A melt charging system for the horizontal strip casting of a molten metal with a run-out element, in particular with a nozzle (9), is characterized in that at least one heating device (21, 22, 28) is arranged in the region of the run-out element for heating up the run-out element.
MELT CHARGING SYSTEM FOR STRIP CASTING

[0001] The invention relates to a melt charging system for the horizontal strip casting of a molten metal with a run-out element, in particular with a casting nozzle for the free overflow of the molten metal, referred to as “nozzle” further below.

[0002] The horizontal strip casting of metals, also referred to as Direct Stripp Casting and BCT (Bond Casting Technology), is used, for example, in the case of steel, for example, with a near-final-dimension casting in combination with an offline or an inline rolling. The forming or rolling step here has the purpose of both reducing the thickness and also of restructuring, i.e., recrystallizing. It is a method intended for the production of a wide hot rolled strip for steel alloys.

[0003] In strip casting, liquid steel is charged through a feed system with an appropriately designed nozzle onto a circulating conveyor belt cooled with water from below. The melt addition in the horizontal strip casting occurs via the melt charging vessel or charging system. Here, the melt flows through a filling region and subsequently a run-out region, before it reaches the conveyor belt through a ceramic component, for example, a nozzle with free overflow. The conveyor belt is driven and guided by two deflection rollers. The melt charged onto the conveyor belt solidifies completely while still in the region of the primary cooling. After the solidification, the strip moves for inline rolling into the rolling stand. After the inline rolling and an additional cooling process, the strip is wound. Such a casting method for strip casting is known from DE 198 52 275 A1.

[0004] It is known to preheat the melt charging system in order to prevent the freezing of the solidifying metal onto the run-out element (nozzle). However, in this technology, it is impossible to prevent the run-out element, after the completion of the preheating process, from being no longer sufficiently hot, and freezing on of the metal to be cast occurs. This leads to an uneven melt stream and to defects in the cast strip profile and on the surfaces of the cast products. Similarly, detachment of frozen on portions during the casting also leads to non-stationary states with regard to the flow and the surface quality. A very long preheating time in the region of the metal charging in the melt charging system, i.e., up to the time immediately before the entry of the melt, cannot be carried out as a result of the melt being rendered inert by means of an inert gas, which also occurs in the region of the metal charging.

[0005] The problem of the invention is to avoid the disadvantages of the state of the prior art and in particular the freezing on of the solidifying metal at the outlet of the run-out element (nozzle).

[0006] According to the invention, this problem is solved in a melt charging system of the type mentioned at the start in that, in the region of the run-out element, at least one heating device for heating the run-out element is arranged.

[0007] According to the invention, an active heating of the run-out element, i.e., in particular the nozzle, is provided. Similarly, the region near the nozzle can also be heated.

[0008] Advantageous variants of the invention can be obtained from the dependent claims.

[0009] A particularly suitable embodiment of the invention provides for the run-out element itself to be provided with the heating device, or for the heating device to be arranged adjacently to the run-out element.

[0010] The run-out element is preferably designed partially from a fire-resistant ceramic.

[0011] Advantageously, the heating device is designed as a gas heater and/or an electrical heater.

[0012] It is also advantageous to provide that the heater is arranged or integrated in a bottom, in side walls, in a weir, a dam, an overflow and/or a cover of the run-out element or of the nozzle.

[0013] The heating device is preferably arranged, in the form of heating rods, in recesses or grooves in the bottom and/or in the cover.

[0014] In an additional advantageous embodiment, the heating device is surrounded by ceramic components. They can be used in different geometries.

[0015] Advantageously, the heating rods are designed as carbide heating rods, in particular as lithium carbide or as silicon carbide heating rods.

[0016] When the heating device comprises at least one pore burner, it is possible to provide a heater that can be regulated in a continuously variable manner and rapidly over broad ranges. The pore burner can be operated with a liquid heating agent, but preferably with a gas. Here, in the case of simultaneous feeding of a combustible fluid and of air, a combustion reaction occurs in a ceramic foam. The pore burner can thus fill a nozzle bottom part and/or top part completely or partially in terms of surface area. Owing to the high surface power density that can be achieved with the pore burner, the latter can be operated as a compact burner unit. Since the burner power can be adjusted in a continuously variable manner, it is possible to provide the burner heat in a finely dosed manner as required respectively in the process, in order to adapt the nozzle surfaces to the melting parameters required in the respective melting process.

[0017] In a further embodiment, inductive heating means are advantageous used, for example, WS “Inducer” Company RHI.

[0018] It is particularly advantageous to use a system with an induced mean frequency of approximately 10 kHz. The coil geometry should be adapted to the ceramic component to be heated, in order to ensure a rapid and even heating. The ceramic should moreover have a sufficient electrical conductivity in order to allow, together with the required power density, a brief heating time of preferably approximately 10 minutes.

[0019] The melt charging system according to the invention advantageously also provides a unit for feeding an inert gas on the line section of the metal strip to be cast in the region of the run-out element.

[0020] According to the invention, different technologies can be integrated, particularly

[0021] 1.) Heating elements integrated in ceramic or as substitute for ceramic

[0022] 2.) Pore burner, as described above, and

[0023] 3.) Induction for heating the run-out element, in particular the nozzle. If the nozzle is designed as a ceramic element, a ceramic temperature of approximately 1100°C is sought for casting a steel melt. If the nozzle cover or the nozzle roof is replaced by a heated component, the heat heats the ceramic via radiation. The heating elements can also be integrated in the cover of the nozzle, particularly in the region of the overflow.

[0024] If the nozzle bottom is replaced by a heated component, the radiation also heats the ceramic. All that needs to be done is take suitable cooling measures for the conveyor belt.
by means of which the metal strip is transported for removal. Similarly, the heating elements can be integrated in the bottom of the nozzle, particularly in the region of an overflow, in a dam, a weir or in the sidewalls of the nozzle.

Overall, the advantage provided by the invention is also that the casting process is more robust with regard to time and also temperature losses. The casting can here also occur over a longer time period.

The invention is explained in greater detail below in embodiment examples.

FIG. 1 shows a diagrammatic side view of an installation for strip casting.

FIG. 2 shows a cross-sectional view of a run-out region provided with heating elements in an installation for strip casting, and

FIG. 3 is a perspective view, with partial cross section, of a nozzle in an installation for strip casting.

A strip casting installation 1 (FIG. 1) for casting a steel strip or a strip made of another metal comprises a feed system for the liquid metal with an oven 2 which initially contains a melt 3.

Via a stopper rod 4, the oven 2 can be opened downward to a tapping channel 5. Here, the stopper rod 4 is mounted in the closed state opposite a sealing ring 6.

The melt flows out of the tapping channel 5 into a preferably also heated or insulated charging vessel 7. From the latter, the melt is through an outlet channel 8 which ends in an outlet run-out region, particularly in a nozzle 9.

The nozzle 9 is provided with a dam 10 and with a weir 11 in order to channel the stream of the melt. In the region of the outlet of the nozzle 9, a gas nozzle 12 is provided, which generates a stream of an inert gas against the direction of flow of the melt, in order to distribute the melt, preferably also transversely to the casting direction, and/or in order to prevent the surface corrosion of the solidifying melt.

Said melt forms a metal strip 14 on an endless conveyor belt 13. The conveyor belt 13 runs over a deflection or drive roller 15. Furthermore, the conveyor belt 13 is led over supporting rollers 16 and/or a honeycomb grid. Between the latter, spraying nozzles 17 are arranged, which spray a cooling medium collected from a basin 18 onto the bottom side of the conveyor belt 13 in order to solidify the metal strip 14.

Preferably, on the two small sides of the belt of the conveyor belt 13—not shown here—shaping segments are provided that move along with said conveyor belt, and are arranged with mutual overlap or closely adjacent to each other, in order to prevent the run-out of the solidifying metal. The spacing of the segments is determined either by the width of the conveyor belt 13 or it is adjustable in accordance with the desired width.

A nozzle 9 constructed like nozzle 9 and therefore provided with the same reference numeral (FIG. 2) is provided at several places with heating elements, in order to make available, by way of the surfaces abutting against the metal melt, a constant ambient temperature for the melt. Preferably, heating devices are provided both in the nozzle top part 19 and also in the nozzle bottom part 20. In the nozzle top part 19, two heating devices 21, 22 are arranged one after the other in the direction of flow of the melt. Each one of the heating devices 21, 22 comprises a heating rod 24 housed in a ceramic pipe 23. A heating rod 26 is also arranged in a front weir 25 of the nozzle 11. The weir here is preferably designed inside as a ceramic pipe. The heating rod 26 can be integrated in the ceramic pipe. The weir 25, on the outlet side, controls the flow of the melt out of the nozzle 9.

Similarly, in the nozzle bottom part 20, in a ceramic pipe 27, a heating rod 28 is accommodated. The heating rods 24, 26, 28 are produced, for example, from silicon carbide or lithium carbide.

In a further embodiment of a nozzle 30 (FIG. 3) having a bottom part 31 and a top part 32, heating rods 33, 34, as ohmic resistance heaters, are formed on the top side and they extend transversely to the direction of flow of the melt which is exiting the nozzle via a dam 35.

The nozzle top and bottom parts 19, 20 and 31, 32 are made completely from a fire-resistant ceramic, for example. In this case as well, the fire-resistant ceramic can be provided with recesses into which the ceramic jacketed heating elements, such as the heating rods 33, 34, are introduced.

On the other hand, depending on the melt temperature of the metal to be cast, the nozzle top and bottom parts 19, 20 and 31, 32 can also be made of a metal having a sufficiently high melting temperature.

Thus, when the metal to be cast is tin, zinc or aluminum or an alloy of said metals, the nozzle top and bottom parts 19, 20 and 31, 32 can also be made entirely or completely of steel, for example, a stainless steel with properties that are adapted to the use, particularly with regard to corrosion, wherein, in this case as well, heating rods with ceramic jacketing can be introduced into appropriate recesses in the nozzle top and bottom parts.

The arrow S in FIGS. 2 and 3 denotes the direction of flow of the melt.

LIST OF REFERENCE NUMERALS

1. Strip casting installation
2. Oven
3. Melt
4. Stopper rod
5. Tapping channel
6. Sealing ring
7. Charging vessel
8. Outlet channel
9. Nozzle/run-out element
10. Dam
11. Weir
12. Gas nozzle
13. Conveyor belt
14. Metal strip
15. Deflection or drive roller
16. Supporting rollers
17. Spray nozzles
18. Basin
19. Nozzle top part
20. Nozzle bottom part
21. Heating device
22. Heating device
23. Ceramic pipe
24. Heating rod
25. Weir
26. Heating rod
27. Ceramic pipe
28. Heating rod
29. —
30. Nozzle
31. Bottom part
32. Top part
11. Melt charging system for horizontal strip casting of a molten metal (3) with a run-out element, in particular with a nozzle (9, 30) and with at least one heating device (21, 22, 28) for heating the run-out element arranged in the region of the run-out element, characterized in that the heating device is arranged adjacent to the run-out element and comprises at least one pore burner.

12. Melt charging system for horizontal strip casting of a molten metal (3) with a run-out element, in particular with a nozzle (9, 30) and with at least one heating device (21, 22, 28) for heating the run-out element arranged in the region of the run-out element in recesses or grooves in the bottom and/or cover, characterized in that the heating device comprises heating rods.

13. Melt charging system according to claim 12, characterized in that the heating rods (23, 27) are designed as carbide heating rods, particularly, as lithium carbide or silicon carbide heating rods.

14. A combustion-engined setting tool according to claim 11, characterized in that the run-out element is formed at least partially from a fire-resistant ceramic.

15. Melt charging system according to claim 11, characterized in that the heating device (21, 22, 28) is arranged or integrated in a bottom, in side walls, in a weir, dam, a run-out and/or in a cover of the run-out element or of the nozzle.

16. Melt charging system according to claim 11, characterized in that the heating device (24, 28) is surrounded by ceramic components (23, 27).

17. Melt charging system according to claim 11, characterized in that the heating device comprises inductive heating means.

18. Melt charging system according to claim 12, characterized in that the run-out element is formed at least partially from a fire-resistant ceramic.

19. Melt charging system according to claim 12, characterized in that the heating device (21, 22, 28) is arranged or integrated in a bottom, in side walls, in a weir, dam, a run-out and/or in a cover of the run-out element or of the nozzle.

20. Melt charging system according to claim 12, characterized in that the heating device comprises inductive heating means.