PRODUCTION OF INGOTS

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Filed: Mar. 22, 1974

Appl. No.: 453,671

Related U.S. Application Data


U.S. Cl. ..................... 164/137; 29/509; 249/106

Int. Cl. .............................. B22d 7/10

Field of Search ............. 164/6, 137; 249/106, 197, 249/201; 29/508, 509

References Cited

UNITED STATES PATENTS

1,548,177 8/1925 Strange............................. 29/508 X

3,097,423 7/1963 Makowski.......................... 29/508 X

3,467,173 9/1969 Tisdale.......................... 249/201 X

3,547,182 12/1970 Roolofs....................... 249/197 X

FOREIGN PATENTS OR APPLICATIONS

524,383 8/1940 United Kingdom.................. 249/106

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ABSTRACT

Ingot mould and head boxes are lined with slabs or sleeves of deformable lining material. The lower edge only of the slab or sleeve is deformed to fit tightly against the wall of the head box and may be held in such deformed condition by means of a clip. The bottom edge of the lining sleeve may also extend past the bottom surface of the head box and be deformed along the outer surface thereof.

1 Claim, 3 Drawing Figures
PRODUCTION OF INGOTS
RELATED APPLICATIONS

This invention relates to the production of ingots and more particularly to the hot topping of ingot moulds.

It is common technique in the production of ingots, particularly steel ingots, to form the ingot in a mould which is provided at its head or in a head box secured to its head with a lining of a composition which will act as a barrier or hindrance to loss of heat from the molten metal at the head of the ingot mould or within the head box. Such a lining provides a so-called hot top to the ingot mould.

While for many purposes ingot moulds are used of which the inner surfaces are essentially planar, it is also known to employ moulds of which the inner surfaces are curved or corrugated. Such shaped moulds may be used for the production of steel ingots of particular desired physical structure, the wall contour having an effect on the directional solidification of the cast metal.

Clearly, in order to provide a satisfactory hot top lining it is necessary to make the contour of the lining fit snugly against the walls which are to be lined, i.e. if the inner surface of the mould or head box is corrugated then the lining must be corrugated to conform with it. Such specially shaped lining slabs or sleeves are more difficult to make than planar slabs and are therefore less economical.

The invention is illustrated in the accompanying drawings, in which:

FIG. 1 is a partial diagrammatic or schematic view and showing a lining slab positioned against the wall of an ingot mould;

FIG. 2 is a perspective view of a sleeve and

FIG. 3 is a partial perspective view and illustrating a sleeve positioned against the wall of a head box and forming a seal between the head box and the mould.

The present invention is based on the discovery that, provided the lower edge of the lining slabs or sleeve is made to fit snugly against that portion of the wall of the head box which it is designed to contact, it is unnecessary to cause the rest of the lined head or sleeve so to conform since the ferrostatic pressure of the molten metal will, if the material of the slab or sleeve is deformable, cause the slab or sleeve so to deform that it takes up the shape at which it fits snugly against the inner wall.

This technique is of general application, making it possible also to start with any shape which does not conform to the inner surface to be lined and cause it so to conform, e.g. a sleeve of circular cross-section may be designed so that it fits snugly against the planar surface of a normal plane-sided mould.

According therefore to the present invention there is provided a method of lining a head box for an ingot mould which comprises locating within the mould or head box slabs or a sleeve of a deformable refractory composition, said slabs or sleeve having an outer contour which does not in its undeformed condition match the inner contour of the surface to be lined and securing the lower edges only of said slabs or sleeve to the outer surface of the head box in such a way as to deform the lower edges and to cause said lower edges to conform to the contour of this surface.

In using the mould so lined and constructed, molten metal e.g. steel, as it fills the space within the lining causes, by hydraulic (metalstatic) pressure, the lining slabs or sleeve to be deformed to fit snugly against the inner surface of the head box. In some instances it may be desirable partially to deform the slabs or sleeve by a forming device during the step of lining the mould or head box to ensure that complete wall contact is achieved.

In accordance with this invention, the slabs or sleeve used for lining the head box extend below the head box structure so as to constitute a seal between the head box and the ingot mould on which it is placed. Thus, the lining element extends about the inner and bottom surfaces of the head box, and the edge of the lining element terminates adjacent the outside surface of the head box. The edge of the lining element is then secured to the outer surface of the head box by applying force in such a way as to deform the edge to the outside surface. The head box is then assembled onto the ingot mould so that the lining element forms a seal between the head box and the ingot mould. The lining element, which is about the inner surface of the head box, is thus in a position to be deformed to the contour of the inner surface of the head box by the metalstatic pressure of the molten metal contacting the lining element.

Preferably, in order to give the required deformation, an expansible resilient metal band is located at the bottom edge of the lining material and is then sprung outwardly to deform the lining material against the walls of the head box.

The slabs or sleeves used in the practice of the present invention may be of refractory heat insulating material or may be of an exothermic composition which on ignition by molten metal burns to leave a refractory heat-insulating residue.

In either event, and the former is generally preferable, the slabs or sleeve must be deformable under pressure. Suitable heat insulating refractory slabs having the desired degree of deformability may be obtained from compositions which comprise, in addition to a refractory particulate material a substantial proportion of fibrous material.

Suitable particulate refractory materials are: sand, zircon, calcined dolomite, chamotte, alumina, magnesia and various silicates. The fibrous component is conveniently asbestos but where use of asbestos is undesirable for health reasons it is possible to replace the asbestos wholly or in part by synthetic refractory fibres such as glass wool, slag wool and aluminium silicate fibres. The fibres may also be of metal e.g. a ferrous metal wool. Organic fibrous materials may also be employed, e.g. of cotton or synthetic materials such as rayon, acrylonitrile fibre, nylon fibres, polyester fibres and other synthetic textile fibres. Additional deformability is also achieved by including a proportion of very short fibre material such as cellulose fibre e.g. paper pulp. Mixtures of any of the foregoing may be used.

A binder for aforesaid ingredients may be provided e.g. a synthetic resin such as a phenol-formaldehyde resin or sodium silicate or silica gel, but is generally not necessary.

The precise composition of the slabs or sleeves will be chosen with respect to the pressure likely to be de-
developed by the molten metal, compositions of high effective deformability being required if the developed pressure is not likely to be large, and vice versa. The compositions may in general contain the following ingredients in the proportions stated:

| Particulate refractory material | 2-50 parts by weight |
| Fibrous refractory material     | 0.5-40 parts by weight |
| Organic fibrous material        | 0-40 parts by weight |
| Binder material                 | 0-15 parts by weight |

The lower edges of the slabs or sleeves are conveniently caused to take up the contour of the inner surface by the provision of a metal strip itself of the desired contour that is pushed out during the fitting of the hot top into the mould or head box by some mechanical means, but does not have to be left in place during the pour.

The structure characteristic of the present invention is illustrated very diagrammatically in the accompanying drawing (FIG. 1) which shows a part only of the wall of an ingot mould having a corrugated inner surface. The part of the mould is shown at 1 and its corrugated inner surface at 2. A lining slab 3 has at its lower end a pre-contoured metal strip 4 which deforms the lower edge of the slab so that it conforms to the corrugations 2 of the mould wall, this strip either being left in position or removed before pouring commences. The remainder of the slab 3 stands free from the wall corrugations 2 but when molten metal is poured into the mould so that it is against the lining slab 3 the metallostatic pressure developed causes the whole slab to take up a corrugated shape and so conform to the surface corrugations 2.

Where the lining is for a head box and the lining slabs or sleeves extend around the bottom of the head box structure the lower edges thereof may be secured to the structure by deforming them to the outside of the head box structure by applying pressure by means of a contoured strip, the strip again either being left in position to provide a chill or removed so that only the excess insulating material is left to form the gasket or wiper strip between the mould body and the head box. One convenient method of providing the outward deforming force needed to deform the edge of the slabs or sleeve into contact with the mould or head box wall is a loop of stiff spring wire 20 as illustrated in FIG. 2. The wire is forced out against the sleeve 21 to deform it into contact with the mould or head box walls and then held in place by tying at 22. This method is particularly applicable to contoured but not corrugated moulds.

In FIG. 3, a lining element 30 is positioned against the inner surface 31 of a head box 32 and extends past the bottom surface of the head box 32. The bottom edge 33 of the lining element 30 terminates adjacent the outside surface 34 of the head box 32. The bottom edge 33 of the lining element is then secured to the outer surface of the head box by applying force in such a way as to deform the edge to the outside surface, as by a loop of stiff spring wire. The head box 32 is then assembled onto an ingot mould 35 so that the lining element 30 forms a seal between the head box 32 and the ingot mould 35, as shown generally at 36. The lining element 30, which is about the inner surface of the head box 32, is thus in a position to be deformed to the contour of the inner surface of the head box by the metallostatic pressure of the molten metal contacting the lining element.

We claim as our invention:

1. In the lining of a head box for an ingot mould wherein the head box has an inner contour surface to be lined and an outside surface joined by a bottom surface adapted to rest on the upper surface of the ingot mould and wherein molten metal contacts a lining element, the method which comprises locating within the head box at least one lining element selected from the class consisting of lining slabs and sleeves of a deformable refractory composition, the lining element extending about the inner and bottom surfaces of the head box and the edge of the lining element terminating adjacent the outside surface thereof, securing the edge of the lining element to the outer surface of the head box by applying force in such a way as to deform the edge to the outside surface, assembling the head box on the ingot mould so that the lining element forms a seal between the head box and the ingot mould, and charging molten metal into the assembled ingot mould and head box whereby the lining element about the inner surface of the head box is deformed to the contour of the inner surface by the metallostatic pressure of the molten metal contacting the lining element.