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(71) Applicant: **Obschestvo S. Ogranichennoi Otvetstvennostyu "Mednogorsky Medno-Serny Kombinat"**
462270 Mednogorsk (RU)

(72) Inventors:
- **Barsukov, Nikolai Mikhailovich**
  194017 St.Petersburg (RU)
- **Bulatov, Konstantin Valerievich**
  620026 Ekaterinburg, Sverdlovskaya obl. (RU)
- **Ibragimov, Andrey Faritovich**
  462274 Mednogorsk, Orenburgskaya obl. (RU)
- **Iskhakov, Ilfat Ildusovich**
  624330 Krasnouralsk, Sverdlovskaya obl. (RU)
- **Lepin, Sergei Aleksandrovich**
  462274 Mednogorsk, Orenburgskaya obl. (RU)
- **Ruzanov, Artem Nikolaevich**
  462274 Mednogorsk, Orenburgskaya obl. (RU)
- **Kirichenko, Aleksandr Nikolaevich**
  462280 Mednogorsk, Orenburgskaya obl. (RU)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(54) TUYERE FOR BOTTOM AND SIDE BLOWING AND METHOD FOR COOLING THE SAME

(57) The group of inventions relates to metallurgy, and more particularly to devices for blowing oxidizing blast through molten copper sulfide or polymetallic raw material and methods for cooling these devices, and can be used in nonferrous and ferrous metallurgy. The group of inventions offers higher performance characteristics of a tuyere for bottom and side blowing, including, inter alia, enhanced reliability and longer service of the tuyere, improved efficiency of cooling the tuyere under high heat strains. A tuyere for bottom and side blowing comprises a tuyere body having a passage, a main blast pipe, a protective blast pipe, a tuyere nose, a cooled element and a ceramometal headpiece. The main blast pipe and the protective blast pipe are arranged coaxially with respect to each other. The ceramometal headpiece is disposed on the tuyere nose and is made of a material having an average thermal conductivity of at least 30 W/m°C and a phase transition latent heat of at least 1000 kJ/kg. Method for cooling a tuyere comprises cooling the tuyere nose at a coolant flow rate of at least $25 \cdot 10^{-3}$ m^3/s per 1 m^2 of the surface area of the nose, and maintaining negative pressure within the cooled elements.

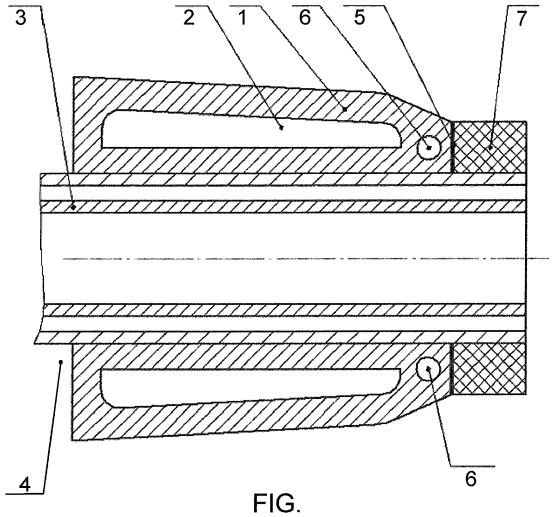

FIG.

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Description

[0001] The group of inventions relates to metallurgy and more particularly to devices for blowing oxidizing blast through molten copper sulfide or polymetallic raw material and methods for cooling these devices, and can be used in nonferrous and ferrous metallurgy.

[0002] When molten copper sulfide is blown in the blast flame region, high temperatures and hence high heat strains are developing, which lead to burnout of the cooled element. Therefore, cooled tuyeres are not used for blowing molten sulfide (matte) as their use can lead to burnout and thereupon to explosion.

[0003] Inventor's Certificate SU 1667920 and patent RU 2152441 disclose the use of tuyeres with coaxial pipes (tuyere with a protective envelope shell) to reduce the heat impact on the tuyere nose (end). Oxidizing blast is fed through a main passage, and a weakly oxidizing, inert or reducing blast is fed through a protective passage.

[0004] However, the tuyere with a protective shell reduces the rate of heat impact on the surface of the tuyere nose, but does not protect it from burnout.

[0005] Headpieces can be used to protect the tuyere end face from burnout, as described in patent RU 2235789. End face headpieces protect the tuyere nose for a certain period of time.

[0006] However, low thermal conductivity of the headpiece prevents forming a stable skull layer on the headpiece, thereby leading to burnout of the headpiece and the tuyere nose surface.

[0007] The prior art most closely related to the present device is a blast furnace tuyere disclosed in patent RU 2299243. Cooling passages are formed by a filled pipe, and the cooling intensity is attained by the use, in the nose, of a coil with a specified section of the cooling passage. The main cooling intensity characteristic is the coolant velocity, i.e. the flow rate of coolant, and maintenance of the specified flow rate at the proper level.

[0008] However, if the specified flow rate is not provided, the nose wall cannot be kept integral under heat strains of >1000 kW/m^2.

[0009] The prior art most closely related to the inventive method is patent US 5,989,488, which uses cooling the tuyere end face for its protection.

[0010] However, the unregulated flow rate of coolant per the nose surface area cannot protect it when the blast flame hangs near the tuyere surface; this leads to the tuyere surface burnout despite the fact that the nose surface is protected by a ceramic insert.

[0011] The object of the present group of inventions is to provide a tuyere for bottom and side blowing an oxidizing blast through a molten copper sulfide in a protective shell under high heat strains in the blast flame region, and enable long operation of the tuyere.

[0012] The group of inventions offers higher service characteristics of a tuyere for bottom and side blowing, including, inter alia, enhanced reliability and longer service of the tuyere, improved efficiency of cooling the tuyere under high heat strains.

[0013] The object is attained in a tuyere for bottom and side blowing, comprising a tuyere body having a passage, a main blast pipe, a protective blast pipe, a tuyere nose, a cooled element and a ceramometal headpiece, wherein the main blast pipe and the protective blast pipe are arranged coaxially with respect to each other, the ceramometal headpiece is disposed on the tuyere nose and is made of a material with an average thermal conductivity of at least 30 W/m°C and a phase transition latent heat of at least 1000 kJ/kg.

[0014] Length of the ceramometal headpiece can be determined by the formula:

$$L = 0.862 \cdot (P_{o2})^{-0.992},$$

where L is the length of the headpiece, millimeters, P_{o2} is the partial pressure of oxygen of the main blast, MPa.

[0015] The object is further attained by a method for cooling a tuyere, comprising cooling the tuyere nose at the coolant flow rate of at least $25 \cdot 10^{-3}$ m^3/s per 1 m^2 of the surface area of the nose, and maintaining negative pressure within the cooled elements.

[0016] The present group of inventions provides a tuyere, cooled from an explosion-proof cooling system, with a protective envelope of air or another blast, and the end face (nose) of the tuyere and the coaxial pipes is protected by a headpiece contacting the molten material, which is explosive in reaction with water.

[0017] The group of inventions is disclosed with reference to the drawing showing a longitudinal section of a tuyere, where reference numerals stand for:

1 - tuyere body;
2 - passage;
3 - main blast pipe;
4 - protective blast pipe;
5 - tuyere nose;
6 - cooled element;
7 - ceramometal headpiece.

[0018] A tuyere for bottom and side blowing comprises a tuyere body 1 with a cooling passage 2, a main blast pipe 3, a protective blast pipe 4, a tuyere nose 5, a cooled element 6 and a ceramometal headpiece 7.

[0019] The main blast pipe 3 and the protective blast pipe 4 are arranged coaxially with respect to each other.

[0020] The cooling element 6 is formed by filled pipes or a slit-like passage.

[0021] The ceramometal headpiece 7 is arranged on the tuyere nose 5 to protect the surface of the tuyere nose 5 and the spout of pipes 3, 4, and is made of a material having an average thermal conductivity of at

least 30 W/m°C and a phase transition latent heat of at least 1000 kJ/kg.

[0022] Reduction in the thermal conductivity of the headpiece 7 prevents formation of a protective skull and causes wear of the headpiece 7 and the tuyere. Reduction in the phase transition latent heat of the headpiece 7 decreases the time of thermal impact of the blast flame on the headpiece 7 and causes thereby melting the protective skull, overheating the headpiece 7 and the tuyere. The ceramometal headpiece 7 is made of layers of different materials: those having a low thermal conductivity and a high melting point, and those having a high thermal conductivity and a melting point of about 1100°C.

[0023] Length of the ceramometal headpiece is determined by the partial pressure of oxygen of the main blast according to the formula

$$L = 86.2 \cdot (P_{o2})^{-0.992},$$

where L is the length of the ceramometal headpiece, millimeters,

P_{o2} is the partial pressure of oxygen, MPa.

[0024] Thermal conductivity of the ceramometal headpiece is determined as the average of the sum of products of mass fraction of the layer by thermal conductivity for cross-section of the ceramometal headpiece. Phase transition heat or latent melting heat is determined for a particular ceramometal headpiece. To determine characteristics of the ceramometal headpiece, thermocouples are caulked into its working surface on the side of molten sulfide. Temperature of 960° C, equivalent to the skull melting temperature, is taken for the instant of melting the protective skull. The coefficient of heat transfer from the cooled element wall to the coolant was about 3700 kW/m^2°C. Experiments have shown that a decrease in the average thermal conductivity of the ceramometal headpiece by less than 30 W/m°C leads to increasing the headpiece surface temperature above 980° C, which is the evidence that the skull is melting. Based on the headpiece surface temperature, removed heat flux and heat applied to the headpiece surface, the impact of the latent phase transition heat on the time of decay of the heat flux on the headpiece surface is mathematically determined as compared to experimental data. Mathematical modeling has identified that the use of a headpiece with latent heat of phase transition of more than 1000 kJ/kg causes an increase in the time of heat flux impact on the headpiece skull from 0 to 60 sec, and no melting of the skull occurs during this time.

[0025] The method is implemented in the following manner.

[0026] The tuyere is installed in the molten sulfide zone. Oxygen for main blast is fed though the main blast pipe 3, and air is fed through the protective blast pipe 4. Skull layer forms on the surface of the ceramometal headpiece 7, which protects the headpiece 7 and the tuyere from wear. Water coolant is supplied on the surface of the tuyere nose 5, and a negative pressure is created in the cavity of the cooled element 6. Negative pressure is provided by installing the tuyere in a certain place of the explosion-proof cooling system. In a case of uncontrolled destruction (burnout) of the headpiece and the tuyere end wall, molten sulfide penetrates into the cooled element, crystallizes, the flow of water inside the element is stopped and no explosion occurs. Water flow rate on the surface of the nose 5 should be at least $25 \cdot 10^{-3}$ m^3/s. With reduction in the flow rate the cooling intensity decreases and involves melting the skull on the headpiece surface, wear of the headpiece, and as a consequence, possible burnout of the tuyere.

[0027] Performance of the tuyere was tested on "Noranda" system. The tuyere was installed in the tuyere belt and in the bottom of the system. Surface of the headpiece was in contact with molten copper sulfide. A layer of protective skull formed on the surface of the tuyere headpiece. Main oxygen blast was fed through the central passage. Air blast was fed through the protective shell. Tuyeres in the bottom and side part of the system were operated for a long time. No wear and overheating of tuyere occurred, which was confirmed by determined parameters of the tuyere.

[0028] The above examples are particular cases and do not cover all possible embodiments of the present group of inventions.

[0029] Those skilled in the art will appreciate that variations of the present device and method do not alter the matter of the invention, but only determine specific embodiments thereof.

Claims

1. A tuyere for bottom and side blowing, ***characterized in that*** the tuyere comprises a tuyere body having a passage, a main blast pipe, a protective blast pipe, a tuyere nose, a cooled element and a ceramometal headpiece, wherein the main blast pipe and the protective blast pipe are arranged coaxially with respect to each other, the ceramometal headpiece is disposed on the tuyere nose and is made of a material having an average thermal conductivity of at least 30 W/m°C and a phase transition latent heat of at least 1000 kJ/kg.

2. The tuyere according to claim 1, ***characterized in that*** the length of the ceramometal headpiece is determined by the formula:

$$L = 0.862 \cdot (P_{o2})^{-0.992},$$

where L is the length of the headpiece, millime-

ters,
P_{o2} is the partial pressure of oxygen of the main blast, MPa.

3. A method for cooling a tuyere according to claim 1, ***characterized in that*** the method comprises cooling the tuyere nose at the coolant flow rate of at least $25 \cdot 10^{-3}$ m^3/s per 1 m^2 of the surface area of the nose, and maintaining negative pressure within the cooled elements.

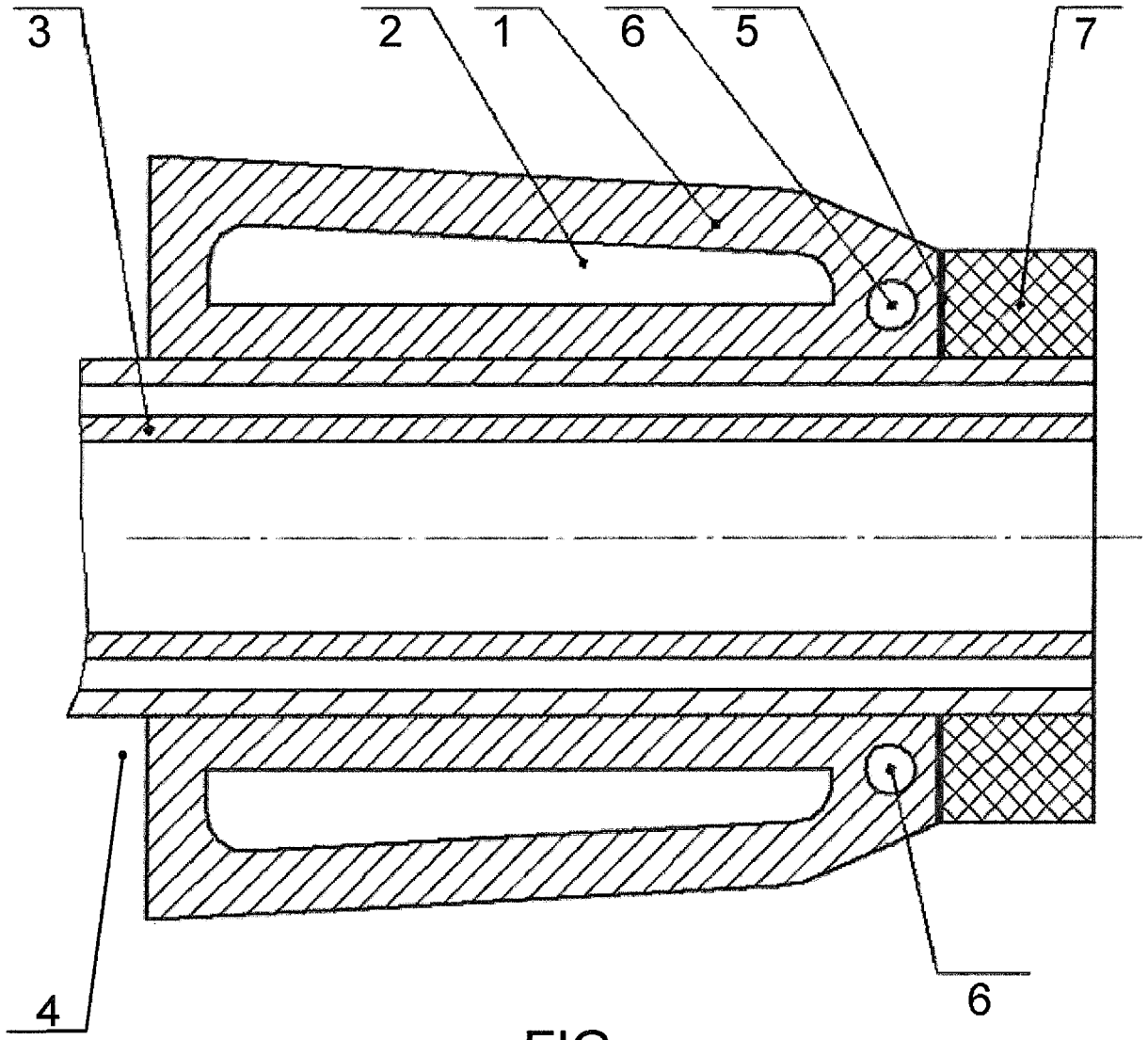

FIG.

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EUROPEAN SEARCH REPORT

Application Number
EP 18 18 2891

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	DE 10 2009 048351 A1 (SIEMENS AG [DE]; SIEMENS VAI METALS TECH GMBH [AT]) 2 June 2010 (2010-06-02) * paragraph [0013] - paragraph [0017] * * figure 1 *	1,3 2	INV. C21B7/16
X A	FR 2 549 489 A1 (SACILOR [FR]) 25 January 1985 (1985-01-25) * figure 1 * * page 3, line 15 - line 25 *	1,3 2	
X A	GB 518 921 A (FREYN ENGINEERING CO) 12 March 1940 (1940-03-12) * abstract * * figure 1 * * claim 1 * * page 1, line 15 - line 45 *	1,3 2	

TECHNICAL FIELDS SEARCHED (IPC)
C21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 August 2018	Gimeno-Fabra, Lluis

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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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28-08-2018

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- RU 2152441 **[0003]**
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