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Korshunov et al.

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[54] **DEVICE FOR COOLING THE CRYSTALLIZER IN A PLANT FOR CASTING METAL INGOTS WITH A PERIODIC DISCHARGE THEREOF**

[76] Inventors: **Evgeny Alexeevich Korshunov,** pereulok Otdelny, 5a, kv. 29; **Jury Avramovich Samoilovich;** ulitsa Engelsa, 27, kv. 26; **Valery Pavlovich Kostrov,** ulitsa Bazhova, 57, kv. 10; **Oleg Ashotovich Aragilian,** ulitsa Kuibysheva, 137, kv. 3; **Vladimir Alexeevich Goryainov,** ulitsa Malysheva, 82, kv. 2; **Anatoly Grigorievich Tarasov,** ulitsa Lunacharskogo, 76, kv. 75, all of Sverdlovsk, U.S.S.R.

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[52] **U.S. Cl.** ..... **164/283 M,** 164/154, 165/34, 165/107

[51] **Int. Cl.** **B22d 11/14,** F28d 15/00

[58] **Field of Search** ..... 164/48, 49, 82, 154, 250, 164/283 M; 165/30, 34, 36, 107

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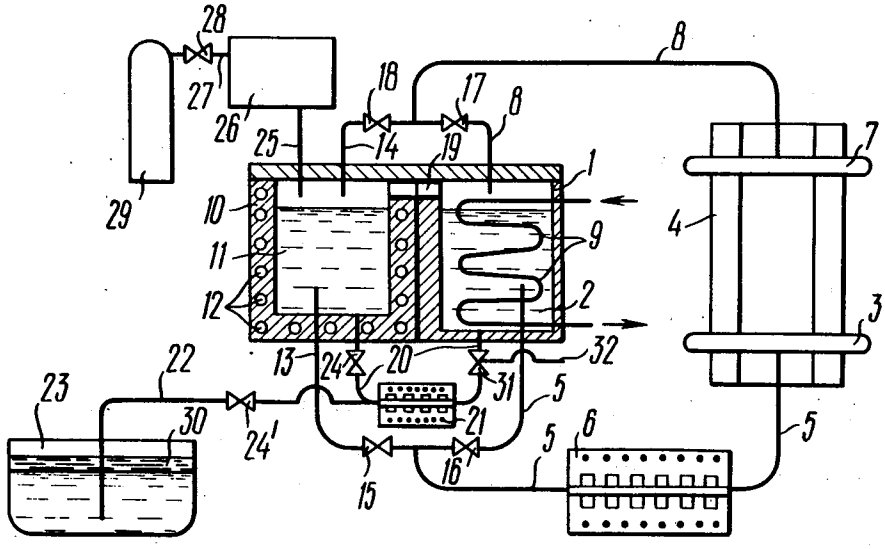
Primary Examiner—R. Spencer Annear

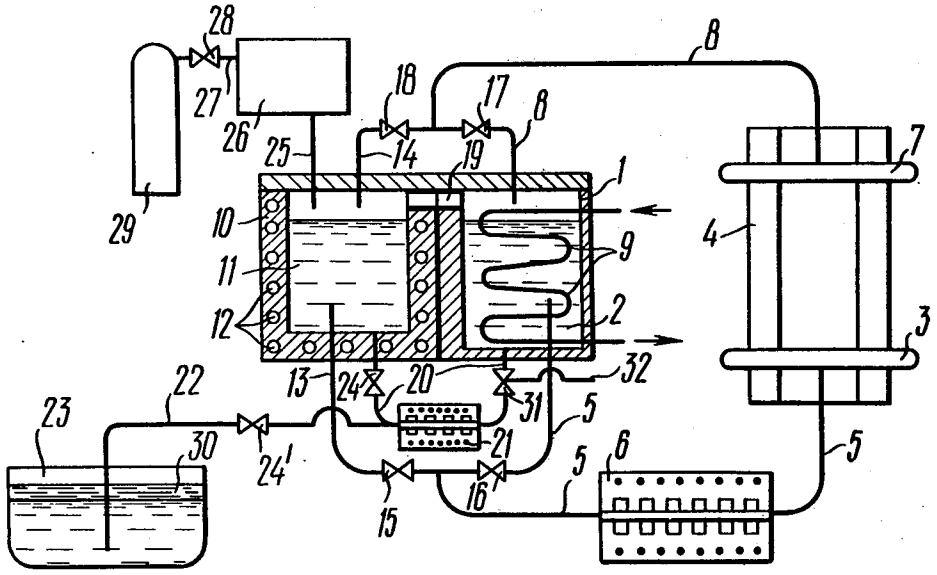
[57] **ABSTRACT**

A device for cooling the crystallizer in a plant for casting metal ingots comprises pipelines connecting at least two coolant vessels to the pump and the crystallizer. According to the invention, one of the vessels incorporates an arrangement for lowering the coolant temperature, while the other one incorporates a heater for raising the coolant temperature to 400°C. Both vessels are connected to pipelines bringing the coolant to the crystallizer and taking it away there from, whereas the pipelines and pipe connections mount valves to ensure an alternate delivery of coolants from said vessels to the crystallizer.

Successive change of coolant temperature in the crystallizer brings more favourable conditions for forming an ingot and its discharge and for producing an ingot with an upgraded surface quality.

3 Claims, 1 Drawing Figure




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DEVICE FOR COOLING THE CRYSTALLIZER IN A PLANT FOR CASTING METAL INGOTS WITH A PERIODIC DISCHARGE THEREOF

The invention relates to devices for cooling the crystallizers in metal ingot casting plants with a periodic discharge of ingots, primarily upwards.

Semi-continuous, and particularly continuous, metal casting plants have become widely popular in a relatively short period of time. There are known for example such plants of vertical, radial, curvilinear and horizontal types.

Recently, there has been developed and disclosed a continuous metal ingot casting method providing for positive delivery of liquid metal through the siphon device from underneath into the curved and cooled crystallizer and a periodic discharge of ingots from the crystallizer upwards into the secondary cooling device, under the condition of a periodically variable pressure of liquid metal on the ingot crust in the crystallizer zone.

The known crystallizer cooling devices usually incorporate pipelines connecting the coolant vessel to the pump and the crystallizer being cooled. Water is most frequently used as a coolant, delivered from a water supply system at a temperature close to that of the ambient medium which is warmed up several degrees when passing through the crystallizer. This warmed water is cooled down by means of special facilities before being directed to the crystallizer cooling device.

The temperature of water delivered to the crystallizer may vary within narrow limits, but such variations are not called for by the production process requirements especially in those plants where the ingot is drawn from the crystallizer continuously.

However, the research and estimations performed by the inventors have shown that the continuous metal casting process accompanied by a periodic drawing of the ingot from the crystallizer being cooled, under the conditions of varying the crystallizer coolant temperature within the given limits during stop periods in the course of drawing the ingot from the crystallizer, affords substantial technological advantages to produce a higher-quality ingot.

The known crystallizer cooling devices, however, are unable to vary the temperature of coolant delivered to the crystallizer within a range of several hundred degrees, for example 200–400°C, whereas this particular variation of the coolant temperature is desirable in the plants with a periodic drawing of the ingot during stop periods in the course of drawing the ingot from the crystallizer.

The principal object of the invention is to provide a device for cooling the crystallizer in the metal ingot casting plant, which would upgrade the quality of ingot surface.

Another important object of the invention is to provide such temperature conditions in the crystallizer that are favourable for forming an ingot and its subsequent extraction from the crystallizer upwards.

One more object of the invention is to provide such a device that would allow a liquid metal heat carrier to be used as a coolant, for example, a sodium and potassium alloy possessing high chemical activity.

These and other objects are achieved due to the provision of a device for cooling the crystallizer in a metal ingot casting plant with a periodic discharge of ingots,

comprising a coolant storage connected by a pipeline to a coolant vessel connected further by inflow and outflow pipelines to a pump and crystallizer, wherein, according to the invention provision is made for an arrangement adapted for lowering coolant temperature which is built in into said low-temperature coolant vessel, and also for a high temperature coolant vessel, incorporating a preheater to heat the coolant to approximately 400°C and said latter vessel has pipe connections to connect it to inflow and outflow pipelines, whereas the pipe connections and pipelines correspondingly have valves for an alternate connection of said vessels to or their disconnection from the crystallizer to ensure an alternate inflow of the coolant at a corresponding temperature to or its outflow from the crystallizer.

Due to this device the crystallizer is cooled alternately by heated and cooled coolant, thus accelerating the forming of an ingot and facilitating its discharge from the crystallizer which brings a favourable effect on forming a higher-quality outer surface of the ingot.

It is convenient that the device be equipped with an additional pump and the latter be connected by pipe connections to each of said coolant vessels and to the pipeline connected to the coolant storage, while the walls of said vessels above the given level of coolant therein might have holes to make up a passage for communicating these vessels with each other to transfer the coolant from one vessel to another.

The passage in the walls of vessels makes the latter intercommunicating, while the additional pump transfers the coolant from vessel to vessel, thus allowing the coolant temperature in each vessel to be stabilized according to the given value, and in addition, fills vessels and pipelines of the device with the coolant taken from the storage before commencing operation of the plant.

It is advisable that the device be provided with a reservoir to be connected by pipe connections to a source of compressed gas and to one of said coolant vessels.

The expediency of filling the crystallizer cooling device preminently with inert gas should be understood as follows.

At present, the cooling agent of the crystallizer may be effectively represented by a liquid metal heat carrier such as a sodium-potassium alloy. Sodium and potassium are chemically active metals particularly intensively interacting with hydrogen and water vapours which as a rule are found in the air. To prevent objectionable interaction of sodium and potassium with air when the above alloy is used as a coolant it is reasonable before feeding the coolant to the vessels to fill the inner passages of the crystallizer and the pipelines of the device pre-eminently with inert gas supplied from the above-mentioned reservoir.

In order to make the present invention more readily understood an actual embodiment of the device for cooling the crystallizer in a metal ingot casting plant will now be described with reference to the accompanying drawing that gives a schematical representation of the device disclosed herein, according to the invention.

The device for cooling the crystallizer in a metal ingot casting plant with a periodic discharge of ingots from the crystallizer incorporates a vessel **1** to contain coolant **2** of low-melting temperature. The vessel **1** is connected to an inflow manifold **3** of a crystallizer **4** by means of an inflow pipeline **5** through which the cool-

ant is delivered to the crystallizer. Installed between the sections of the pipeline **5** is a pump **6** to deliver the coolant through the pipeline **5** to the crystallizer **4.**

Connected to an outflow manifold **7** of the crystallizer **4** is one end of an outflow pipeline **8** for the coolant outflow from the crystallizer **4.** The other end of the outflow pipeline **8** is connected to the vessel **1.**

Provided inside the vessel **1** is an arrangement **9** for cooling the coolant **2** which is actually a coiled pipe for a cooling medium, preferably water to flow through.

Installed adjacent to the vessel **1** is an additional vessel **10** for a high temperature coolant **11,** equipped with a heater **12** for preferentially initial heating of the coolant **11** to a temperature of approximately 400°C.

Instead of the two vessels the device may incorporate a chamber having several compartments.

The vessel **10** has two pipe connections **13** and **14** through which this vessel is connected to the inflow pipeline **5** and the outflow pipeline **8.**

Installed respectively on the pipelines **5** and **8** and pipe connections **13** and **14** are valves **15, 16, 17** and **18** for an alternate connection of the vessels **1** and **10** to alternately deliver the coolant of the given temperature to the crystallizer **4.**

A passage **19** is made in the upper portions of the walls of the vessels **1** and **10** to allow the coolant to transfer from one vessel into another.

The inner spaces of vessels **1** and **10** are also interconnected by pipe connections **20** with an additional pump **21** installed there between to transfer the coolant from one vessel into another.

Coupled to one of the pipe connections **20** is a pipeline **22** which is connected to a coolant storage **23.** The pipe connection **20** of the vessel **10** and the pipeline **22** are fitted with valves **24.**

One end of a pipe connection **25** may be coupled atop to either of the vessels **1** and **10,** whereas the other end thereof is coupled to a reservoir **26** containing preferably an inert gas.

The reservoir **26** in its turn is connected through a pipe connection **27** fitted with a valve **28,** to a compressed-gas source **29.**

Installed on the pipe connection **20** coupled to the vessel **1** is a valve **31** coupled through a pipe **32** to a vacuum source (not shown in the drawing), wherein the gas pressure is below the atmospheric.

The recommended coolant is a liquid-metal heat carrier with low melting temperature such as a sodium-potassium alloy which at the eutectic content (22.8 per cent sodium and 77.2 per cent potassium) has a melting point at 12°C, a boiling point at 784°C and is readily transferred by induction pumps. Other substances, however, may also be used as a coolant.

The device for cooling the crystallizer in a metal ingot casting plant functions as follows.

Before starting the plant for metal casting, the device is prepared for operation. For this purpose the device is first prepared for filling with the coolant, then the device is filled with the coolant, thereafter the coolant itself is correspondingly prepared so that it could be delivered alternately at different temperatures to the crystallizer **4.**

The preparation of the device for cooling and for filling with the coolant consists in that all the pipelines and pipe connections, the vessels **1** and **10** and the passages of the crystallizer **4** are filled preferably with an inert gas supplied from the reservoir **26.** The gas is delivered to the reservoir **26** from the compressed gas source **29** through the pipe connection **27** and valve **28.**

Having filled the device with the inert gas, the coolant should start to be filled thereinto.

Because a sodium-potassium alloy is recommended as a cooler the latter is transferred to the cooling device from the storage **23** through the pipeline **22** and the open valve **24** by means of the induction-type pump.

Inside the storage **23** the sodium-potassium alloy is kept under the bed of a mineral oil **30.**

To make it possible to start the induction pump **21,** its passage should be first filled with the coolant transferred from the storage **23.** This operation can be effected after evacuation the pipeline **22** through the valve **31** installed on the pipe connection **20** coupled to the vessel **1.** The zone of the valve **31** is evacuated through the pipe **32** connected to an evacuation outfit (not shown in the drawing).

After filling the passage of the induction pump **21** with the coolant the pump is started and at the same time the valve **31** is used to close the passage of the pipeline **32** and open that of the pipe connection **20.**

The coolant taken from the storage **23** flows via the pipeline **22,** pump **21** and pipe connection **20** first to the vessel **1,** then via pipelines **5** and pipe connection **13,** with valves **15** and **16** kept open, to the vessel **10** and the passage of the main induction-type pump **6.**

Further filling of the cooling device with the coolant is effected with the induction pump **6** engaged, which first brings the coolant to the passages of the crystallizer **4,** then to the outflow pipeline **8.**

Filling of the device with the coolant may be considered complete after the pipelines, pipe connections and passages of the crystallizer **4** are fully filled with the coolant, while in the vessels **1** and **10** the coolant **2** reaches approximately the level of the passage **19** connecting the vessel **1** and **10.**

Further, the valve **24** on the pipe connection **20** is opened and the valve **24** on the pipeline **22** is closed to shut off coolant supply from the storage **23.**

In the course of filling the device with the coolant, the inert gas is expelled from the device into the reservoir **26,** wherein it is compressed and via the reduction valve (not shown in the drawing) is finally released into the atmosphere.

Upon filling the device with the coolant, idle transfer of the coolant is recommended to be carried out by the pumps **6** and **21** during a certain period of time required for a complete extraction of gas from the cooling device, afterwards the pumps **6** and **21** are disengaged and all pipe connections and pipelines are closed by valves with the exception of the pipe connection **20** coupled to the vessel **1,** said pipe connection being held open during operation of the device in the course of metal casting.

Further preparation of the device for operation consists in that in the vessel **10** the coolant **2** is heated to the required temperature of approximately 400°C (designated herein at Ref. No. **11**) while the arrangement **9** installed in the vessel **1** is fed with a cooling medium, preferably water.

This terminates the preparation of the device for operation.

In the course of metal casting in the plant with a periodic discharge of ingots from the crystallizer **4,** in accordance with the adopted technological process, the pump **6** periodically feeds the crystallizer **4** with the

low-temperature coolant **2** from the vessel **1** and the high-temperature coolant **11** from the vessel **10** in the alternate succession. When feeding the low-temperature coolant **2**, valves **16** and **17** are open, while valves **15** and **18** are closed. For feeding the high-temperature coolant, valves **15** and **18** are open, while valves **16** and **17** are closed.

The low-temperature coolant **2** and the high-temperature coolant **11**, after having passed through the crystallizer **4**, have their temperature raised by several degrees.

The following measures are taken to prevent gradual overheating of the coolants **2** and **11**.

The low-temperature coolant **2** is cooled by giving off its heat through the arrangement **9** in which the cooling medium is circulated. The high-temperature coolant **11** is cooled by its being diluted with the low-temperature coolant **2**, which is forced to flow by means of the auxiliary pump **21**. In this case, the valve **24** on the pipeline **20** is opened, and the induction pump **21** forces the required amount of the low-temperature coolant **2** through the pipe connection **20** into the vessel **10**, whereas the surplus of the high-temperature coolant **11** from the vessel **10** overflows into the vessel **1** via the passage **19**.

On completion of the plant operation the coolant from the pipelines, pipe connections, crystallizer passages and the vessels **1** and **10** of the device for cooling the crystallizer **4** is returned to the storage **23** with simultaneously filling the above components of the device with the inert gas taken from the reservoir **26**.

What is claimed is:

1. A device for cooling the crystallizer in a plant for casting metal ingots with a periodic discharge thereof, comprising: a coolant storage; a vessel for low-temperature coolant connected by pipeline to said storage; an arrangement for reducing the coolant temperature built in into said vessel for low-temperature coolant; an inflow pipeline connecting said crystallizer being cooled to said vessel for low-temperature coolant; an outflow pipeline connecting said crystallizer being cooled to said vessel for low-temperature coolant; a vessel for high-temperature coolant coupled by means of pipe connections to said inflow and outflow pipelines; a heater mounted in said vessel for high-temperature coolant to heat it to approximately 400°C; valves installed on said pipelines and pipe connections for an alternate connection of each of said vessels to said crystallizer being cooled for the purpose of an alternate inflow to or outflow from the crystallizer of the coolant of the corresponding temperature and for a correspondingly alternate disconnection of said vessels from the crystallizer; a pump connected to said inflow pipeline to alternately deliver the coolant from said vessels to said crystallizer being cooled.

2. A device according to claim **1**, wherein an auxiliary pump is provided, connected by means of pipe connections to each of said vessels and to said pipeline coupled to said coolant storage, and the walls of said vessels above the required level of coolant contained therein, have holes forming a passage to communicate these vessels with each other.

3. A device according to claim **1**, wherein a reservoir is provided, connected by means of pipe connections to a source of compressed gas and to one of said coolant-containing vessels.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,874,439

DATED : April 1, 1975

INVENTOR(S) : Evgeny A. Korshunov

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[22] Filing Date:

January 2, 1974

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks