July 18, 1967 G. C. EARL, JR 3,331,430

CONTINUOUS CASTING APPARATUS FOR CASTING HOLLOW BILLETS

Filed Sept. 10, 1964

FIG. 1

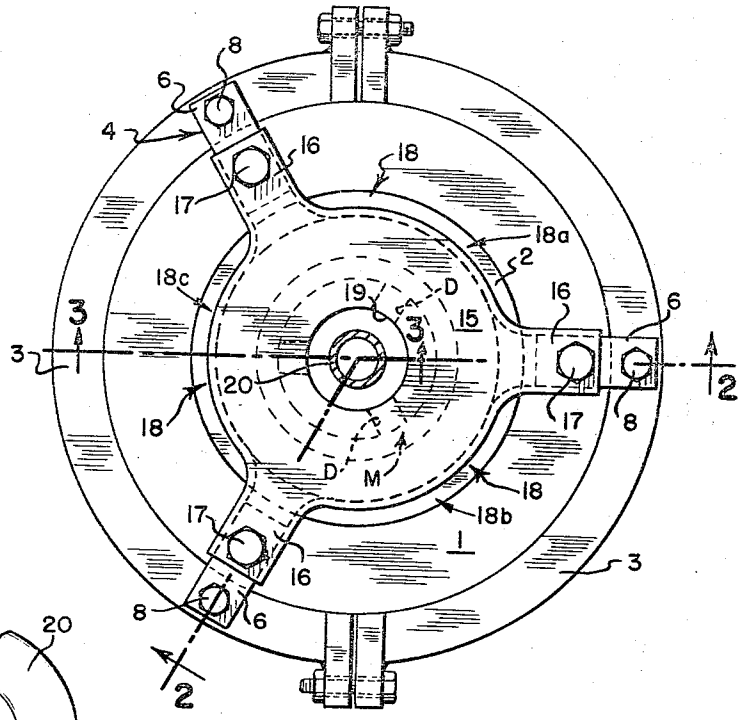


FIG. 2

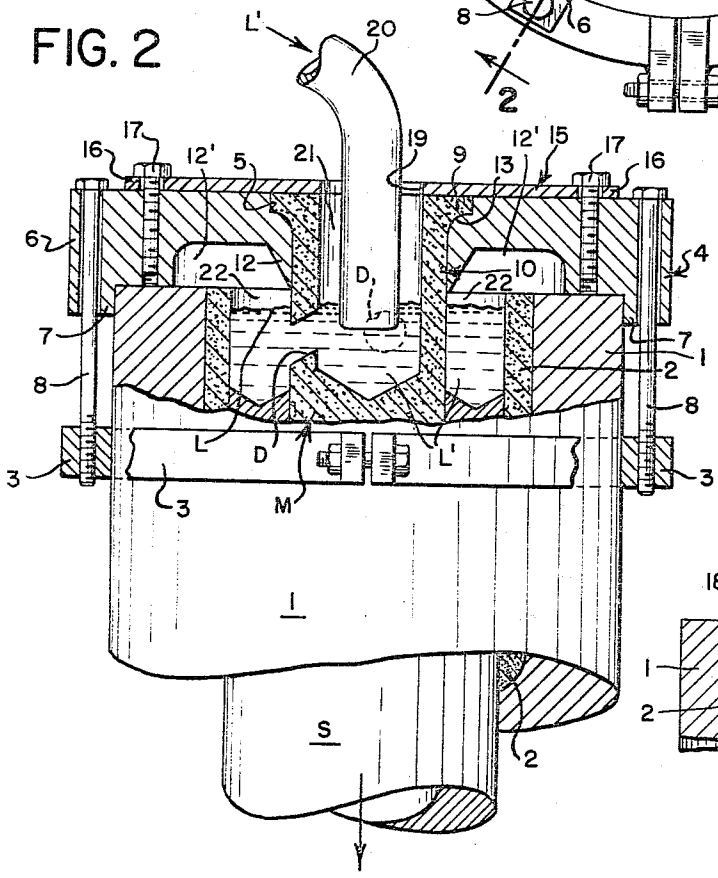
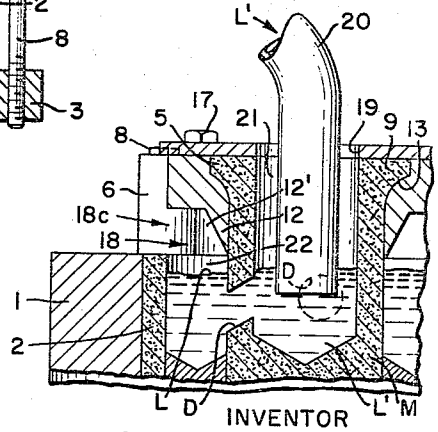


FIG. 3



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United States Patent Office 3,331,430 Patented July 18, 1967

3,331,430

CONTINUOUS CASTING APPARATUS FOR CASTING HOLLOW BILLETS

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Filed Sept. 10, 1964, Ser. No. 395,541
8 Claims. (Cl. 164—281)

This invention relates to apparatus for the continuous casting of metal such as copper, brass or aluminum, and has for its object the provision of an improved apparatus for supporting and protecting graphite mandrels used in graphite molds to cast hollow billets.

Apparatus for continuously casting hollow billets usually comprises a mold having an inner lining of graphite, a graphite mandrel suspended in the mold forming an annular upright space in which the metal is poured and solidified, means for lubricating the graphite surfaces and means for cooling and vibrating the mold and drawing the cooled billet out of the mold. The improved apparatus of the invention is used in a casting apparatus of this type.

The improved apparatus of the invention comprises means for supporting and holding a graphite mandrel in position inside a graphite mold. The graphite mold is secured inside a metal support and the improved apparatus for supporting the mandrel is removably attached to the mold support, and is constructed to secure and center the mandrel in the mold. The invention is advantageously applicable to mandrels having a head portion with a mounting flange and a hollow head open at the top into which a siphon tube is inserted for flowing metal into the mold. A preferred type of mandrel has a receptacle or cup in the head for receiving the molten metal and ducts through which the metal flows into the casting of the mold.

The apparatus includes a plate cover having an opening which permits the siphon to enter the hollow head. It is necessary that the mandrel head extend above the level of liquid maintained in the mold in order to confine the metal in the head so that it can flow into the mold. Also, the extended head serves to define the space between the mold and the mandrel so that a hollow billet can start forming where the metal is molten. This leaves a part of the mandrel head exposed to the atmosphere and since the mandrel is in contact with hot metal, for example at about 1000° C. for copper, the exposed mandrel portion is subject to oxidation and resulting deterioration. The mounting support of this invention has a depending tapered skirt which covers a major part of the otherwise exposed mandrel head and protects it from oxidation. The skirt preferably tapers to a thin edge to enlarge the space near the surface of the metal in the mold to permit the use of floating carbon or graphite beads to minimize oxidation of the mandrel head as will be described hereinafter. Additionally the tapered support permits the operator to view the level of metal in the mold and regulate the flow of metal accordingly.

The mandrel support member and associated means for securing the mandrel in the metal mold support are constructed to provide a small space for the operator to see the level of metal in the mold from nearly the entire circumference of the casting.

In the accompanying drawings

FIG. 1 is a plan view of the top of a continuous casting mold showing the mandrel mounting support,

FIG. 2 is a side elevation, with parts in section, taken at 2—2 of FIG. 1, and

FIG. 3 is a side elevation, with parts in section, taken at 3—3 of FIG. 1.

The apparatus of FIG. 1 comprises a metal mold support 1, circular in cross-section, a graphite mold or liner 2, a graphite mandrel M, coupling ring 3, preferably formed in two parts and bolted in snug contact with the mold support 1. The support 1 and the mold 2 are preferably provided with cooling means and the mold 2 with lubricating means (not shown). The mandrel support 4 has a central circular part in which the recess 5 is formed and three radially spaced legs 6 which rest on the mold support 1 and have depending flanges 7 through which bolts 8 connect the legs 6 to the ring 3. The flanges 7 center the mandrel support on the mold support 1. The annular recess 5 receives the annular flange 9 of the mandrel head 10 which is preferably circular in transverse or horizontal section. The mandrel support 4 has a depending shield 12 which covers part of the mandrel head extending above the liquid metal L to protect it from oxidation. The annular top flange 9 of the mandrel is fairly deep and is strengthened where it joins the rest of the mandrel by the fillet 13 which bears on a correspondingly curved part of the annular recess 5.

The cover plate 15 for securing the mandrel in place has a center opening and three radial legs 16 which are secured to legs 6 by bolts 17. The mandrel support 4 and cover plate 15 are proportioned to provide an almost annular space 18 surrounding the mandrel head, as shown in FIG. 1. As also shown in the particular construction of FIG. 1, almost annular space 18 is subdivided clock-wise into three segments 18*a*, 18*b* and 18*c*, extending partially under cover plate 15, the three segments being limited at their ends by spaced radial legs 16; thus providing passageways from space 12' above the molten metal level L to the open atmosphere for the ready escape of gases, if any should collect in the space 12'. This open space 18 (or space segments 18*a*, 18*b* and 18*c*) permits the operator to view the level of metal L from different positions.

The cover plate 15 has a central opening 19 through which the siphon tube 20 enters the mandrel. The mandrel has a cylindrical recess or cup 21 in the head for receiving molten metal which flows in through the siphon tube 20. Three radial ducts D connect the cup 21 with the annular space 22 between the mandrel and the mold liner 2 for the flow of molten metal into the space.

The siphon tube 20 delivers molten metal from a supply vessel (not shown) into the hollow cup 21, and the molten metal L' flows through ducts D into annular space 22, where it is cooled to form hollow solid billets. The rate of withdrawal of the resulting continuous hollow solid billet S is such as to maintain a level of liquid metal L appreciably above the bottom of cup 21 so as to submerge the lower end of the siphon tube in the liquid metal. The rate of pouring the metal into the cup is carefully controlled to maintain this level. The maintenance of this metal in the cup assures a smooth, non-turbulent flow of metal into the space between the mold 2 and the mandrel M.

The nearly annular space 18 around the mandrel support enables the operator to see the surface of metal L and adjust the flow to maintain this level in the cup 21 which is practically level with the metal in the mold 2. The skirt 12 approaches closely the level of the liquid metal and practically eliminates the exposed area of the mandrel head 10 to oxidizing gases which would react with the graphite at the temperatures used. To further minimize oxidation of the narrow area of exposed mandrel small beads of graphite may be floated on the metal around the mandrel to cover this space between the skirt and the metal.

The mandrel head is the subject of the copending patent application of William H. Ludwig, having a common assignee with the instant application, Ser. No. 398,844, filed Sept. 24, 1964.

The mandrel may have a hollow central lower portion in which either or both gas lubricant supply means and internal cooling means are employed which is the subject of the copending patent application of William A. Wood and Camille A. Zeldin, having a common assignee with the instant application, Ser. No. 396,687, filed Sept. 15, 1964.

I claim:

1. In apparatus for the continuous casting of hollow metal billets which includes an upright stationary outer annular graphite mold with an open ended bottom mounted snugly within an annular mold support, an inner annular upright hollow graphite mandrel extending into the annular mold from above to provide an interior annular space between the mandrel and the mold, the annular mandrel forming an upright hollow inner chamber open at its top and closed at its bottom for receiving and flowing therefrom a body of molten metal, a plurality of peripherally spaced ducts extending through the wall of the lower portion of the mandrel chamber and communicating with the upper portion of the annular space between the annular mandrel and the annular mold, and a feed pipe extending into the mandrel chamber, so that molten metal may flow continuously through the feed pipe downwardly into the mandrel chamber and thence through the ducts into the annular space between the annular mandrel and the annular mold where molten metal freezes to form a continuous progressively advancing hollow billet, the improvement in combination therewith which comprises:

(a) the inner annular upright hollow mandrel (M) is in the form of a removable peripheral sleeve having a mandrel head (10) fitting snugly in and supported exteriorly by an outer annular mandrel head support (4).

(b) the outer mandrel head support (4) is securable to and detachably removable from the annular mold support (1);

(c) the outer annular mandrel head support (4) is provided with an annular depending shield portion (12) into which the annular mandrel (M) fits snugly to protect a part of the annular mandrel (M) above the operating level (L) of casting molten metal (L') in the mandrel chamber (21) and the annular space (22) between the annular mold (2) and the annular mandrel (M); and

(d) the inner annular mandrel (M) and the outer annular mold (2) are uniformly spaced from each other to provide an annular space (22) of predetermined cross-section to produce a continuous hollow billet (S) having a solid wall of uniform predetermined thickness.

2. Apparatus according to claim 1, in which a removable cover and holding plate (15) with a central opening (19) for the feed pipe (20) rests on the top of the inner annular mandrel (M) for holding it in place; and the plate (15) extends over and is securable to the top of the outer annular mandrel head support (4).

3. Apparatus according to claim 1, in which a removable cover and holding plate (15) with a central opening (19) for the feed pipe (20) rests on the top of the inner annular mandrel (M) for holding it in place; and the plate is provided with a plurality of spaced radial legs (16) extending over and securable to the top of the outer annular mandrel head support (4).

4. Apparatus according to claim 1, in which a removable cover and holding plate (15) with a central opening (19) for the feed pipe (20) rests on the top of the inner annular mandrel (M) for holding it in place; the plate (15) is provided with a plurality of radial legs (16) extending over and securable to the top of the outer annular mandrel head support (4); and the annular mandrel head support (4) is provided with at least one annular depending flange (7) to center the annular mandrel head support (4) on the annular mold support (1).

5. Apparatus according to claim 1, in which the inner annular dependent shield portion (12) of the annular mandrel head (10) extends downwardly an appropriate distance to provide an upper open space (12') above the normal molten metal level (L) in the annular space (22) between the annular mandrel (M) and the annular mold (1) in which the level (L) of the molten metal level may freely rise and fall.

6. Apparatus according to claim 1, in which a removable cover and holding plate (15) provided with a central opening (19) for the feed pipe (20) rests on the top of the inner annular mandrel (M) for holding it in place; the plate (15) extends over and is securable to the top of the outer annular mandrel head support (4); and the removable cover and holding plate (15) is shaped to provide an almost annular open space (18) extending outwardly from but surrounding the annular mandrel (M) and extending under the mandrel head support (4) to the open space (12') below to provide an opening through which an operator can view from different positions the level of molten metal (L) in the annular space (22) between the annular mandrel (M) and the annular mold (1) and through which gases may escape to the open atmosphere.

7. Apparatus according to claim 1, in which the top portion of the annular mandrel (M) is in the form of an outwardly extending annular flange (9) provided with an annular under-recess portion (5); the outer mandrel head support (4) is provided with an annular fillet portion (13); and the recess portion (5) of the flange (9) and the fillet portion (13) of the mandrel head support (4) fit snugly into and against one another.

8. Apparatus according to claim 6, in which the almost annular space (18) is subdivided into a plurality of segments (18*a*), (18*b*), (18*c*), extending partially under cover plate (15) to the annular space (12') in the mandrel head support for and the annular space (22) above the molten metal level (L), the segments being limited at their ends by the spaced radial legs (16).

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