

May 21, 1968

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3,384,152

STARTING BLOCK ASSEMBLY FOR CONTINUOUS CASTING APPARATUS

Filed April 1, 1966

2 Sheets-Sheet 1

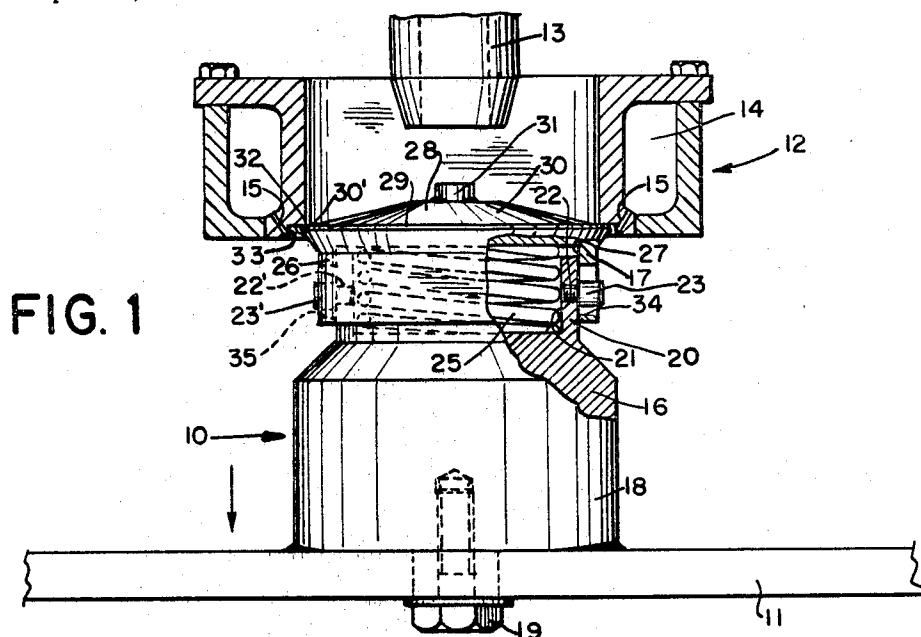


FIG. 1

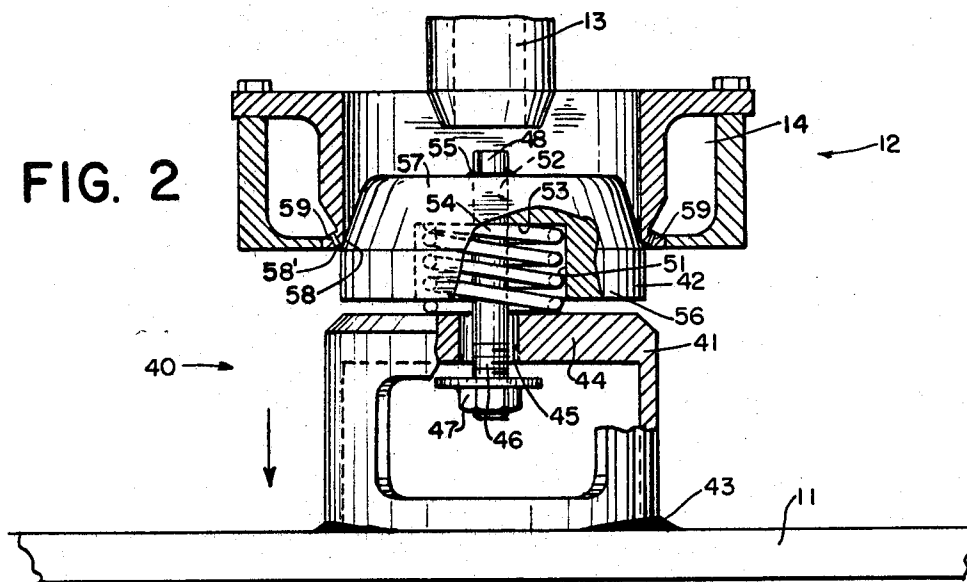


FIG. 2

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FIG. 3

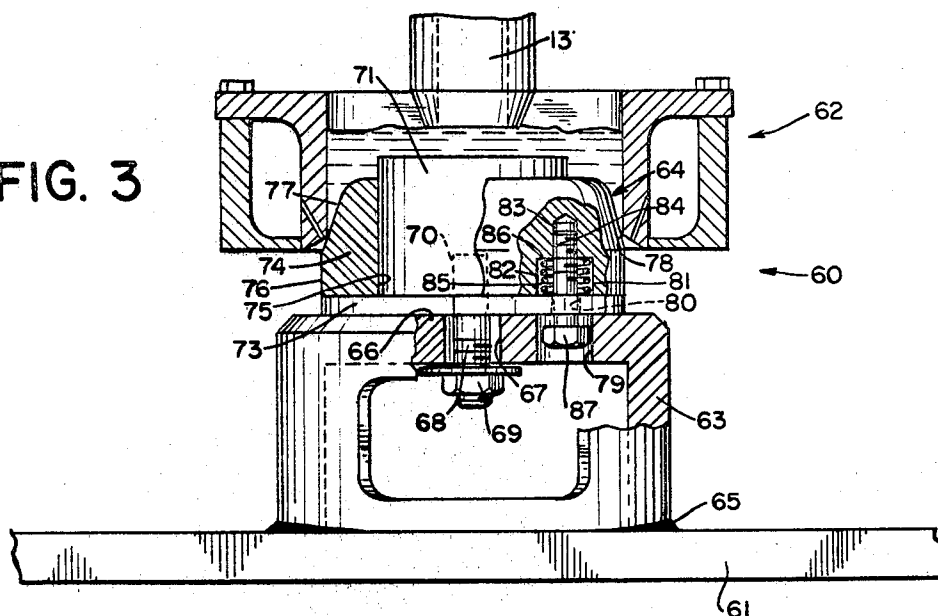
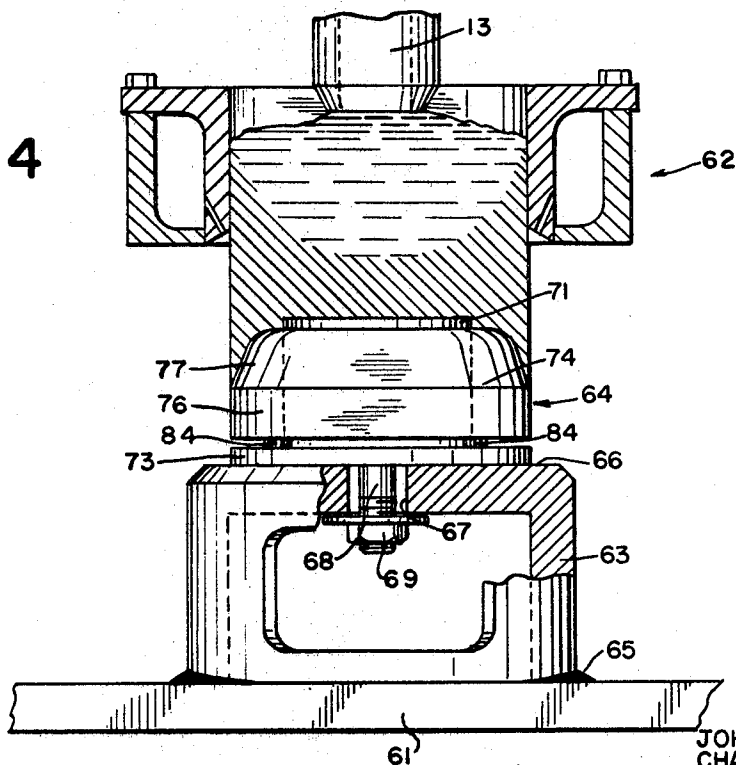


FIG. 4



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Filed Apr. 1, 1966, Ser. No. 539,412
8 Claims. (Cl. 164-274)

This invention relates to apparatus for the continuous casting of metals by the direct chill method and more particularly to a starting block device used for plugging the open end of a mold at the beginning of a continuous casting operation and for supporting an ingot as it is being cast.

In the continuous casting of metal bars or ingots of various sizes and shapes by the direct chill method, molten metal is poured into an open ended mold which is continuously cooled. The molten metal is thereby partially solidified in the mold to form a solid outer shell. This solid molded metal, preferably called an ingot, is withdrawn from the mold and further cooled by a water spray or similar means as it emerges from the outlet end of the mold. The molds, used in this continuous casting process, are generally open at both ends to receive the molten metal and discharge the cast ingot. They can be either mounted in a vertical or a horizontal position. In the case of a vertical mold, the ingots are lowered into a pit below the molding apparatus, and the length of the ingots is limited by the depth of the pit; where horizontal molds are used, the ingots are run out on a series of rollers and may be limited by cutting to a desired length.

Before starting the casting operation, a suitable device, preferably called a starting or bottom block, is used to seal one end of the mold in order that the mold be completely filled with molten metal. Thus solidification of the molten metal begins before it would pour completely through the mold. As molten metal is poured into the mold, it begins to cool and forms a junction with the starting block. The starting block is normally attached to a withdrawal apparatus which is then used to withdraw the solidified ingot from the mold.

Various types of starting blocks have been utilized in continuous casting processes, however, all have attendant disadvantages. Conventional starting blocks are rigidly attached to the withdrawal apparatus and must completely enter into the mold to seal it with respect to the mold in order to effect the starting operation. It is difficult to align and maintain alignment of this type starting block with the axis of the molds. This misalignment caused the starting block to scuff the mold wall upon withdrawal, resulting in a poorly cast ingot. Also, with this type of starting block, there is a possibility of the cooling water spray seeping between the starting block and mold wall forming further imperfections in the ingot.

Other continuous casting methods leave the final length of the casting within the mold to serve as a starting block for the next cast ingot. However, a good fit does not result due to the nonuniform cooling of the ingot. With this type of starting block, the additional step of cutting the cast ingot so as to leave a piece remaining within the mold is required.

It is also known to utilize devices called connection units that are molded integrally with the trailing end of the cast ingot. A portion of such a unit is then left in the mold to serve as the starting block for the next casting. This type of starting block requires a separate piece of equipment with the additional disadvantage of expense, storage and handling.

The present invention overcomes these disadvantages by providing a mold starting block that is permanently attached to the casting apparatus and is freely movable to

insure proper alignment with the mold and resiliently mounted to provide resilient axial pressure against the outlet end of the mold; it is an additional object of the invention to mount a part of the starting block in partial floating relationship to permit self-alignment of the starting block with the mold.

Broadly stated, the invention is in combination with continuous casting apparatus of the type having a mold open at both ends, means for introducing molten metal into one end of the mold, means for cooling the mold and withdrawal means for continuously withdrawing the cast metal from the outlet end of the mold. The improvement is in a base section of the starting block fixed to the withdrawing means and movable with the withdrawing means and an upper section which is mounted on the base section and is movable with the base section; axial pressure means are positioned between the base section and the upper section for holding the sections normally axially and resiliently spaced from each other. An enlarged seating portion is provided on the upper section by a portion which has a circumference greater than that of the mold opening and a mold outlet seating portion frames the outlet end of the mold and to receive the upper section seating portion in sealing contact.

In addition to mounting the upper section to the base section to provide means for exerting a resilient axial pressure of the starting block against the mold in its starting position, by mounting the upper section in a limited floating relationship with respect to the base section so that some lateral movement of the upper section is permitted, the starting block is essentially self-aligning in the mold.

Preferred embodiments of the invention are described below with reference to the drawings wherein:

FIGURE 1 is a front elevation, partly in section, of a first embodiment of a starting block assembly;

FIGURE 2 is a front elevation partly in section, of a second embodiment of a starting block assembly;

FIGURE 3 is a front elevation, partly in section, of a third embodiment of the starting block assembly; and

FIGURE 4 is a front elevation, partly in section, of the starting block assembly of FIGURE 3 in a different position.

Continuous type casting apparatus utilized with the present mold starting blocks is well known in the art. A mold starting block serves two purposes, as a plug in the open end of the mold during the starting operation, and as a support for the ingot as it is being cast, especially in the vertical method. In FIGURE 1, a mold starting block assembly 10 is shown rigidly affixed to a supporting member 11 which is a portion of a withdrawal apparatus that moves downwardly from a mold 12 during casting in the direction of the arrow shown in the drawing. Conventionally the supporting member 11 is a crosshead on which a plurality of starting blocks are mounted; the crosshead is mounted in guides and is generally activated by a hydraulic system.

The mold 12 is of generally conventional construction with a spout 13 positioned at the inlet end of the mold for feeding molten metal from a crucible and the starting block assembly is located at the outlet end of the mold at the beginning of the casting operation.

The mold 12 has a hollow wall construction which forms a water jacket 14 through which water or any other suitable coolant can be circulated for cooling of the mold. Small openings in the mold 12 at its outlet end are in communication with the water jacket 14 and form water spray nozzles 15 which are peripherally spaced about the outlet end of the mold and angularly positioned so as to direct a cooling spray of water inwardly onto the formed ingot as it is withdrawn from the mold.

The first starting block assembly 10 is positioned against

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the bottom of the mold 12 to close the lower end and to form a liquid tight seal. As the molten metal is poured into the mold it solidifies into a cast ingot. The mold starting block 10 is lowered by the withdrawal apparatus and the cast ingot is withdrawn. The process is continuous, with additional molten metal being added to the mold to supplement that withdrawn as a cast ingot.

The first starting block assembly 10 comprises a base section 16 and an upper section 17. The base section 16 has a generally cylindrical bottom portion 18, which seats on the supporting member 11 and is secured to it by means of a bolt 19, and a top portion of smaller diameter than the bottom portion defined by an upstanding cylindrical flange portion 20 which defines an axial bore 21 extending into the top end of the base section 16 and terminating substantially at the bottom portion 18. Formed in the flange at diametrically opposed portions are radial openings 22 and 22' and positioned within each slot are studs 23 and 23'. A spiral spring 25 seats within the bore and extends axially beyond the top end of the top portion.

The upper section 17 is comprised of a generally cylindrical collar portion 26 of greater inside diameter than the outside diameter of the upstanding flange portion 20 of the base section 16, which collar defines an axial bore 27 in the upper section, solid intermediate portion 28 to the upper section defines the bottom of the bore and flares outwardly to define an enlarged rim portion 29 which has a greater circumference than the mold outlet opening and is generally square-shaped to match the mold shape. From the rim portion 29, the upper section has surfaces which taper inwardly at an angle of about 15° with respect to a plane drawn perpendicular to the axis of the assembly to define a tapered end portion 30. A marginal portion of the tapered end portion 30' extends substantially perpendicular to the axis of the assembly. Extending axially from the center of the tapered end portion is a button 31; although a button is shown and preferred, a cavity at the same position would function nearly as well.

The mold 12 has a generally square-shaped opening but at the outlet end of the mold wall has an enlarged stepped outlet and defines a mold outlet shoulder seating surface 32 facing axially and substantially perpendicular to the plane of the axis by the increase in circumference and a generally square-shaped circumferential wall surface 33 by the increased size. The water spray nozzles 15 extend through the mold wall with their outlet end opening axially spaced from the outlet of the mold along a position outwardly beyond the wall surface 33.

The upper section 17 is mounted on the base section by placing the collar portion 26 over the flange portion 20 of the base section. Elongated closed slots 34 and 35 are provided in the collar portion at diametrically opposed portions to match the position of the radial openings 21 and 22. Once the base and upper sections are positioned as described, the studs 23 and 24 are inserted into openings 21 and 22 and the heads are positioned within the slots 34 and 35 to provide a locking mechanism for locking the upper section to the base section and to permit relative axial displacement limited by the length of the slots.

Because the spiral spring has an axial length greater than that of the upstanding flange portion 20, one end of the spring 25 seats in the bottom of the bore 21 in the base section and the other end of the spring abuts the intermediate portion 28 defining the bottom of the bore 27 in the upper section and provides a resilient axial support for the upper section.

In operation, the starting block assembly is brought into its starting position at the outlet end of the mold so that the rim portion 29 is positioned within the circumferential wall surface 33 and the marginal portion 30' of the tapered end portion 30 adjacent the rim abuts tightly against the mold outlet shoulder seating surface

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32 in surface-to-surface contact and is resiliently held under pressure axially against the shoulder surface by the action of the spring 25 in a liquid tight seal. The starting block does not fully enter the mold as do conventional starting blocks; instead, positive sealing and alignment are insured by the freedom of movement which the assembly permits of the upper section and the axial pressure of the spring. Thus, as the molten metal solidifies into a casting of the shape of the mold, it shrinks around the button to form a solid junction; the starting block assembly is then withdrawn without danger of the block scuffing the mold walls; further, because of the positioning of the nozzles 15, water is sprayed beneath the flared rim 29 and is thereby diverted away from the juncture between the upper section and the mold so as to prevent seepage of liquid into the mold.

A second embodiment of a starting block assembly 40 is shown in FIG. 2. The basic continuous casting apparatus is identical to that described above except for a different configuration in the mold seating surface adjacent its outlet end. Here the second starting block assembly 40 is comprised of a pedestal base section 41 and an upper section 42. The pedestal base section is of generally hollow cylindrical configuration and seats on the supporting member 11 and is held in position by a weld joint 43. The base section is substantially closed at its top end 44 with a bore 45 extending through the end 44 at its center. Extending axially through the bore 45 is an elongated bolt 46 which has a nut and washer 47 on the end of the bolt positioned within the base section to prevent displacement of the bolt through the bore.

Mounted on the opposite end 48 of the bolt is the upper section 42. A stepped diameter axial bore extends through the upper section with a larger diameter bore 51 opening into the bottom end and a smaller diameter bore 52 opening into the top end. An annular shoulder 53 is defined within the upper section by the differences in diameter. A spiral spring 54 seats on the top end 44 and surrounds the bolt 46 and abuts against the annular shoulder 53. The spiral spring 54 has a length greater than the axial length of the larger diameter bore 51 and thereby supports the upper section resiliently in the base section, and normally axially spaced from the base section in substantial floating relationship thereon as some lateral displacement of the upper section is permitted. The upper section is secured to the upstanding end of the bolt 46 by a weld joint 55.

The upper section has an outer configuration consisting of a generally square-shaped bottom portion 56 of greater diameter cross section than the cross section of the mold opening and a tapered upper seating portion 57. Since the mold usually has a generally square-shaped opening to form ingots with a substantially square cross section, the upper section matches the shape of the mold opening and thus there are essentially four planar tapered surfaces tapered at an angle of about 75° to a plane drawn perpendicular to the axis of the assembly.

At the outlet end of the mold, the mold walls flare outwardly from the outlet rim 58 at an angle to define flared surface 58' which frames the outlet end of the mold. Circumferentially spaced openings extend through the mold wall slightly outwardly beyond the flared seating surface to define nozzles 59 extending angularly inward toward the axis of the assembly to spray water in the direction of withdrawal of the casting.

In operation, the starting block assembly is brought into position at the outlet end of the mold and the tapered seating portion 57 enters the mold opening until a portion of the tapered portion makes contact with and seats against outlet rim 58. The spring 53 permits axial movement of the upper section relative to the base section and some limited lateral movement of the upper section is permitted because of the manner in which it is mounted it is essentially in

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floating relationship on the bolt; this freedom of movement allows self-alignment and the resiliency of the spring exerts an axial pressure to provide a liquid tight surface-to-surface sealing engagement between the upper section and the mold outlet rim 58 without contact of the starting block against the mold walls proper and danger of scuffing upon withdrawal. As in the first embodiment, the arrangement of the nozzles diverts the spray of water away from the position between the starting block assembly and mold outlet and this prevents seepage of liquid into the mold. The bolt extends beyond the end of the upper section so as to essentially define a button about which the molten metal can shrink to provide a rigid attachment to the starting block assembly and casting. Once metal solidifies about the button, the withdrawal apparatus is activated and the casting operation is initiated.

Referring now to FIGS. 3 and 4, a third embodiment of a mold starting block assembly 60 is shown rigidly affixed to a supporting member 61 which is a portion of conventional withdrawal apparatus that moves away from a mold 62 during casting. The mold 62 has the same construction as that of FIG. 2.

This third embodiment starting block assembly is comprised of a pedestal base section 63 and an upper section assembly 64. The pedestal base section 63 is of generally hollow cylindrical configuration and seats on the supporting member 61 and is held in position by a weld joint 65. The base section is substantially closed at its top end 66 with a bore 67 extending through the center of the top end. Extending axially through the bore 67 is an elongated bolt 68 which has a nut and washer 69 on the end of the bolt and is positioned within the base section to prevent displacement of the bolt through the bore.

Mounted on the opposite end 70 of the bolt 68 is the upper section assembly 64. The upper section assembly is comprised of a cylindrical center stub 71 into which bolt end 70 is fixed; the stub 71 has an integral flange base portion 73 of generally square shaped outer configuration and extends laterally outward beyond the stub 71. Slidably mounted on the stub 71 is a collar member 74 which has a cylindrical bore 75 extending axially therethrough of a diameter slightly greater than the outside diameter of the stub; it is comprised of a base portion 76 which has a generally square shaped outer configuration larger in cross sectional size than the size of the mold opening and tapered seating portion 77 which is defined by inward bevel from the base portion 76. As described with respect to the second embodiment, since the mold has a generally square shaped opening to form ingots with a substantially square cross section, usually with rounded corners, the upper section matches the shape of the mold opening and thus there are essentially four planar tapered surfaces tapered at an angle of about 75° to a plane drawn perpendicular to the axis of the assembly.

As mentioned above, the mold 62 has the same construction as described in the second embodiment and an outlet rim 78 is provided to contact the tapered portion in sealing engagement when positioned against the mold in its starting position.

In this embodiment, in addition to the center bore extending through the top 66 of the base 63, there are four additional openings 79 spaced 90° apart so as to underlie the collar member of the upper section assembly. Four openings 80 in matching position to openings 79 also extend through the flange base portion 72 and are aligned in assembly. Formed in the collar portion are four cylindrical bores 81 of stepped diameter. These collar bores have a first enlarged diameter section 82 and a second closed smaller threaded section 83. Bolts 84 are threaded into the smaller threaded section 83 and a spring 85 seats against a shoulder 86 defined by the reduction in diameter between the first and second sections at one end and seats against the flange portion 72 at the other end. A nut 87 is threaded on the opposite end of the bolt which is positioned in the base section. By these four spring mount

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assemblies (only one is shown but it is to be understood that four are provided) the collar member 74 is resiliently mounted relative to the center stub 71 and is slidable thereon under axial compression when the tapered seating portion 77 is brought into contact with the outlet rim in its starting position. By providing the four spring mount assemblies spaced 90° apart, the axial force will be evenly distributed to the four spring mounts and binding of the collar against the stub by misalignment will be prevented. It is also to be noted that the diameters of the center bore and four openings in the top 66 of the base section are larger than the diameter of the bolt 68 extending through the center bore and the nuts 87 positioned in the four openings so that the upper section assembly 64 is free to move within the limits of these oversize openings, thereby permitting alignment.

In operation, the starting block assembly is brought up so that the outlet rim 78 of the mold is in sealing engagement with the tapered portion 77 of the collar 74. Upon initially contacting the mold outlet rim 78 continued axial pressure forces the upper and base sections together with the collar sliding on the stub and compressing the spring mount assemblies. The molten metal is then fed into the mold and it solidifies about the exposed end of the stub. The starting block assembly is then progressively withdrawn as shown in FIG. 4.

We claim:

1. In continuous casting apparatus having a mold open at both ends, means for introducing molten metal into one end of the mold, means for cooling the mold, and withdrawal means for continuously withdrawing the cast metal from the outlet end of the mold, the improvement in combination therewith of a starting block assembly comprising:

- (a) a base section of the starting block fixed to the withdrawing means and movable therewith,
- (b) an upper section mounted on the base section and movable therewith,
- (c) axial pressure means positioned between the base section and the upper section for holding the sections normally axially and resiliently spaced from each other,
- (d) an enlarged seating portion of said upper section having a circumference greater than that of the mold opening, and
- (e) a mold outlet seating portion framing the outlet end of the mold for receiving the seating portion of the upper section in sealing contact.

2. In continuous casting apparatus according to claim 1 wherein the axial pressure means is a spring.

3. In continuous casting apparatus according to claim 1 wherein said axial pressure means is comprised of four spring mounts evenly spaced 90° apart.

4. In continuous casting apparatus according to claim 1 where said enlarged seating portion of said upper section and said mold outlet seating surface extend substantially perpendicular to the axis of the apparatus and are in opposed axial surface-to-surface positions and are pressured axially in sealing contact by said axial pressure means in its starting position.

5. In continuous casting apparatus according to claim 1 wherein said enlarged seating portion of said upper section tapers inwardly at an angle to a plane drawn perpendicular to the axis of the apparatus to a smaller size than the mold opening so that a portion of the upper section can enter the mold but is held spaced from the mold walls by the surface-to-surface contact between the seating portion and seating surface.

6. In continuous casting apparatus according to claim 5 wherein said enlarged seating portion is slidably mounted on a center stub member, and is mounted on said base section by four spring mounts evenly spaced 90° apart.

7. In continuous casting apparatus according to claim 1 wherein mounting means are provided between the upper section and the lower section for holding the upper sec-

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tion in substantially floating relationship on the base section to permit self-alignment of the upper section relative to the mold.

8. In continuous casting apparatus according to claim 1 the improvement comprising a plurality of circumferentially spaced coolant spray nozzles positioned about the mold outlet outwardly spaced from the mold outlet seating portion and directed inwardly toward the axis of the assembly in a direction away from the outlet end of the mold.

References Cited

UNITED STATES PATENTS

2,772,459 12/1956 Wieland ----- 164—89

5

10

3,262,161
3,274,653
3,324,934

8

7/1966 Andrzejak et al. ----- 164—274
9/1966 Foldessy et al. ----- 164—274
6/1967 Hess et al. ----- 164—274

FOREIGN PATENTS

1,310,964 10/1962 France.
704,512 4/1941 Germany.
1,061,039 7/1959 Germany.
722,140 1/1955 Great Britain.
873,973 8/1961 Great Britain.
998,796 7/1965 Great Britain.

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