



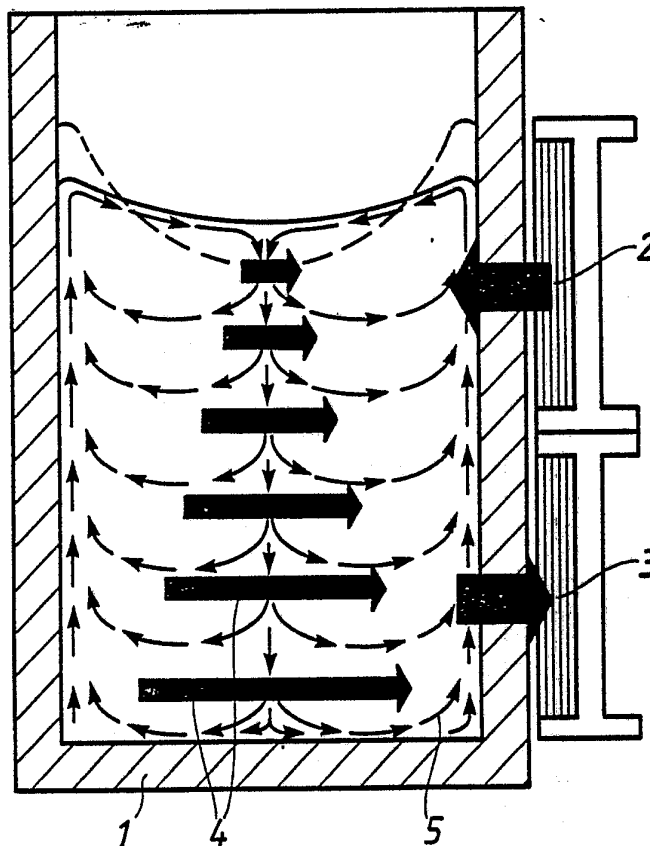
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : F27D 23/04	A1	(11) International Publication Number: WO 87/ 06332 (43) International Publication Date: 22 October 1987 (22.10.87)
(21) International Application Number: PCT/SE87/00182 (22) International Filing Date: 10 April 1987 (10.04.87) (31) Priority Application Number: 8601763-9 (32) Priority Date: 16 April 1986 (16.04.86) (33) Priority Country: SE (71) Applicant (for all designated States except US): ASEA AB [SE/SE]; S-721 83 Västerås (SE). (72) Inventor; and (75) Inventor/Applicant (for US only) : BERKESTAD, Karl-Erik [SE/SE]; Långgatan 6, S-582 67 Linköping (SE). (74) Agent: BERGGREN, Björn; Patentavdelningen, Asea AB, S-721 83 Västerås (SE).		(81) Designated States: BR, DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, US. Published <i>With international search report.</i> <i>With amended claims.</i> <i>In English translation (filed in Swedish).</i>

(54) Title: ARRANGEMENT IN STEEL MANUFACTURING BY MEANS OF INDUCTIVE STIRRING

(57) Abstract

An arrangement for steel making with inductive stirring of the steel melt in a steel melt container. It is desirable for the various parts of the steel melt to be forced up to the surface, while at the same time being mixed, in order to be exposed there to as large an area as possible. This task has been solved by the inductive stirring producing at least one magnetic field which acts in the lower part of the steel melt and which there, substantially in the horizontal plane, drives the steel melt to rotate in a certain direction, and by the inductive stirring producing at least one further magnetic field which acts in the upper part of the steel melt and which there, substantially in the opposite direction, drives the steel melt.



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Arrangement in steel manufacturing by means of inductive stirring

The present invention relates to an arrangement for steel making in a container for molten steel with inductive stirring of the molten steel.

- In the manufacture of quality steel, different steel qualities
5 require different metallurgical measures while simultaneously stirring and mixing the molten steel. It has long been known that a so-called inductive stirrer, located on the outside of the steel melt container, may cause the steel melt to rotate while being influenced by the magnetic field created by the induc-
10 tive stirrer. Known applications comprises one or more inductive stirrers, which however primarily cause the steel melt in its entirety to rotate rather than to be mixed. Since the metallurgical penetrations in most cases occur at the surface of the steel melt, it would be desirable - in addition to achieving
15 improved mixing - for the various parts of the steel melt to be forced up to the surface, while at the same time being mixed, in order to be exposed there to as large an area as possible. Such a movement pattern of the steel melt would provide more uniform steel qualities in a shorter process time, which in turn
20 would result in a direct reduction of the cost of production. As examples of measures which are taken on the surface of the steel melt may be mentioned heating, dehydrogenation under vacuum, desulphurizing by means of lime, carbon combustion by means of oxygen, and supplying alloying materials.
- 25 The invention aims to provide a solution to the above-mentioned problems and other problems associated therewith and is characterized in that the inductive stirring is adapted to be brought about by at least two substantially horizontally acting induc-
30 tive stirrers, located at different levels of the steel melt, the stirring direction of one stirrer thus being substantially opposite to that of the other stirrer.

By means of the invention, a stirring is achieved in which the different parts of the steel melt, while being simultaneously mixed, are forced up to the surface in order to be exposed at the surface to as large an area as possible. This has been
5 solved by the inductive stirring producing at least one magnetic field which acts in the lower part of the steel melt and which there, substantially in the horizontal plane, drives the steel melt to rotate in a certain direction, and by the inductive stirring producing at least one further magnetic field
10 which acts in the upper part of the steel melt and which there, substantially in the opposite direction, drives the steel melt.

In a preferred embodiment of the invention, the stirring is given greater force and/or speed in the lower parts of the steel melt container than in the upper parts. The ideal condition
15 would then be to have the highest speed of rotation at the bottom of the steel melt container and the lowest at the surface of the steel melt.

At different levels of the steel melt - and while at the same time the layers of the steel melt are twisted in relation to
20 each other - the steel melt will be pressed from the centre of rotation and outwards towards the walls of the steel melt container and there, while being at the same time rotated, be pressed further up towards the surface of the steel melt and then, from all directions, float inwards towards the centre of rotation
25 and be sucked down there, and then again, at different levels, be pressed out towards the walls of the steel melt container. Where necessary, a slag layer may also be broken up and be splashed with steel melt by reducing the counteracting effect of the upper inductive stirrer and/or increasing the driving
30 effect of the lower inductive stirrer, which leads to a major depression on the surface of the steel melt and thus enables splashing and breaking-up.

The stirrers may be powered with different frequencies, for example a lower frequency for the upper stirrer, which then
35 achieves a longer depth of penetration in that part of the melt.

The frequency range may be from very low values up to mains frequency (0.1-60 Hz).

The invention will be exemplified in greater detail with reference to the accompanying drawing, wherein

- 5 Figure 1 shows a ladle with two multi-phase, electromagnetic, horizontal stirrers and

Figure 2 shows the configuration of flow in the ladle.

- Figure 1 shows a ladle 1 for molten steel with an upper (2) and a lower (3) stirrer. The stirrers provide a mutually substantially opposite travelling field (see 21 and 22). Possibly, the lower stirrer 3 is also given a greater power so that the magnetic field from this stirrer is more powerful than the field from the upper stirrer 2. It is also possible to stir with a greater speed in the lower parts than in the upper parts. In order to achieve this, the upper stirrer 2 may have a lower frequency. However, this will result in a greater depth of penetration for the field from the stirrer supplied with lower frequency.

- Of course it is also possible to supply the stirrers with the same frequency, however with greater power in the other one.

Figure 2 shows two thick arrows 2 and 3, which symbolically show the mutually opposite directions of stirring, i.e. arrow 2 shows the upper magnetic field acting on the steel melt and arrow 3 shows the lower magnetic field acting on the steel melt.

- 25 The arrows 4 in the middle of Figure 2 illustrate the speeds of rotation diminishing in an upward direction, and the small arrows 5 show the superimposed movements of the melt.

It is thus clear that the different parts of the melt are forced up to the surface while at the same time being mixed.

The arrangement according to the invention can be varied in many ways within the scope of the appended claims.

CLAIMS

1. Arrangement for steel making in a container for molten steel with inductive stirring of the molten steel, c h a r a c t e r i z e d in that the inductive stirring is adapted to be accomplished by at least two substantially horizontally acting inductive stirrers located at different levels of the steel melt, the stirring direction for one of the stirrers being substantially opposite to that for the other stirrer.
2. Arrangement according to claim 1, c h a r a c t e r i z e d in that the stirring force and/or the rate of stirring for the lower stirrer is/are greater than for the upper stirrer.
3. Arrangement according to claim 1 and possibly claim 2, c h a r a c t e r i z e d in that the power of the magnetic fields from the respective stirrers may be varied and/or that the stirring direction may be reversed.
4. Arrangement according to one or more of the preceding claims, c h a r a c t e r i z e d in that the frequency for one of the stirrers is lower than for the other stirrer.

AMENDED CLAIMS

[received by the International Bureau on 11 August 1987 (11.08.87);
original claims 1-4 replaced by amended claims 1-4 (1 page)]

1. Arrangement for steel making in a container for molten steel with inductive stirring of the molten steel, characterized in that the inductive stirring is adapted to be accomplished by at least two substantially horizontally acting inductive stirrers located at different levels of the steel melt and one after the other, the stirring direction for one of the stirrers being substantially opposite to that for the other stirrer.
2. Arrangement according to claim 1, characterized in that the stirring force and/or the rate of stirring for the lower stirrer is/are greater than for the upper stirrer.
3. Arrangement according to claim 1 and possibly claim 2, characterized in that the power of the magnetic fields from the respective stirrers may be varied and/or that the stirring direction may be reversed.
4. Arrangement according to one or more of the preceding claims, characterized in that the frequency for one of the stirrers is lower than for the other stirrer.

FIG. 1

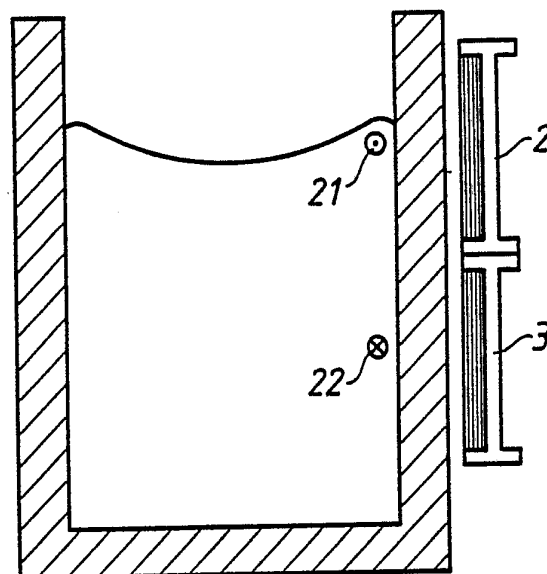
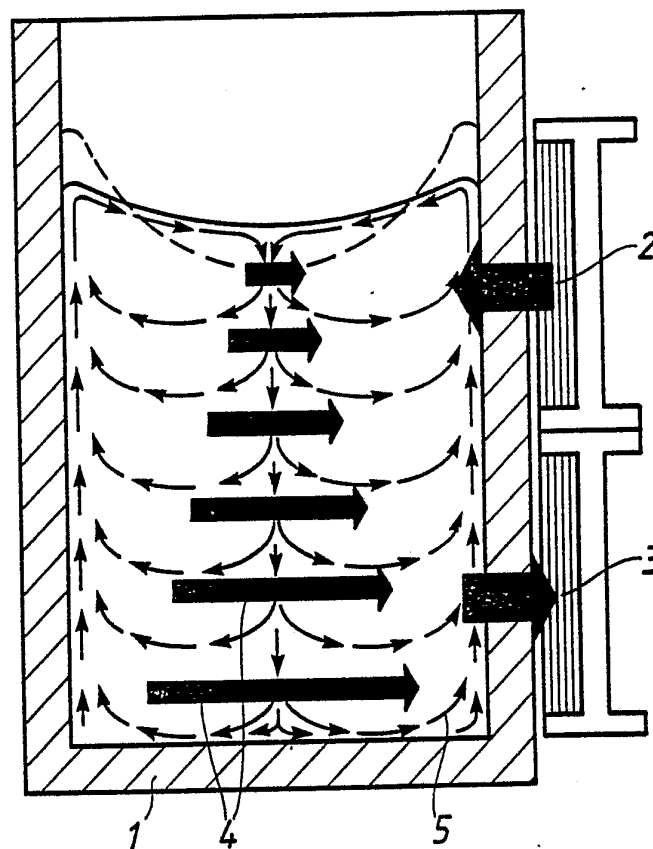
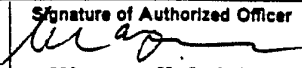


FIG. 2



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00182

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC 4		
F 27 D 23/04		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC 4	F 27 B 14/06, /08; F 27 D 11/06, 23/04; B 01 F 13/08; B 22 D 27/02; H 05 B 6/24, /34, /44	
US Cl	13: 26, 27; 266: 233, 234; 373: 85, 116, 138, 146	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	SE, A, 997 713 (ASEA) 27 August 1940 see figure and claim	1-4
A	SE, A, 194 474 (ASEA) 16 February 1965 see details 7 & 8	1
Y	US, A, 1 822 539 (E F NORTHROP) 8 September 1931 see page 1 lines 49-55	1-4
X	US, A, 1 943 802 (E F NORTHROP) 16 January 1934 see claim 1	1-4
X	US, A, 3 314 670 (T R KENNEDY) 18 April 1967 see figure 6	1-4
Y	US, A, 3 472 941 (J FLOYMAYR) 14 October 1969 see column 2 lines 61-66 .../...	1-4
¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1987-06-12	1987-06-22	
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	US, A, 3 478 156 (R S SEGSWORTH) 11 November 1969	1-4
X	DE, A, 2 350 090 (H W MAUVE) 10 April 1975 see page 2 lines 8-11	1-4
X	DE, A1, 2 708 227 (P G BLUMBACH ET AL) 1 September 1977 see figures 3 & 5 & JP, 52103729	1-4