



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.10.2017 Bulletin 2017/42

(51) Int Cl.:
B22D 11/06 (2006.01) **B22D 11/16** (2006.01)
B22D 11/18 (2006.01)

(21) Application number: **17000615.9**

(22) Date of filing: **11.04.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(30) Priority: **13.04.2016 IT UA20162539**

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(54) **APPARATUS FOR THE AUTOMATIC STARTUP OF A CONTINUOUS CASTING LINE**

(57) An apparatus for the automatic startup of a continuous casting line, for example for the production of aluminum or zinc strips, including a vessel which is connected to a tip by means of a gate, the tip feeding a casting housing; the apparatus is characterized in that it includes a laser device which measures the level of the metal within the vessel, a level control device, which adjust the introduction of liquid metal into the vessel, a gate actuator to control the gate for providing a barrier between the

vessel and the tip, a transducer for the temperature of the metal inside the vessel, and a PLC which receives data from the temperature transducer and from the laser device in order to control the level control device and the gate actuator, so as to adjust the level of the metal in the vessel in order to ensure a correct and continuous flow of metal toward the casting cylinders, in order to avoid poor diffusion of the metal inside the tip.

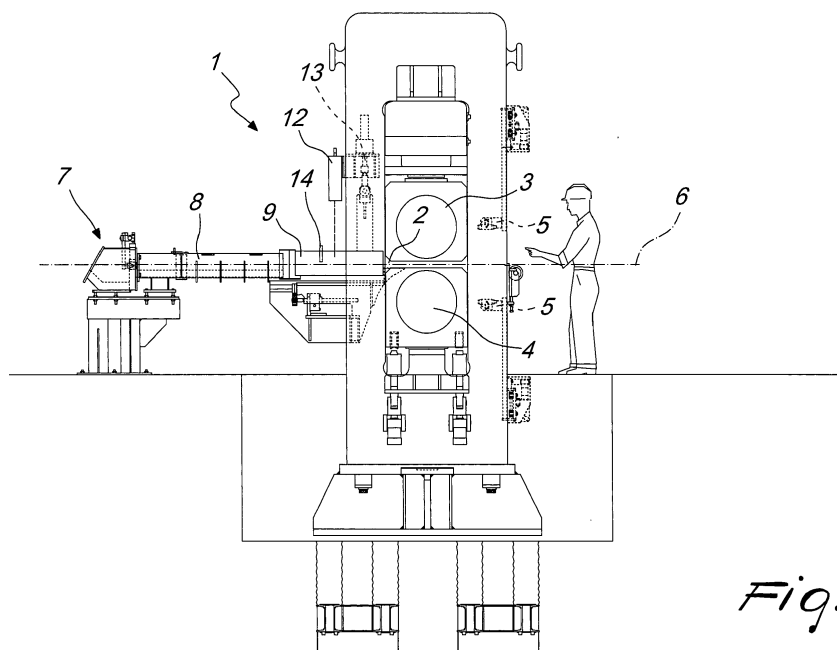


Fig. 1

Description

[0001] The present invention relates to an apparatus for the automatic startup of a continuous casting line, particularly for the production of aluminum or zinc strips.

[0002] More particularly, the invention relates to a system installed in a caster for controlling the flow of metal with which the tip of the caster is fed.

[0003] Conventionally, the startup of a continuous casting machine is a completely manual operation effected by the operator, the person in charge of the caster line, until the standard production conditions are reached, which include:

- 1) metal level;
- 2) strip thickness;
- 3) line speed;
- 4) roller lubrication;
- 5) temperature of casting roller cooling water.

[0004] The startup of the continuous casting (caster), as well as control of the metal level, is a critical step in the operation of the system.

[0005] The startup is in fact a very delicate operation that determines the final quality of the product.

[0006] The entire operation is entrusted to the management of the line on the part of the operator, who, depending on his experience, might perform the operation more or less appropriately.

[0007] The duration of a startup is around 15-20 minutes and the operations to be performed are numerous and must be performed in a timely and sequential manner, considering the duration of the event, which is limited.

[0008] The startup of a continuous casting for aluminum or zinc consists in making liquid metal flow by means of casting channels, passing through a vessel known as a head box, which has a barrier at the end in order to prevent the access of the liquid metal to the inside of the tip while waiting for the required metal temperature to be reached (for aluminum approximately 735°C and 470°C for zinc), the metal is conveyed into the collection vessels (ladles).

[0009] Once the required temperature has been reached, the operator throttles the flow of metal by means of the level control (actuator), using the manual closing/opening controls that are present on the control post.

[0010] At this point the operator visually checks that the metal level that is present in the head box reaches the required level.

[0011] Once the level height has been reached, the operator prepares for removal of the manual barrier (monolith plate) arranged in the end of the head box, making the liquid metal converge toward the inlet of the tip; in this operation, which lasts approximately 20-30 seconds, the operator must pay maximum attention to correctly dosing the quantity of metal, then he must adjust the flow constantly and precisely, assisted by the com-

mands of the operators who wait for the solid strip at the output of the caster (on the front part of the cylinders), until the tip is completely filled.

[0012] Once the colleagues upstream of the line, who are waiting for the solidification of the strip, have given clearance, the operator who is performing the starting operation must adjust the level by means of a flow regulator (actuator) by means of the manual controls (open/close button).

[0013] During the adjustment step, the operator controls the level detected by the laser that is present above the head box.

[0014] Once the level has stabilized, the operator engages the automatic metal level adjustment control by pressing the "automatic level" button.

[0015] This function provides for the flow regulator (actuator) to enter a symbiosis with the laser, giving rise to an automatic adjustment, using the latter as feedback for the closure of the PID adjustment loop.

[0016] During casting it is necessary to complete the rest of the operations, which are:

- power-on of the spraying system (graphite);
- power-on of the cylinder cooling water pump.

[0017] These two operations are manually controlled by the operator.

[0018] The spraying system is fundamental in order to avoid the adhesion of the aluminum strip on the casting cylinders; graphite performs the role of release agent and also is fundamental in the first minutes of casting; an excessive or insufficient quantity would compromise the continuation of casting.

[0019] The power-on of the water pump avoids an overheating of the jacket of the steel roller, usually the water must be activated after reaching the surface temperature of the jacket, not before 200°C in order to avoid thermal shocks to the steel, thus the operator must perform manual control, after ascertaining the temperature of the jacket he can proceed with flushing of the cooling water.

[0020] The aim of the present invention is to improve the prior art.

[0021] Within the scope of this aim, an object of the invention is to provide an apparatus which, in a continuous casting line, or caster, allows to perform the appropriate automatic adjustments in relation to the working conditions required to start the line automatically.

[0022] Another object of the present invention is to provide a reliable and safe apparatus.

[0023] This aim and these objects and others which will become better apparent hereinafter are achieved by an apparatus for the automatic starting of a continuous casting line, comprising a vessel which is connected to a tip by means of a gate, the tip feeding a casting housing; the apparatus being characterized in that it includes a laser device which measures the level of the metal within the vessel, a level control device, which adjust the intro-

duction of liquid metal into the vessel, a gate actuator to control the gate for providing a barrier between the vessel and the tip, a transducer for the temperature of the metal inside the vessel, and an electronic management unit; the electronic management unit receiving data from the temperature transducer and from the laser device in order to control the level control device and the gate actuator, adjusting the level of the metal in the vessel in order to ensure a correct and continuous flow of metal toward the casting housing.

[0024] Further characteristics and advantages will become better apparent from the description of preferred but not exclusive embodiments of the invention, illustrated by way of nonlimiting example in the accompanying drawings, wherein:

Figure 1 is side view of the apparatus for the automatic starting of a continuous casting line, according to the present invention;

Figure 2 is a side view of a continuous casting line, for the production of aluminum or zinc strips, provided with the automatic starting apparatus according to the present invention.

[0025] With reference to the cited figures, the automatic starting apparatus according to the invention, globally designated by the reference numeral 1, is inserted in a continuous casting line for the production of aluminum or zinc strips, known as caster, which is shown schematically in Figure 2.

[0026] The apparatus 1 according to the present invention is installed in the caster to control the flow of metal with which the nozzle, or tip, 2 is fed.

[0027] The tip 2 distributes the molten metal in a casting housing which is constituted by two casting rollers 3 and 4, which are water-cooled by means of a spraying system 5, where the molten metal is cooled and solidified to form a strip 6.

[0028] The molten metal flows in a channel 8, until it reaches a vessel 9, known as head box, which reaches the tip 2.

[0029] The strip 6 then passes through a series of apparatuses which include shears 10 and a winding spool 11.

[0030] According to the present invention, the apparatus includes a laser device 12 for controlling the level of the metal inside the vessel 9, a level control device 7, which adjusts the introduction of the liquid metal in the vessel 9 and a gate actuator 13 for the control of the gate for providing a barrier between the vessel and the mouth of the tip.

[0031] The apparatus also has a temperature transducer, constituted by a thermocouple 14, for controlling the temperature of the metal in the vessel 9, and a PLC management unit with a corresponding operator panel.

[0032] The operation of the automatic control apparatus according to the present invention is as follows.

[0033] Initially, the molten metal is made to flow into

the vessel 9, the end of which is blocked by the refractory barrier, i.e., the gate, which is not visible in the figures, connected to the motorized system constituted by the gate actuator 13, until the required parameters are reached.

[0034] Once the start temperature, measured by means of the thermocouple 14, has been reached, the electronic control system sends a command to the level control device 7, which reaches a set closure position, waiting to reach the preset level, through the drain channel, which is calibrated depending on the thickness of the strip, on the widths and on the alloys.

[0035] The level of the metal, previously established by a set point, is further confirmed by means of a reading performed by the laser device 12, which actuates the gate actuator 13 so that the motorized refractory barrier opens gradually and progressively, according to a positioning profile stored previously on a work recipe.

[0036] Once the filling of the tip 2 has been completed, the level of the metal in the vessel 9 is adjusted by means of an automatic system, in order to ensure a correct and continuous flow of metal toward the casting rollers 3 and 4, in order to avoid poor diffusion of the metal within the tip 2, avoiding so-called freezing.

[0037] During the entire starting step, the level control device 7, communicating with the laser device 12, maintains the previously entered set point, i.e. the optimum casting level.

[0038] Once the casting strip has formed, the automatic control system adjusts three other fundamental parameters: the speed of the rollers 3 and 4, the cooling water dispensed by the spraying system 5, and the release agent on the cylinders.

[0039] In practice it has been found that the invention has achieved the intended aim and objects, providing an apparatus for the automatic start of a continuous casting line that allows to obtain some important advantages with respect to traditional systems.

[0040] The present apparatus ensures an increase in startups performed successfully and a decrease in the waste of consumables (tip, end dam, fiber).

[0041] The apparatus according to the present invention furthermore offers an increase in productivity due to the higher percentage of startups completed successfully.

Claims

1. An apparatus for the automatic startup of a continuous casting line, comprising a vessel which is connected to a tip by means of a gate, said tip feeding a casting housing; said apparatus being **characterized in that** it comprises a laser device which measures the level of the metal within said vessel, a level control device, which adjust the introduction of liquid metal into said vessel, a gate actuator to control said gate for providing a barrier between the vessel and

the tip, a transducer for the temperature of the metal inside said vessel, and an electronic management unit; said electronic management unit receiving data from said temperature transducer and from said laser device in order to control said level control device and said gate actuator, adjusting the level of said metal in said vessel in order to ensure a correct and continuous flow of metal toward said casting housing.

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2. The apparatus according to claim 1, **characterized in that** said electronic management unit comprises a PLC.

3. The apparatus according to claim 1, **characterized in that** said temperature transducer comprises a thermocouple.

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4. The apparatus according to claim 1, **characterized in that** said gate comprises a refractory barrier.

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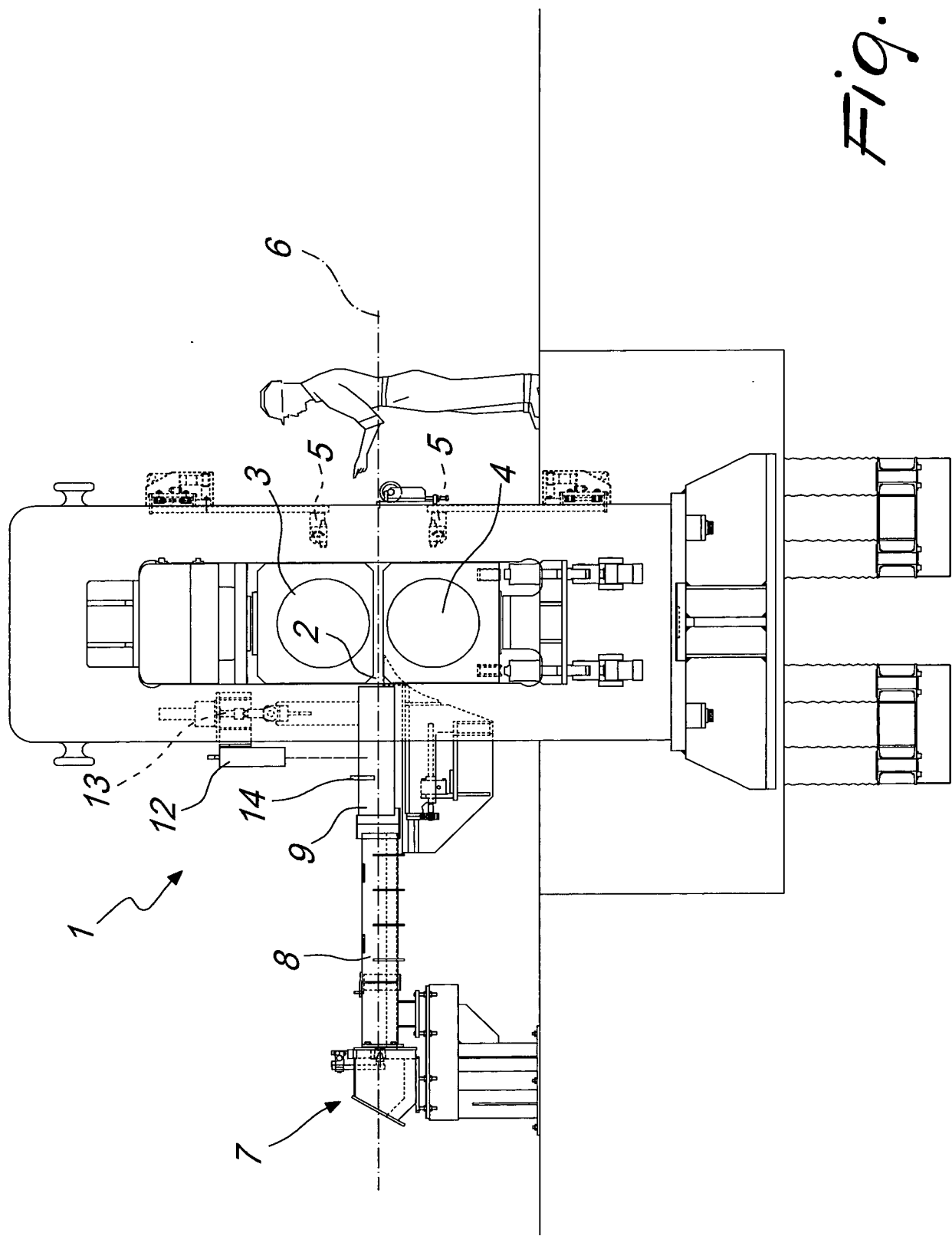


Fig. 1

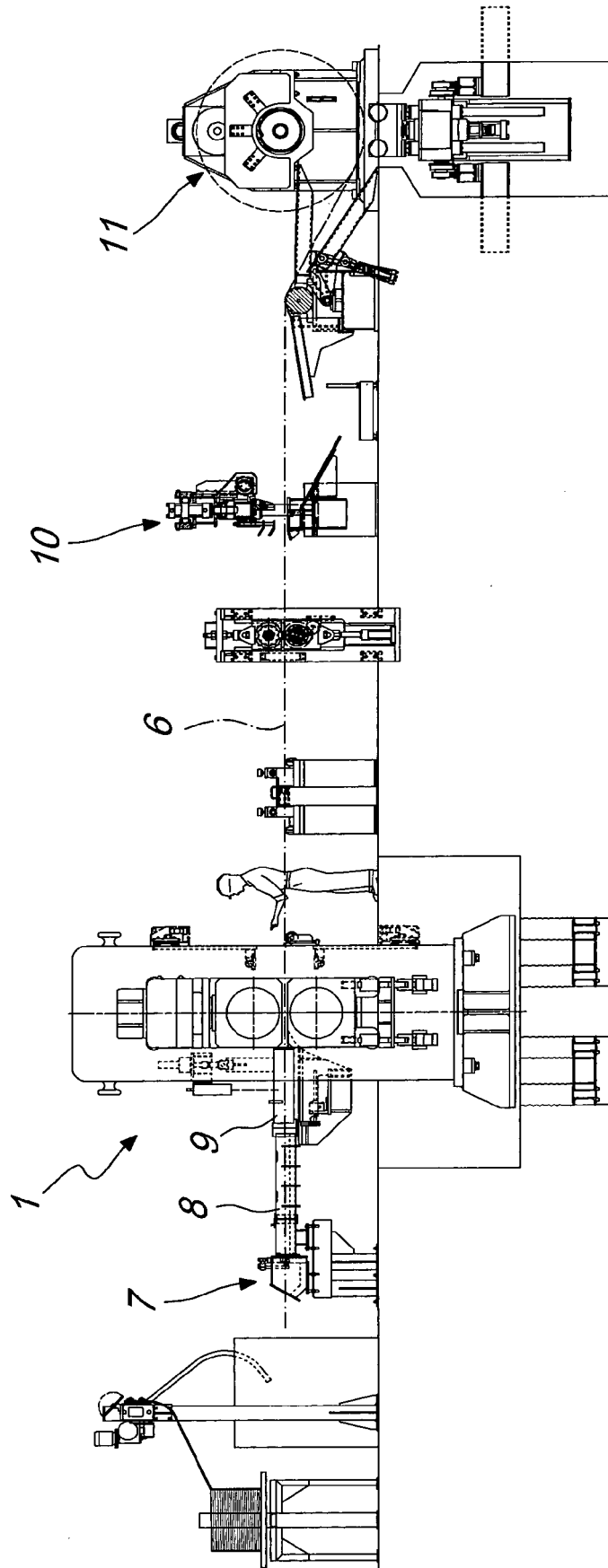


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 17 00 0615

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A	GB 2 524 962 A (CAMBRIDGE ENTPR LTD [GB]) 14 October 2015 (2015-10-14) * the whole document *	1-4	TECHNICAL FIELDS SEARCHED (IPC)
A	WO 01/74517 A1 (PECHINEY RHENALU [FR]; GRIFFON JACQUES [FR]; BREYSSE CLAUDE [FR]) 11 October 2001 (2001-10-11) * abstract; figures 1-5 *	1-4	B22D
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 September 2017	Examiner Nikolaou, Ioannis
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 00 0615

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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