PROCESS FOR CONTINUOUS CASTING

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Inventor:
H. Ruppik

By: Slasche, Downing, Subolcy, Alays.
The production of articles from metal is effected according to the methods known up to the present either by pouring the metal into a mold corresponding to the shape of the article, or the article is produced by shaping of the material in solid state by hot or cold treatment.

The invention relates preferably to the production by casting of rod-, band- or tube-shaped elements or of elements having a special cross-section in such a manner, that it is no longer necessary to use for every casting proceeding casting molds which have to be especially prepared and that also the expensive shapings by heat or cold are no longer necessary. For the solution of this problem the novelty consists therein that the molten material is directly conducted, for example by pouring, into a cooling medium so that a part or complete solidification of the material takes place directly after it has come into contact with the cooling medium; the speed at which the molten material enters into the cooling medium is regulated according to the relation of the profile to the cross-section of the workpiece to be produced and to the cooling speed of the molten material when the same enters into the cooling medium.

During the production of a rod-, band-, or tube-shaped workpiece or of workpieces of any desired section for instance from steel, according to the invention the material is molten, brought into a ladle and then conducted from the ladle directly into a bath of lead or of similar cooling medium. The spout, through which the steel flows into the cooling medium is equipped with a nozzle or the like corresponding in shape to the section of the workpiece to be produced, said spout projecting into the cooling medium.

The cooling medium possesses a higher specific gravity than the molten material. Consequently the workpiece is submitted to pressure from the outer side allround, wherefrom results that, the core being still liquid, bursting of the outer layer of the workpiece which has solidified or the production of fissures is avoided. A certain composition of the workpiece in its final state and a protection for the surface of the workpiece are attained by using a cooling medium which neither alloys with the molten material nor undergoes a chemical combination.

For securing a continuous casting it will be necessary in certain instances to expose the molten material in the ladle, besides not only to hydrostatic pressure but also to an additional pressure. This additional pressure can be obtained by means of a piston in the ladle or by the employment of a pneumatic or hydraulic pressure.

The regulating of the additional pressure can further be effected by corresponding subsequent pouring of molten material into the ladle so that by the height to which the ladle is filled with molten material, the pressure actually required on the nozzle is obtained.

Tensions in the workpiece may be avoided or equalized by regulating the temperature of the cooling bath by suitable means.

A further regulation of the temperature can be effected by maintaining the cooling bath at such temperatures that during the travel of the workpiece through the cooling bath a refining proceeding of the material is effected at the same time.

The nozzle in the cooling bath is preferably arranged so that its outlet aperture is directed towards the surface of the cooling bath so that to the workpiece, owing to its lighter specific gravity, a buoyancy is given so that it rises through the cooling bath.

The above mentioned method can be applied also for the production of string casting and in this instance an improvement relative to the known methods consists therein that the molten steel is solidified on the surface in a mold or the like and conducted into a lead bath as the molten material comes out of the mold. Instead of the mold a thin-walled container made from sheet metal or the like may be used, this container during the continuous filling with molten material sinking deeper into the lead bath so that the level of the molten material is at approximately the same height as the level of the lead bath.

Several embodiments of the invention are diagrammatically illustrated in the accompanying drawing, in which

Fig. 1 illustrates the continuous casting of steel in a lead bath, whereas

Fig. 2 shows a part section of Fig. 1 on larger scale.

Fig. 3 is a vertical section through a modified ladle which can be substituted for that shown in Figs. 1 and 2 and used to supply additional pressure on the molten steel introduced into the lead bath.

Fig. 4 illustrates the casting of the molten
steel into a mold constructed as a floating body, whereas

Fig. 5 illustrates the casting of the molten steel in a thin-walled container of sheet metal.

As shown in Figs. 1 and 2 the molten steel 1 is poured into a ladle 2 and thence conducted through a nozzle 3 into a lead bath 4. As soon as the liquid steel comes into contact with the nozzle wall which is cooled by the lead, a thin layer on the surface of the steel solidifies. Corresponding to the increasing shrinking of the solidified steel the nozzle 3 is tapered towards its discharge aperture. The steel which at the beginning of the casting comes out of the middle of the nozzle-mouth in liquid state solidifies as soon as it comes into contact with the lead. Bursting of the solid steel layer, which is still thin after the molten material has come out of the nozzle 3, by the pressure of the following liquid molten steel is prevented by the counter pressure of the liquid lead. The steel which has already solidified is designated in the drawing by 1a and it comes out of the lead bath 4 in the form of a rod-, band-, or tube-shaped workpiece or as a workpiece of any other desired section according to the cross-section of the mouth of the nozzle 3.

Fig. 3 shows a modified ladle which can be used when it is desired to increase pressure on the molten steel introduced into the lead bath above that produced by its hydrostatic head. The ladle is provided with a piston 10 and a cover 11, the space between the piston and the cover being supplied with compressed air or the like through the pipe 12. The ladle is provided with a filling funnel 13, the stem 14 of which slides in the cover 11. The funnel serves to conduct the molten steel into the ladle.

In the ladle shown in Fig. 4 the molten steel is poured into the mold 5 which is cooled in known manner by any suitable cooling medium. At the beginning of the pouring, the mold 5 is closed at the lower end by a piston 6 shiftable in vertical direction. The mold 5 projects into a lead bath 7. When the mold 5 has been filled, the piston is moved downwards in the lead bath 7. Owing to the high specific gravity of the lead, the forming steel string is kept under pressure on all sides, so that bursting of the string by the pressure of the steel which is still liquid in the interior of the string, and also the formation of fissures in the material after this has come out of the mold 5 are avoided. In a simple manner strings can thus be cast of a length and thickness which up to the present could never be attained.

The casting device consisting substantially of the mold 5 is preferably constructed as a floating body.

During the casting the level of the lead bath 7 rises in accordance with the quantity of lead displaced by the string casting. As the mold 5 is constructed as a floating body, it moves with the rising level of the lead bath so that it is not necessary to lead off the quantity of lead which is displaced by the string casting.

According to Fig. 5 the molten steel is poured into a thin-walled container 8 of sheet metal and this container is dipped into the lead bath 7.

This sheet metal container 8 can be substituted for the mold 5. The container 8 is subdivided into several parts for assisting the continuous casting, said parts being adapted to be placed one over the other. During the filling the container 8 continually sinks deeper into the lead bath 7 so that the level of the molten steel is approximately at the same height as the level of the lead bath. The thickness of the sheet metal plates from which the container 8 is made is such that the sheet metal plate can yield under the pressure of the liquid lead and is permanently pressed tightly against the steel.

I claim:

1. In the continuous casting of steel, the process which comprises passing molten steel through a forming means into intimate heat conductivity relationship with a substantially quiescent, compact bath of molten lead, the lead being at a temperature sufficiently lower than that of the steel to produce at least partial solidification of the steel while it is in contact with said forming means, said forming means being at least partly submerged in said lead bath, and withdrawing the solidified steel from the point at which said solidification takes place at a rate substantially equal to the rate at which the molten steel is introduced into said forming means, thereby continuously producing an elongated casting of steel having the shape produced by said forming means.

2. In the continuous casting of steel, the process which comprises passing molten steel through a forming means into contact with a substantially quiescent, compact bath of molten lead, the lead being at a temperature sufficiently lower than that of the steel to produce at least partial solidification of the steel while it is within said forming means, said forming means being at least partly submerged in said lead bath, and withdrawing the solidified steel from the forming means at a rate substantially equal to the rate at which it is supplied to said forming means, thereby continuously producing an elongated casting of steel having the shape produced by said forming means.

3. Process of continuously pouring steel castings comprising introducing a stream of molten steel directly into contact with and beneath the surface of a liquid lead bath so that at least a partial solidification of the steel begins immediately after its entrance into the lead bath below the surface of the lead.

4. A method as specified in claim 1 in which the forming means is a nozzle submerged in the lead bath and directed upwards towards the level of the lead bath so that the workpiece owing to its lighter specific gravity rises to the top through the lead bath.

5. A method as specified in claim 1, in which for the production of string casting the molten steel is solidified in said forming means before being conducted into said lead bath.

6. A method as specified in claim 1 in which the height of the forming means is maintained at approximately the same height as the level of the lead bath.

HERBERT RUPP.