitators 5 are provided one behind another on a line 23. As shown, this line 23 is substantially straight. The shafts of the agitators may be offset in respect to line 23 insofar as the width of the trough 18 and the length of the agitators 5 permit. After complete utilization, the slag 21 is removed in the slag discharge 24 and the liquid metal leaves through the passage 25 for further processing. Two slag discharges 25 are provided. Slag discharge 24 serves to draw off the treatment slag 21 and the slag discharge 17 permits removing the smelting slag before treatment of the liquid metal. The removal of both slags occurs in the direction proceeding from the associated discharge stations 17 or 24 through the associated conduit 26 and 25. The removal is facilitated by a tool which is moved backwardly and forwardly. The drive of the tool is adjustable on the basis of the flow 20. On the other hand, the flow 20 can be regulated by a sluice 27, as shown in FIG. 1, which is designed to be raised or lowered by means of a rod 28.

As shown in FIG. 4, two taps 16*a* and 16*b* extend outwardly from the melt furnace 16 in the system shown. Consequently, there are also two troughs 18, one associated with each tap, to permit a particularly advantageous mode of operation. The feed device 19, therefore, works into one or both troughs 18, and has separate feed channels 29 and 30 for this purpose.

In order to achieve an effective operation, each of the two existing housings 1 is attached to the indicated cranes 31 and 32 and movable with them.

The pig iron desulfurization device thus designed as a twin system permits either discharging relatively large total quantities at the metal outlets 33 or selective operation with only one of the troughs 18. Another advantage to the system consists in that the purified liquid metal obtained at the metal outlets 33 can be charged directly in a subsequent treatment unit, as for example a converter, or in a pig iron mixer car or casting unit.

While specific embodiments on the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A method for varying the substance composition in metal melts, and particularly for desulfurizing pig iron, where the contact surfaces of the reacting substances are enlarged by stirring the melt in motion, comprising producing a flow of the metal melt carrying a slag layer along at least one continuous flow path defined by a substantially straight channel having a relatively small cross-section in respect to its length, such as a trough, and rotatably stirring the flow close below the slag layer or at the slag metal interface simultaneously in a plurality of appropriately spaced adjacent zones located along the path of flow one behind the other in the flow direction so as to produce interacting turbulences across the flow and along said zones.

2. A method for varying the substance composition in metal melts, according to claim 1, wherein the flow is produced by establishing a flow gradient.

3. A method for varying the substance composition in metal melts, according to claim 1, wherein after the eddies are produced in the flow path the slag is removed continuously with a movement adapted to the velocity of the flow produced.

4. A method for varying the substqance composition in metal melts, according to claim 1, wherein at several locations, the stirring is carried out in an opposite sense of rotation.

5. A method for varying the substance composition in metal melts, according to claim 1, wherein the eddies are produced by stirring the melt at a plurality of spaced locations one behind the other in the direction of flow.

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