APPARATUS WITH SELF-CENTERING STOOL FOR CONTINUOUS CASTING OF METALS

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ABSTRACT
In a continuous casting apparatus in which stools are supported on a vertically movable table, a fluid (liquid or air) under pressure is supplied to the underside of the stools. The stools and table are so arranged that the fluid forms a thin continuous support film between the periphery of the stool and a flat surface of the table, so that the stool may be moved laterally on the table with minimum force while the supply of fluid is switched on. This permits the stools to be centered automatically when entering their associated moulds before the commencement of a casting cycle.

7 Claims, 2 Drawing Figures
Fig. 1.
FIG. 2.
The present invention relates to the continuous casting of ingots by the direct chill method. In the apparatus employed for continuous casting the bottom of the mould is closed by a stool or plug at the beginning of each casting operation to allow the mould to be filled with molten metal to a desired level. When this level is attained the table, on which the stool is supported, is lowered at a predetermined rate and coolant is applied to the surface of the growing ingot around the bottom margin of the mould, the metal level within the mould being maintained by pouring additional molten metal.

Where the moulds are small in cross section, it is usual to pour a substantial number of ingots at the same time.

It is found that the mechanical inaccuracies inherent in the casting apparatus make it very difficult to ensure that a stool, rigidly fixed to the support table, will be accurately aligned with a mould. Where a number of stools are supported on a single table for co-operation with a number of separate moulds the normal practice is to support the stools loosely on the table and to align each stool manually with the corresponding mould as the table is raised into position. This operation is performed by inserting a bar through the top of the mould and levering the stool into alignment with the mould. However, when the mould is equipped with a fragile "hot top" this no longer remains a practicable mode of operation, since the risk of damaging the "hot top" is excessive.

Various forms of self-centering stool have been tried, but usually the friction between the stool and the table has been too large to provide wholly satisfactory operation. It has also been proposed in U.S. Pat. No. 3,844,152 to provide a spring loaded stool which essentially seals against the bottom of the mould, but has a tapered portion to enter the mould so as to provide some self-centering action. However, since the mounting for the lower end of the compression spring is not truly aligned with the axis of the mould, such arrangement cannot result in a wholly satisfactory seal between the stool and the mould, since there will be some lateral force component between the stool and the mould.

There is thus always the risk of escape of molten metal at the beginning of the casting operation and/or entry of coolant water into the space above the stool.

The present invention is based on the appreciation that a stool freely mounted on the table could be operated satisfactorily in self-aligning manner if the friction between the stool and the table could be reduced and, in particular, be reduced during the period when the stool is being entered into the mould. During the rest of the casting operation it is, in fact, preferred that the stool should remain solidly supported by the table.

With this object in view the table of a continuous casting apparatus of the present type is provided with at least one stool having a limited degree of freedom of sliding movement laterally in relation to the table, the table being provided with means for delivering a fluid under pressure to the underside of the stool to provide a cushion of fluid between the table and the stool to permit the stool to be moved relative to the table by a very small lateral force. The upper end of the stool is preferably slightly rounded to allow the stool to enter the mould as the table is raised. Provided that pressurised fluid is being supplied, the desired lateral movement of the stool is very readily effected automatically as the stool enters the mould.

According to the present invention there is provided a continuous casting apparatus comprising a vertically movable table having a horizontal support surface adapted to support at least one ingot-receiving stool at a predetermined location on the upper surface thereof, said table having a flat surface at such location to permit lateral sliding movement of said stool, a stool located on said table at such location and having a substantially continuous peripheral surface for support by said table, said stool being arranged to have at least limited free movement in relation to said table both horizontally and vertically, means for supplying a fluid under pressure through said table to the underside of the stool at a location lying within said substantially continuous peripheral surface to establish a laterally escaping fluid layer between said table and said stool to lift said stool out of contact with the table, allowing lateral sliding movement of said stool without lifting in relation to said table.

The table is preferably formed so that its whole upper surface is flat. It is however only essential that there shall be at each stool position a flat area of sufficient extent to permit the essential lateral freedom of movement. The stool or stools may be solid or may be internally hollow. It is necessary for the bottom of the stool to have an essentially flat surface surrounding the fluid supply port means in the upper surface of the table so that an essentially uniform stream of fluid may escape laterally from beneath the stool when the fluid supply is switched on, thus maintaining the stool or stools out of direct contact with the table during the upward movement of the table to bring the stool or stools into closing relation with the mould or moulds. It will be readily apparent that when a stool has been brought into aligned relation with the corresponding mould, accidental lateral movement of the stool on the table during the lowering of the table in the course of the casting operation would be extremely undesirable and for that reason it is preferred to take positive measures, such as roughening the bottom of the stool, to prevent movement of the stool on the table when the pressure fluid supply is switched off. Whilst the fluid may be a liquid, such as water, it is most conveniently air under pressure.

As compared with the construction of the prior U.S. Pat. No. 3,844,152 the self-centering floating stool of the present invention may enter the mould to form a seal with the peripheral wall instead of sealing against the bottom end of the mould.

In a preferred arrangement the table of a continuous casting apparatus is provided with a plurality of stools at positions corresponding to the locations of a plurality of moulds, into which metal is poured simultaneously by pouring metal from a holding furnace into a common trough system, from which metal is fed through dip tubes to the individual moulds in a manner which is well-known in the art. The table itself is preferably a laminated construction, in which passageways are formed leading from a fluid inlet to the stool portion.

In the accompanying drawings:

FIG. 1 is a part section through a table equipped with the floating stool of the present invention, and

FIG. 2 is a diagrammatic plan view of the table.
Referring to FIG. 1, the stool 1 is provided with a retainer member 2, trapped within a fluid support port 3 in the table 4, so that the stool 1 has a limited freedom of movement both vertically and laterally in relation to the table 4 and can float in relation to the table on a cushion or film of air or water supplied under pressure through the port 3.

The stool 1 has a rounded corner 5 to assist entry of the stool into the mould 6. However, supplementary centering action may be provided by pegs 7 which contact a conical surface 8 at the bottom of the mould, as indicated in FIG. 1. Although four pegs 7 have been shown for convenience of illustration, three pegs are preferably provided at equiangular spacing around the periphery of the stool. With this arrangement, no contact at all will occur between the stool and the mould, thus eliminating all possibility of damage to the mould by the stool. The conical surface 8 and pegs 7 are an optional feature, but when employed it permits the radius of the rounded corner to be reduced to a low value.

In operation it is found necessary to switch on a supply of pressure air for only 10 - 15 seconds as the stool is entering the mould. This is sufficient to raise the stool by a few thousandths of an inch on a cushion of air. A pressure of 40 - 60 p.s.i. was found satisfactory to support stools of conventional weight. At the end of this short interval the stool was allowed to fall back onto the table 4. The bottom end of the stool is preferably toughened or knurled to increase friction between it and the table when in actual contact therewith.

The supply of air to the ports 3 may be achieved as illustrated diagrammatically in FIG. 2. Air may be fed through a flexible hose 10 and through an on-off valve 11 to a manifold 12, from which galleries 14 lead to the ports 3.

1. A continuous casting apparatus comprising a vertically movable table having a horizontal upper support surface, adapted to support at least one ingot-receiving stool at a predetermined location on said upper surface, said table upper surface being flat at such location to permit lateral sliding movement of said stool and having an opening at such location for upward flow of fluid therethrough, a stool disposed on said table upper surface at such location and having a flat bottom surface extending at least continuously around the periphery of said opening, said stool being arranged to have at least limited free movement in relation to said table both horizontally and vertically, and means for supplying a fluid under pressure through said table and said opening to the underside of the stool at a location lying within said substantially continuous periphery of said flat bottom surface to establish a laterally escaping fluid layer between said table and said stool to lift said stool out of contact with the table, allowing lateral sliding movement of said stool without tilting in relation to said table.

2. A continuous casting apparatus according to claim 1 in which the stool is shaped to enter the mould and seal with the side wall thereof, the stool being provided with laterally projecting formations to engage with a tapering ring arranged below and concentric with the mould.

3. A continuous casting apparatus according to claim 2, wherein said projecting formations comprise three pegs equiangularly spaced around the periphery of the stool.

4. A continuous casting apparatus according to claim 1, wherein said opening includes an enlarged portion provided within, and below the upper surface of said table; and further including a retainer member confined within said enlarged portion of said opening for restricted vertical and lateral movement, and a shaft disposed in coaxial relation to said stool and projecting downwards through said opening for firmly securing said retainer member to said stool.

5. A continuous casting apparatus according to claim 1, wherein said stool has a rounded upper peripheral edge for facilitating properly positioned entry of the stool into the lower end of a mould.

6. A continuous casting apparatus according to claim 1, wherein said stool has a roughened flat bottom surface for providing frictional resistance to lateral movement of said stool relative to said table when said stool bottom surface is resting on said table upper surface.

7. A continuous casting apparatus according to claim 1, wherein said table has a plurality of openings for upward flow of fluid disposed at spaced locations in the upper surface of said table, and further including a plurality of stools each identical to the first-mentioned stool and respectively disposed at said spaced locations to be lifted by fluid escaping through said openings; wherein a common fluid passage is provided in said table, communicating with all of said openings; and wherein said fluid-supplying means comprises means for supplying fluid to said common passage.