Jan. 18, 1966 C. ERICSSON 3,230,073

PROCESS FOR VACUUM DEGASSING WITH ELECTROMAGNETIC STIRRING

Filed July 20, 1962

Fig.1

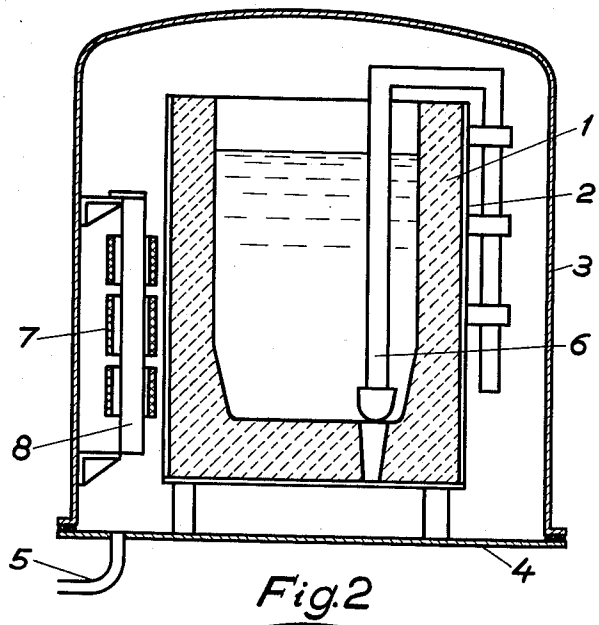
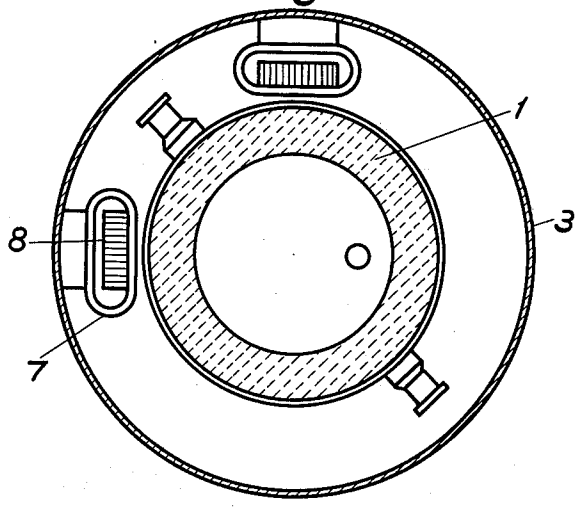


Fig.2



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United States Patent Office 3,230,073 Patented Jan. 18, 1966

3,230,073

PROCESS FOR VACUUM DEGASSING WITH ELECTROMAGNETIC STIRRING

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Filed July 20, 1962, Ser. No. 211,380
2 Claims. (Cl. 75—10)

This application is a continuation-in-part of our co-pending application Serial No. 734,866, filed on May 13, 1958 and now abandoned, and entitlted "Improvements in the Manufacture of Metal and Metal Alloys."

In the manufacture of metal and metal alloys, the molten metal is usually poured from the melting furnace into a ladle from which it is then transferred to the moulds that form the ingots. In order to obtain ingots that are free from gas inclusions, it has been proposed to place the ladle in a vacuum chamber and thereafter, when a certain time has elapsed, possibly also under vacuum, to pour the metal into the moulds forming the ingots.

It has now been found that this kind of vacuum treatment gives an unsatisfactory result, in spite of long evacuation, because only the top layer in the metal bath in the ladle will be freed from gas in a satisfactory way. This fact can be observed when pouring the melt into the moulds, the major part of the melt giving off a large amount of gas. The explanation of this is that the hydrostatic pressure in the molten metal in the ladle is too high for the gases dissolved in the metal to be given off while the metal is still in the ladle.

The present invention concerns equipment for and a method of forcing the gases to leave the melt while the metal is still in the ladle, instead of remaining until the pouring. According to the invention, this is achieved by stirring the melt electro-magnetically while it is still in the ladle, so that all parts of the melt will gradually come up to the surface of the melt thereby enabling the melt to give off its gases. According to the invention this stirring of the metal melt is achieved by means of stationary electromagnetic stirring coils fed by a suitable low-frequency current. By "low-frequency" is meant here and in the following, 0.5–10 Hz. The stirring is to be accomplished by multi-phase stirrers, the number of phases being 2–3. In one arrangement included in the invention, the magnetic field necessary for stirring the melt is produced by helical coils supplied immediately outside of the ladle, these coils being placed on a number of long steel cores, vertically arranged along the outer wall of the ladle. The coils can also be made as "pancake" coils arranged on the side of the steel core that is towards the ladle wall such cores would then be referred to as yokes.

The stirring magnetic field can also be created by means of cylindrical coils surrounding the ladle and concentric with it. The coils and the cores or yokes can either be solidly connected to the ladle or placed in a stationary position in the chamber into which the ladle is introduced for vacuum treatment. The coils and cores can also be placed outside the vacuum chamber, for example so that the ladle itself becomes the vacuum chamber.

The moulds into which the molten metal is to be poured possibly can be arranged either inside the vacuum chamber or outside.

The attached drawing shows an example of an arrangement for obtaining the described de-gassing. FIG. 1 shows a vertical section and FIG. 2 a horizontal section of the arrangement.

The ladle shown in the example consists of a cylindrical vessel with lining **1** and steel wall **2** and is placed inside a

vacuum chamber suitably consisting of a bell **3** and a bottom **4**, attached to the bell by means of a vacuum-type seal and having a connection pipe leading to a vacuum pumpin arrangement. **6** is a stopper arrangement with operating bath for controlling the pouring of the melt when filling the moulds. Multi-phase, preferably two-phase electro-magnetic stirrers are arranged outside the wall of the ladle, each of them consisting of coils fed with low-frequency current. Electro-magnetic stirrers are arranged outside the wall of the ladle, each stirrer in the example having two windings, each of them consisting of coils **7**, fed with low-frequency current. The coils are arranged on a straight iron core **8**. It is not necessary to have two stirrers, but in the case of there being two stirrers, they can be either series or parallel connected. In the example shown, the stirrers are fixed onto the inner side of the vacuum chamber but it is, as mentioned before, possible to fix them onto the ladle or to support them from the bottom of the chamber, on which bottom the ladle in the example is also placed.

The pressure in the bell **3** above the surface of the melt is after evacuation to be 0.1–50 Torrs, preferably above 20 Torrs. The number of phases is two or three, preferably two.

Instead of the coils described above and in the drawing, it is also possible to arrange the coils concentrically around the ladle.

In view of the heavy current losses in the ladle wall, it is convenient to replace the reinforcement girdles of the ladle by vertical steel bars.

I claim as my invention:

1. Method for treating a molten metal which comprises melting the metal, placing the molten metal in a container having a steel shell, placing the container in a vacuum chamber in the field of a stationary electromagnetic multi-phase stirring means positioned outside and at the side of the container, evacuating the chamber, and subjecting the molten metal while within the vacuum container to a stirring action by feeding to the stirring means current at a frequency of between about 0.5 and 10 cycles per second, said stirrer producing vertical movements in the molten metal from parts close to the bottom of the container to the surface of the melt.

2. A method as claimed in claim **1** in which the pressure in the chamber is between 0.1 and 50 Torr.

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