



US 20170292173A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2017/0292173 A1**
(43) **Pub. Date: Oct. 12, 2017**

(54) **CERAMIC FILTERS AND FILTER SYSTEMS
FOR CONTINUOUS METAL MELT
FILTRATION**(30) **Foreign Application Priority Data**

Apr. 12, 2016 (DE) 10 2016 106 708.3

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Bergakademie Freiberg**, Freiberg (DE)**Publication Classification**(51) **Int. Cl.**
C22B 9/02 (2006.01)(52) **U.S. Cl.**
CPC **C22B 9/023** (2013.01)(72) Inventors: **Andreas Baaske**, Duisburg (DE); **Sven
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Patrick Gehre, Freiberg (DE); **Rüdiger
Schwarze**, Dresden (DE)(57) **ABSTRACT**

With respect to ceramic filters and filter systems for continuous metal melt filtration, to be able to counter high throughputs of steel melt and also the limitations of filter capacities during continuous casting, an alternative technological approach involves the use of novel, replaceable, and/or rotatable filter bodies at positions in the distributor channel. In some cases, the replaceable and/or rotatable filter bodies may be inserted into the distributor channel for 10 seconds to 30 minutes before being replaced. The filter bodies may be configured as an open-celled foam ceramic or a honeycomb body or a spaghetti filter and serve as a filter geometry of the replaceable and/or rotatable filter bodies in the distributor channel.

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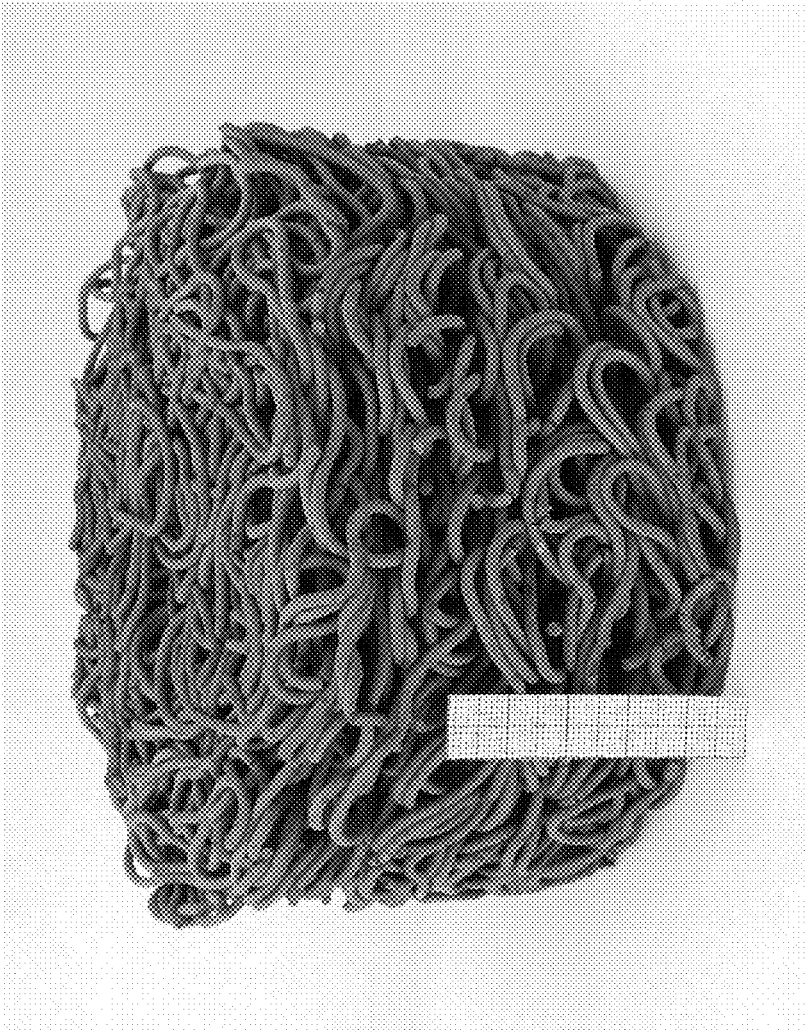
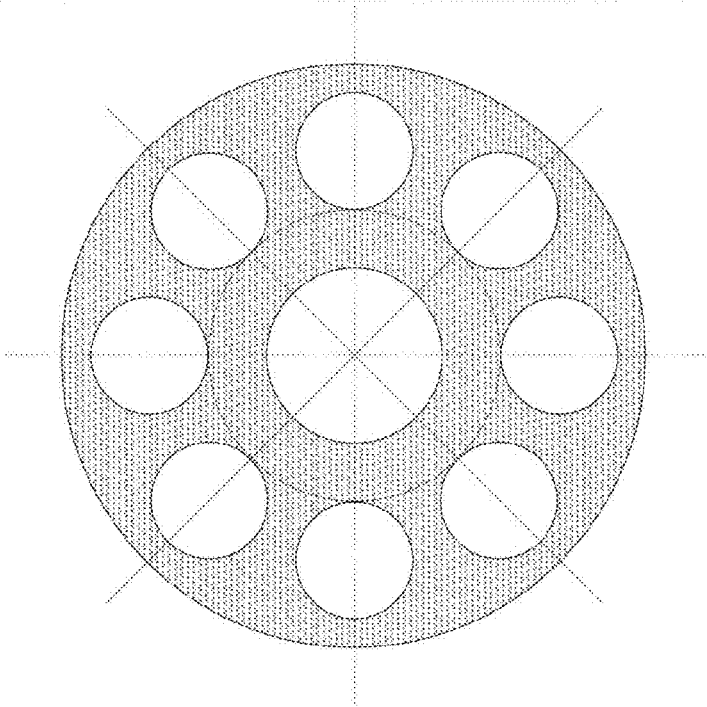


FIG. 1



CERAMIC FILTERS AND FILTER SYSTEMS FOR CONTINUOUS METAL MELT FILTRATION

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a non-provisional application claiming priority to German Patent Application No. DE 10 2016 106 708.3, which was filed Apr. 12, 2016 and is hereby incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates generally to continuous metal melt filtration and, more specifically, to filter systems and ceramic filters for continuous metal melt filtration.

BACKGROUND

[0003] The question of functionality of a metal component is in industry often associated with the concept of the strength and the toughness of the material used. Both properties depend to a great extent on the purity of the material. However, this concept is not a standard unit of measurement but instead a summarized statement about frequency, size distribution, morphology and chemical type of what are known as nonmetallic inclusions (NMI). Safety components, thin- or thick-walled castings or forged components which are required to meet high standards in terms of strength, toughness and fatigue resistance can become unusable as a result of an unacceptable proportion of NMI or lead to a dramatic reduction in the safety properties, e.g., the notched impact toughness, of up to 40%. Nonmetallic inclusions are defined as impurities in solid form. These can either be introduced from the outside (exogenic inclusions) or be formed in the melt (endogenic inclusions).

[0004] The reduction of nonmetallic inclusions can be performed in various ways, such as (a) avoidance of inclusion formation (via a suitable metallurgical process route) and (b) removal of the inclusions. Especially in the field of secondary metallurgy and in foundries, melt refining is a central subject. Different metal melt treatments and different casting processes lead to different generation of inclusions or combinations of inclusions. For example, mention may here be made of oxides, carbides, silicates, etc., which can be formed very quickly during the casting operation due to the high temperature of the melts. Due to the filling of the mould, which is sometimes turbulent in the case of actual castings, these nonmetallic inclusions are swirled into the contour and, due to their nonwettability represent an internal point of separation, frequently with sharp edges. This leads to internal cracks and thus to failure of the component, especially in the case of dynamic or cyclic loads.

[0005] In the filtration of metallic melts, attention is paid to (a) the transport of the inclusions in the metal melt, which is influenced by the flow regime, the size and relative density of the inclusion particles, the relative pore diameter and the wetting of the filter pores, and (b) the actual process of deposition of the inclusions on the filter wall. The latter is made up of three substeps. Firstly, depending on their size, chemistry and the flow conditions, fine particles agglomerate, then they travel to the filter wall and adhesion subsequently has to occur so that the particles can no longer be entrained by the subsequent flow.

[0006] In the case of continuous casting of steel, customary filter systems as are used in casting into moulds are unsuitable. Owing to the small pore size, ceramic filters for steel melt filtration have a high filtration efficiency but a low volume throughput. The filter capacity is very quickly exhausted accompanied by an increased flow resistance of the “clogged” filter medium caused by deposition of the inclusions in its functional macroporosity until the entire casting process comes to a standstill, if indeed the filter has not totally failed beforehand (fracture of the filter geometry).

[0007] In the field of application of continuous casting, what are known as indirect or direct processes are taken into consideration for removing NMI. In the case of indirect processes, attempts are made to influence the flow by installation of what are known as dams and weirs in the distributor in such a way that the path of the inclusion particles to deposition into the slag is shortened or that the residence time for deposition of the particles is increased. In the case of the direct processes, the filtration of the entire melt and the deposition of the inclusions on the filter material of a filter separator whose geometry should influence the flow of the entire melt as little as possible is sought. One such possibility for effectively filtering the nonmetallic inclusions from the steel melt even at high throughputs is described in German Patent Publication No. DE 197 56687C1. A characteristic of the present disclosure is that the nonmetallic inclusions are, as a result of permanent conveying of the metal flow along a circular or spiral path, deposited on the walls of the spiral channel. The patent document DE 4317820C1 discloses a ceramic chamber in which deposition occurs on the interior surfaces of the chamber and on the guide surfaces in the chamber as a result of single or multiple deflection of the metal flow by at least 90°. In both cases, the permanent filter units are quickly saturated and the flow is greatly impaired.

BRIEF DESCRIPTION OF THE DRAWING

[0008] FIG. 1, at left, is a sectional view of an example cylindrical filter body with macrochannels and an external diameter of 200 mm, and FIG. 1, at right, is a perspective view of an example “chaotic” spaghetti filter structure, which is 80 mm in height, includes a 120 in diameter, and has a spaghetti thickness of 2.5 mm.

DETAILED DESCRIPTION

[0009] To be able to counter the high throughputs of the steel melt and also the limitations of the filter capacities during continuous casting, an alternative technological approach using novel, replaceable and/or rotatable filter bodies at positions in the distributor channel is pursued according to the present disclosure. The filter bodies can, according to the present disclosure, contribute directly to removal of inclusions (generation of in-situ layers on their filter surfaces on which the inclusions deposit and lead via sintering processes to fastening to the filter surface) and/or indirectly by the path for deposition of the nonmetallic inclusions into the slag of the distributor being shortened by the design of the filter geometry and in combination with the rotation of the filter body and the flow of the steel melt in the distributor. In addition, larger agglomerates/clusters which owing to their size (additional contribution of buoyancy) move in the direction of the slag can be generated according to the present disclosure by targeted setting of the flow.

[0010] According to the present disclosure, filter bodies in the form of an open-celled foam ceramic, a honeycomb body or a spaghetti filter serve as replaceable and/or rotatable filter geometries in the distributor or distributor channel. According to the present disclosure, porous, replaceable and/or rotatable vessels in which stamped fibres or fibre fabrics or spheres or splintering particles are present serve as filter bodies.

[0011] According to the present disclosure, the filter bodies are, depending on the metal alloy and the preceding secondary metallurgy, dipped into the distributor channel for from 10 seconds to 30 minutes and then replaced. According to the present disclosure, at least one filter body is used in the distributor channel. According to the present disclosure, filter bodies are used in the end faces of the distributor channel. According to the present disclosure, four filter bodies can be used in the vicinity of the shadow tube in the distributor channel.

[0012] According to the present disclosure, refractory oxides and/or non-oxides in combination with or without carbon serve as filter materials. According to the present disclosure, cylindrical carbon-bonded filter bodies based on foam ceramics or spaghetti structures having macrochannels having a minimum diameter of 10 mm are used. According to the present disclosure, filter bodies having a minimum diameter of 100 mm and a height of 100 mm are employed. According to the present disclosure, carbon-bonded support materials can be coated with oxides on their surface in a manner analogous to the patent document DE 10 2011 109 681 B4.

What is claimed is:

1. A system comprising:
a distributor channel; and
ceramic filters or filter systems for continuous metal melt filtration, wherein replaceable and/or rotatable filter bodies are disposed at positions in the distributor channel.
2. The system of claim 1 wherein the ceramic filters or the filter systems are configured to contribute at least one of
directly to removal of inclusions by generating in-situ layers on filter surfaces of the ceramic filters or the filter systems on which the inclusions deposit and lead via sintering processes to fastening on the filter surfaces, or
indirectly to removal of inclusions by shortening a path for deposition of nonmetallic inclusions into a slag of the distributor channel by a design of filter geometries in combination with rotation of the filter bodies and flow of metal melt in the distributor channel.
3. The system of claim 2 wherein the filter bodies configured as an open-celled foam ceramic or a honeycomb

body or a spaghetti filter serve as the filter geometries of the replaceable and/or rotatable filter bodies in the distributor channel.

4. The system of claim 2 wherein porous, replaceable and/or rotatable vessels in which stamped fibres or fibre fabrics or spheres or splintering particles are present serve as the filter geometries of the replaceable and/or rotatable filter bodies.

5. The system of claim 1 wherein at least one filter body is used in an end face of the distributor channel and/or in a vicinity of a shadow tube in the distributor channel.

6. The system of claim 1 further comprising foam ceramics or spaghetti structures with macrochannels and a minimum diameter of 10 mm.

7. A process that employs ceramic filters or filter systems for continuous metal melt filtration, wherein replaceable and/or rotatable filter bodies are disposed at positions in a distributor channel.

8. The process of claim 7 further comprising:

dipping the ceramic filters or the filter systems into the distributor channel for 10 seconds to 30 minutes; and
replacing the ceramic filters or the filter systems.

9. The process of claim 7 wherein the ceramic filters or the filter systems contribute at least one of

directly to removal of inclusions by generating in-situ layers on filter surfaces of the ceramic filters or the filter systems on which the inclusions deposit and lead via sintering processes to fastening on the filter surfaces, or
indirectly to removal of inclusions by shortening a path for deposition of nonmetallic inclusions into a slag of the distributor channel by a design of filter geometries in combination with rotation of the filter bodies and flow of metal melt in the distributor channel.

10. The process of claim 9 wherein the filter bodies configured as an open-celled foam ceramic or a honeycomb body or a spaghetti filter serve as the filter geometries of the replaceable and/or rotatable filter bodies in the distributor channel.

11. The process of claim 9 wherein porous, replaceable and/or rotatable vessels in which stamped fibres or fibre fabrics or spheres or splintering particles are present serve as the filter geometries of the replaceable and/or rotatable filter bodies.

12. The process of claim 7 wherein at least one filter body is used in an end face of the distributor channel and/or in a vicinity of a shadow tube in the distributor channel.

13. The process of claim 7 further comprising providing foam ceramics or spaghetti structures with macrochannels and a minimum diameter of 10 mm.

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