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(54) Method and apparatus for casting metal wires, bars and tubes in an upwardly direction

(57) The invention relates to a method and apparatus for casting particularly non-ferrous wires, bars and tubes continuously upwards, but the casting is not carried out vertically but in an inclined position. After the primary cooler, the cooling of the cast product takes place as direct water cooling.

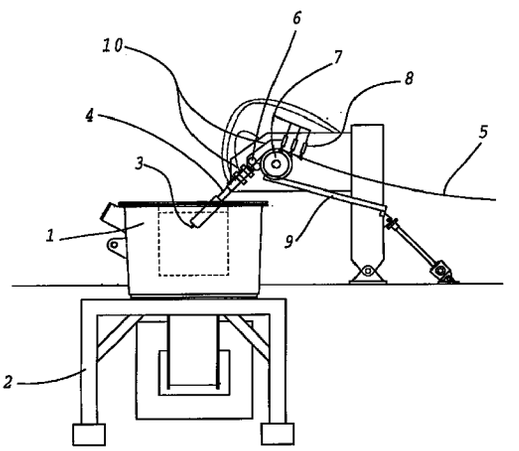

Fig. 1

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Description

The present invention relates to a method and apparatus whereby particularly non-ferrous metal wires, bars and tubes are cast continuously in an upwardly orientation, but the casting is not carried out directly vertically, but in a somewhat inclined direction upwards. After a primary cooler, the cooling of the product takes place as direct water cooling.

The conventional vertical casting method is a method where the wire, bar or tube is cast vertically upwards, and the equipment consists of a primary cooler connected to the casting nozzle as well as of a secondary cooler. When casting for instance a wire with a diameter of 8 mm, which is the most common diameter in cast copper wires, the total length of the coolers is roughly of the order of 2 m. The crystallization and primary cooling of the metal takes place in the primary cooler, particularly in the nozzle part thereof, the length of which is about 1 - 5 % of the total length of the cooler. The secondary cooling takes place in the top part of the primary cooler and in a separate secondary cooler, which again constitutes about half of the total length of the cooler. The top part of the primary cooler and the secondary cooler comprise an outer shell, a cooling water distribution pipe and an inner pipe. The cooling water is outside the inner pipe and the wire to be cast is inside. In between the inner pipe and the wire to be cast, there must be arranged a clearing in order to allow the billet to move without obstacle. Heat transfer takes place over the gap between the wire to be cast and the inner pipe.

In the conventional vertical casting process, the relatively high costs of the production line are a remarkable factor, particularly when talking about a limited production, because the structures must be provided in the same fashion as in production lines with a larger production. The costs of the production line could be lowered by increasing the casting rate, in which case the number of coilers and coolers would be reduced. However, the inefficiency of the secondary cooling forms an obstacle for increasing the casting rate. When the billet is too hot when coming out of the cooler, it is oxidized on the surface and blackened, whereafter it is not accepted for further refining. The maximum casting rate for instance for an unoxidized cast wire with a diameter of 8 mm is about 5m/min when the cooler is clean, the cooling water is sufficiently cold and the melt quality acceptable. Among the obstacles for improving secondary cooling let us point out that the inner pipe cannot be made too tight, because the billet must be able to move freely, and on the other hand it is not profitable to make the coolers much longer owing to the fairly small diameter of the cast wire. A long and thin wire easily looses the impact form made by the casting machine, which has a significant effect to the wire quality.

The method and apparatus of the present invention is developed particularly for small-capacity needs. In this method the product to be cast - wire, bar or tube - is cast, instead of the conventional vertically upward casting method, upwardly in an inclined position, at an angle of 20 - 85°, advantageously 30 - 60° in relation to the vertical axis of the furnace, and there is provided only one cooler per wire, while the secondary cooling is carried out directly on the piece to be cast. The invention also relates to the respective apparatus. The essential novel features of the invention are apparent from the appended claims.

According to the method of the present invention, the casting nozzle and the cooler are immersed in the melt in an inclined position, so that water sprayed on the cast product and meant for secondary cooling can be poured on the hot, cast product outside the walls of the casting furnace. Moreover, the wire coming out of the cooler need not be much bent to the direction of the coiler.

Thus the apparatus according to the invention employs a short cooler, which in practice means that the cooler only comprises a primary cooler used in conventional vertical casting. The purpose of the short cooler is only to cool the smelting heat off the cast metal and to perform a slight primary cooling in order to obtain solidity in the cast product. On top of the hot cast product emerging from the cooler, there is sprayed water in order to achieve secondary cooling and to drop the product temperature sufficiently low, so that oxidation does not take place anymore. In the upper part of the primary cooler, in the orifice thereof, there is prior to the secondary cooling conducted some suitable protecting gas, such as for instance nitrogen, in order to prevent oxidation.

The apparatus according to the invention is further described with reference to the appended drawing 1, which in cross-section illustrates the operation principles of the apparatus.

The casting apparatus according to figure 1 first of all contains a smelting and casting furnace 1, as well as its support structures 2. The primary cooler 4 and the casting nozzle 3 partly inserted therein are immersed in an inclined position, in the case of the drawing at an angle of about 45°, to the melt contained in the furnace. The melt is solidified inside the casting nozzle, so that the formed wire or bar 5 can be pulled, by means of transmission drums 6, over the bending drum 7. The secondary cooling part of the cast product comprises water jets 8 and a chute 9 placed underneath the cast product and the bending drum in order to recover the water sprayed from the jets. It is also seen in the drawing that along the distance in between the upper orifice 10 of the primary cooler and the secondary cooling part, there is conducted a protective gas screen in order to prevent oxidation. The inclined position of the nozzle enables the use of direct water jets outside the walls of the casting furnace.

As is seen in the drawing, the now developed structure is simple and low, wherefore the process is easily

controlled. When there is employed, according to the invention, only one cooler surrounding the cast product, the height of the cooler structure remains only about at a fourth part of the height of a conventional cooler. Moreover, direct water cooling is very efficient, and as a consequence casting speed can be increased higher than in conventional methods without oxidizing the cast product. This in turn results in that the number of the coolers and coilers can be reduced and expenses cut.

In the primary cooler of the now developed apparatus, only about 60 % of the heat amount of the cast product is recovered, which means that the quantity of the required cold water is reduced by about 40 %. The final cooling is carried out by the spray water through direct jets, and it is not subjected to similar high purity and temperature requirements as the water in the primary cooler.

Particularly in small-production casting machines, each cast product has a specific running motor, in which case there are no obstacles for individual starting of each cast product by reducing speed. On the other hand, because every cast product has its own running motor, the size of the motor can be chosen to be very small in order to lower expenses. When the material to be smelted is fed into the casting furnace in an even fashion and the immersion depth of the nozzle is sufficient, a separate height adjusting system that causes expenses can also be left out of the casting machine.

Claims

1. A method for casting non-ferrous metal wires, bars and tubes in an upwardly direction, **characterized** in that the casting takes place upwardly at an angle of 20 - 85° with respect to the vertical axis of the furnace.

2. The method of claim 1, **characterized** in that the cooling of a cast product is carried out, apart from a primary cooling taking place inside the casting nozzle, also as secondary cooling with water jets directly on the cast product.

3. The method of claim 1, **characterized** in that the casting takes place upwardly at an angle of 30 - 60°.

4. The method of claim 1, **characterized** in that the product cast in the area between the primary cooling zone and the secondary cooling zone is surrounded by protective gas.

5. An apparatus for casting non-ferrous wires, bars or tubes (5) in an upwardly direction, said apparatus comprising a smelting and casting furnace (1) and a primary cooler (4) directed upwardly therefrom, as well as a casting nozzle (3) arranged partly inside the primary cooler, **characterized** in that the primary cooler (4) and the casting nozzle (3) arranged partly therein are placed upwards from the furnace at an angle of 20 - 85° with respect to the vertical axis of the furnace.

6. The apparatus according to claim 5, **characterized** in that the primary cooler (4) and the casting nozzle (3) partly located therein are placed upwards from the furnace at an angle of 30 - 60°.

7. The apparatus according to claim 5, **characterized** in that in the proceeding direction of the product to be cast, there is arranged, in succession to the primary cooler (4), a secondary cooling part, which comprises direct water jets (8) as well as a chute (10) for recovering the water.

8. The apparatus according to claim 7, **characterized** in that the secondary cooling part is located outside the walls of the casting furnace (1).

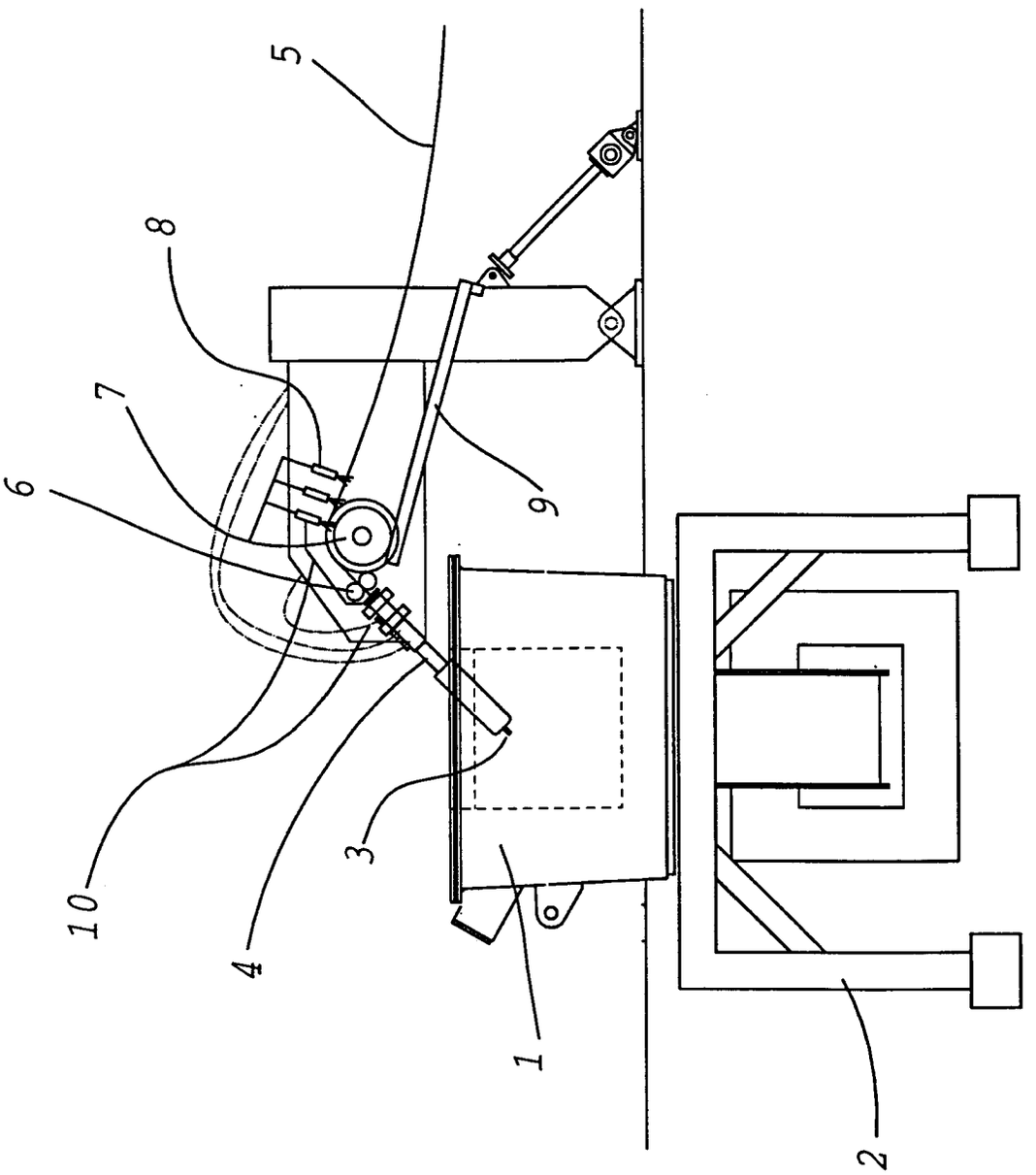

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 98 10 7552

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 008, no. 028 (M-274), 7 February 1984 & JP 58 187243 A (ATSUMI OONO), 1 November 1983 * abstract *	1,3	B22D11/14 B22D11/00
Y		2,6-8	
X	FR 2 367 560 A (MICHELIN & CIE) 12 May 1978 * figures 1,2 *	1,3	
X	PATENT ABSTRACTS OF JAPAN vol. 009, no. 098 (M-375), 27 April 1985 & JP 59 223144 A (SUMITOMO KINZOKU KOGYO KK), 14 December 1984 * abstract *	1,3,5	
Y		2,6-8	
A	EP 0 481 380 A (OUTOKUMPU CASTFORM OY) 22 April 1992 * abstract; figure 2 *	5	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	FR 1 489 021 A (SOCIÉTÉ MÉTALLURGIE D'IMPHY) 3 November 1967 * the whole document *	1-8	B22D
A	EP 0 165 456 A (ROSSI IRVING) 27 December 1985 * abstract; figure 1 *	1-8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 July 1998	Mailliard, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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