ABSTRACT: Pins on the mold table of a continuous casting machine are received in elements on the mold for aligning the mold on the table. The elements are laterally movable for adjusting the position in which the pins and cooperating elements align the mold when the mold is placed on the mold table. The position of the elements are preadjusted, before placing the mold on the table, by a template engaging a portion of the mold and having aligning members that line up with the elements if the elements are properly adjusted.
1. MOLD ALIGNING APPARATUS

The present invention relates to machines for the continuous casting of metal and specifically to apparatus for aligning molds in such machines.

In a usual method of continuous casting, molten metal is poured into the top of an open ended mold which chills and solidifies the periphery of the metal, and a strand of the partially solidified metal is drawn continuously from the bottom of the mold. The molten metal flows into the mold from a ladle or tundish that has suitable means for varying the flow to equal the withdrawal rate of the strand. As the strand emerges from the mold it enters a supporting passageway that is formed of suitable supporting elements, such as rollers, and that conducts the strand through a secondary cooling zone and then on to apparatus for cutting it into desired lengths, or otherwise processing it. This means is used for continuously casting metal in the form of rods, bars, and billets of various shaped and sizes, the cross-sectional configuration and dimensions being determined by the configuration and size of the mold.

In known constructions of continuous casting machines, the mold is supported on a mold table in operative alignment between the mold and the tundish which supplies molten metal to the mold, and the supporting passageway, which defines the exit path for the strand of metal issuing from the mold. The mold is preferably mounted so that it may be removed and replaced by a new mold or by a mold of a different size or configuration. A conventional means of mounting the mold is to suspend it through an opening in the table by flanges, or ears, projecting outward from the sides of the mold body and resting on the portions of the table around the opening. The flanges are normally clamped to the table to hold the mold in position by suitable means, such as bolts through oversize holes in the table, that permit the mold to be moved around on the table into correct operative alignment with the outlet of the tundish above and the supporting passageway below, before being clamped to the table.

In known machines, the mold is set on the table and must then be moved around on the table until it is in correct operative alignment. The machine is, of course, out of operation when one mold is being removed and replaced by another, and the time it takes to align the new mold on the table increases the downtime of the machine. This can be a significant factor in reducing the output of a casting machine when molds must be replaced at frequent intervals — for example, when producing a variety of different stock in a sequence of short production runs, each of which requires a mold of a different size or shape.

It is therefore an object of the present invention to provide means for aligning the mold on the mold table, and to provide means for predetermining the apparatus so that the mold is aligned in correct operative alignment before it is placed on the table, thereby eliminating excessive downtime of the machine required when alignment of the mold is adjusted after the mold is on the table.

The mold aligning apparatus in accordance with this invention comprises at least one pin on the mold table and an element that is supported on the mold and that has a hole therein in which the tube pin is received when the mold is placed on the table. The element is movable on the mold to alternative positions in a plane at right angles to the axis of the hole therein so that the lateral position of the hole may be located to set the mold in correct operative alignment when the mold is placed on the table with the pin in the hole. A template, having a feeler portion and an aligning portion joined in fixed relation by a web portion, is adapted to cooperate with the element and mold to predetermine a position relative to the mold, with the aligning portion axially in a line with the position the axis of the hole should occupy, if the element is in its correct aligning position. The template thus indicates if the element is in proper position, and locates the proper position to which the element must be moved if it is not.

Further objects, advantages and features of the invention will be apparent from the following detailed description of an exemplary embodiment, which is shown in, and described with reference to, the accompanying drawings, wherein:

FIG. 1 is a top plan view, partly broken away, showing a mold in place on the mold table of a continuous casting machine and illustrating the application of the aligning apparatus of this invention for positioning the mold on the table; FIG. 2 is a vertical sectional view on the line 2-2 of FIG. 1; and

FIG. 3 is a vertical sectional view similar to FIG. 2, but illustrating the mold apart from the table and showing the template element of the apparatus in position on the mold for predetermining the indexing element that is on the mold.

Referring to FIGS. 1 and 2 of the drawings, in a conventional continuous casting machine a mold 10, having an open ended mold cavity 11 vertically therethrough, is supported on a mold table 12 for molten metal from a supply in a tundish above the mold table to flow from the outlet of the tundish into the upper end of the mold cavity 11, and for a continuous strand of molten metal to issue from the lower end of the mold cavity into a supporting passageway below. For the mold to be in correct operative alignment, the center of the upper end of the mold cavity 11 should be substantially in line with the center of the flow of molten metal from the tundish outlet and the center of the flow of molten metal from the tundish outlet and the center of the lower end of the mold cavity should be substantially in line with the center of the supporting passageway below. In FIG. 2 of the drawings the center of a flow of metal from the tundish outlet is indicated by the arrow 13 and the center of a supporting passageway is indicated by the arrow 14.

The mold 10 is supported through an opening 15 in the table 12 by flanges 16 and 17 extending from opposite sides of the body of the mold and resting on top surfaces of the table adjacent the opening 15. The flanges 16 and 17 are suitably clamped on the table 12, to fix the mold in position, by bolts 18 that pass through the flanges and extend down through holes 19 in the table. As shown in the lower right corner of FIG. 1, the holes 19 are larger than the shanks 18a of the bolts 18 to permit the mold 10 to be moved around on the table sufficiently to be able to align the mold as described above. The lower ends of the bolts 18 extend below the table and are provided with suitable washers and nuts (not shown) to be tightened on the bolts for clamping the flanges 16 and 17 to the table when the mold is in the desired position. The apparatus of the present invention predetermining the mold 10 in correct operative alignment on the table 12 includes one or more guide pins 21 projecting upward from the table. As shown, a pair of guide pins 21 are spaced apart at one side of the table, and are adapted to be received in holes 22 in elements 23 on the mold when the mold is placed on the table and thereby align the mold in a fixed position on the table.

The elements 23 may be mounted on moveable mold in a plane at right angles to the axes of the holes 22 in the elements for adjusting the lateral positions of the holes relative to the mold. Suitable structure for this mounting, as best seen in FIG. 2, consists of two flanges 24 extending from a side of the mold in a plane at right angles to the vertical axis of the mold and supported by braces 25. Each flange has a ring 26 welded, or otherwise attached, thereon with an aperture 27 through the ring coinciding with an opening 28 through the flange. The openings 28 are of a smaller diameter than the apertures 27 and are approximately concentric to the elements 23 to provide a ledge 29 around each opening 28. The elements 23, which are suitably rings as shown, have outside diameters smaller than the inside diameters of the apertures 27 and rest in the apertures. The elements 23 are suitably moved to selected positions within the apertures by setscrews 30 threaded radially through the walls of the rings 26 to engage the outer walls of the elements 23 at points spaced around them.
When the mold 10 is placed on the table, it is set down so that the guide pins 21 are received through the openings 28 in the flanges 24 and up through the holes 22 of the elements 23. It will thus be seen, referring to FIG. 1, that the lateral positions of the elements 23 within the apertures 27 determine the position of the mold 10 on the table 12 and that the position of the mold 10 assumes on the table is varied by shifting the lateral positions of the elements 23. The differences between the inside and outside diameters, respectively, of the apertures 17 and elements 23 are made large enough to permit sufficient variation in the position assumed by the mold 10 on the table 12 to enable the center of the mold cavity 11 to be positioned in proper alignment with the center, indicated by arrow 13 in FIG. 2, of a flow of molten metal from a tundish above the mold and the center, indicated by arrow 14, of a supporting saggaway below.

A particular feature of the structure of this invention is that the positions of the elements 23 are adapted to be properly adjusted, before the mold 10 is placed on the table 12, so that the mold will be positioned in correct operative alignment when it is subsequently set down on the table. For this purpose, as shown in FIG. 3, the apparatus of the invention includes a template 32 adapted to cooperate with the above-described structure of the mold for predetermining the positions of the elements 23.

Referring to FIG. 3, the template 32 has a finger arm 33, a pair of aligning members 34 (one for each element 23 on the mold, only one of which is shown in the drawing) and a web portion 35 between the finger arm and aligning members to hold them in fixed relation. The finger arm 33 is adapted to embrace or engage points or surfaces on the mold that will cause the template 32 to be steadied in a predetermined position relative to the mold. For this purpose, the finger arm 33 is adapted to be received in the mold cavity 11 with the web portion 35 of the template resting across the top of the mold. The position of the finger arm 33 is fixed in one direction by having the width of the web portion 35 extend entirely across the width of the mold cavity. To fix its position in the direction at right angles to the first direction, side 36 of the arm matches the contour of the insert 37 of the mold cavity and the template is moved relative to the mold until the side 36 of the finger arm 33 engages and butts against the insert 37. When the finger arm 33 is thus seated in the mold cavity 11, the aligning members 34 are located over the positions the elements 23 should occupy for properly aligning the mold.

The aligning members 34 are each constituted by a short tube 38 having a bore 39 that has the same inside diameter as the bore 22 in the element 23. The tubes 38 are molded on the web 35 so that their axes are in axial alignment, respectively, with the axes of the holes 22 in elements 23, when the template is seated on the mold and when the elements 23 are each in the correct position of adjustment. If one or both elements 23 are not in the correct position, their holes 22 will not coincide with the bores 39. They may then be moved to their correct positions by turning the setscrews 30 to shift them until their holes 22 are in line with the bores 39. This latter alignment is suitably gauged by a pin 40, the diameter of which approximates the inside diameters of the bores 39 and holes 22, but is enough, smaller for the pin 40 to fit easily into the bores 39 and holes 22. If the hole 22 is not in correct alignment, the pin will not slip into the hole but a lower tapered end portion 41 of the pin will extend part way into the hole. To adjust the alignment of the hole 22, the pin 40 may be left in place; the setscrews 30 are then backed off to loosen the element 23 so that the tapered portion 41, wedging against the wall of the hole 22 under the weight of the pin, slides the element 23 laterally until the hole 22 is in line for the shaft of the pin to slip into it. The hole 22 is then held in its position and the shaft of the pin may be left through the hole 22 temporarily to hold the element 23 in place while the setscrew 30 are tightened against the periphery of the element. The same procedure is then applied to the other hole 22 through the other tube 38 (not shown).

With the above structure in accordance with the invention, molds of different sizes and configuration can be predeterminably so that any one of them may be substituted for a mold previously on the machine and the substitute will be positioned in correct operative alignment as it is set on the mold table, thereby saving the time heretofore required for aligning the mold after it has been placed on the table. One template 32 may be substituted for a variety of different molds, if each has some portions of its contour in the same position relative to the center of the mold cavity as the other so that the finger arm 33, engaging those contour portions, will locate the aligning members 34 in the same position relative to the center of the mold cavity of each mold. Otherwise, a different template 32, or a substitute finger arm 33, is provided for each different size or configuration.

The apparatus, shown in drawings and described above, is an exemplary embodiment of the invention and it will be understood that some modifications may be made in the structure and the arrangement of the elements of this apparatus without departing from the scope of the invention as defined by the following claims.

We claim:

1. Apparatus for predetermining and aligning a replaceable open-ended mold for locating it on a mold table of a continuous casting machine in operative alignment between a supply of molten metal and a predetermined exit path from the mold, comprising: a pin projecting from the mold table, an element having a bore aligned to receive said pin when the mold is placed on the mold table, said element being supported in an aperture in the mold, and means for moving said element to alternative positions in a plane at right angles to the axis of the hole therein, thereby to shift the lateral position of the mold for adjusting the position assumed by the mold when it is placed on the mold table with said pin in the hole.

2. The apparatus of claim 1 in which said element is a ring supported in the aperture having an axial hole therethrough, and in which said means for moving the ring to said alternative positions comprises a plurality of setscrews means supported through the walls of the aperture to engage the ring at points spaced radially therearound at right angles to the axis of said hole for shifting the lateral position of the hole by selectively withdrawing and advancing said setscrew means.

3. The apparatus of claim 1 in which said aperture is provided by a first ring having a circular hole therethrough and said element is a second ring having an outside diameter smaller than the inside diameter of the hole through the first ring.

4. The apparatus of claim 1 including at least a pair of pins spaced apart on the mold table, a pair of said elements adapted to cooperate with the pins for aligning the mold on the mold table, and means for adjusting the positions of said elements transversely relative to the axes of said holes therein.

5. The apparatus of claim 1 and in combination a template adapted to be temporarily mounted in a fixed relative position on the mold, when the mold is off the table, for predetermining the position of the second aligning means so that the mold will be in said operative alignment when the mold is placed on the mold table said template having a finger portion adapted to engage a contour of the mold and an aligning portion indicating the desired position of alignment of the second aligning means when the finger portion engages said mold contour, said aligning portion of the template comprising a web portion projecting over said element on the mold when the finger portion of the template engages said contour of the mold, and said web portion having a hole therethrough dimensioned and positioned to coincide with the hole in said element if the element is in position for positioning the mold in operative alignment on the support when the mold is placed on the mold table with said pin thereon received in said hole in the element.

6. The apparatus of claim 5 in which the hole through the web portion of the template is a bore arranged to be in axial alignment with the hole in said element when the element is in
the aforesaid indexing position, said bore thus being adapted to receive a pin therethrough to pass into said hole in the element, if the bore and hole are axially aligned, for gauging the alignment of said hole.