United States Patent [19]

Smejkal

[11] **3,882,726**

[45] **May 13, 1975**

[54] **WATER-COOLED LANCE OR PROBE DESTINED TO BE INSERTED INTO METALLURGICAL FURNACES**

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[22] Filed: **Aug. 6, 1973**

[21] Appl. No.: **385,724**

[30] **Foreign Application Priority Data**

Aug. 7, 1972 Austria 6789/72

[52] **U.S. Cl.** .... **73/343 R;** 73/359; 136/234

[51] **Int. Cl.** **G01k 1/12;** G01k 7/04

[58] **Field of Search** .... 73/343 R, 359; 136/231, 136/232, 233, 234, 235, 242

[56] **References Cited**

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[57] **ABSTRACT**

The invention relates to a water-cooled lance or probe destined to be inserted into metallurgical furnaces, comprising an inner tube, a concentrical outer tube and a guiding tube arranged between said inner and outer tubes for the formation of a coolant circulation, which lance or probe over part of its circumference and part of its longitudinal extension is exposed to increased heat influence. In the area of increased heat influence, the lance or probe is cooled to a greater degree by increasing the cooling area and the free current cross section there relative to the other parts of the lance or probe.

8 Claims, 2 Drawing Figures

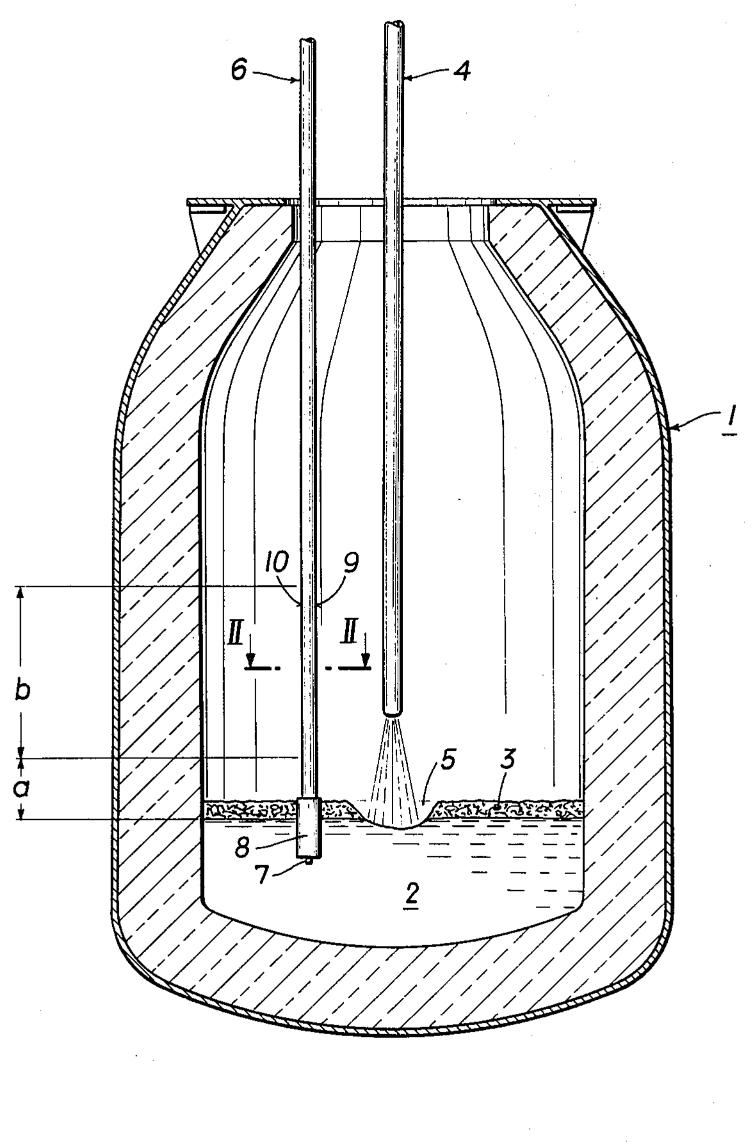


FIG. 1

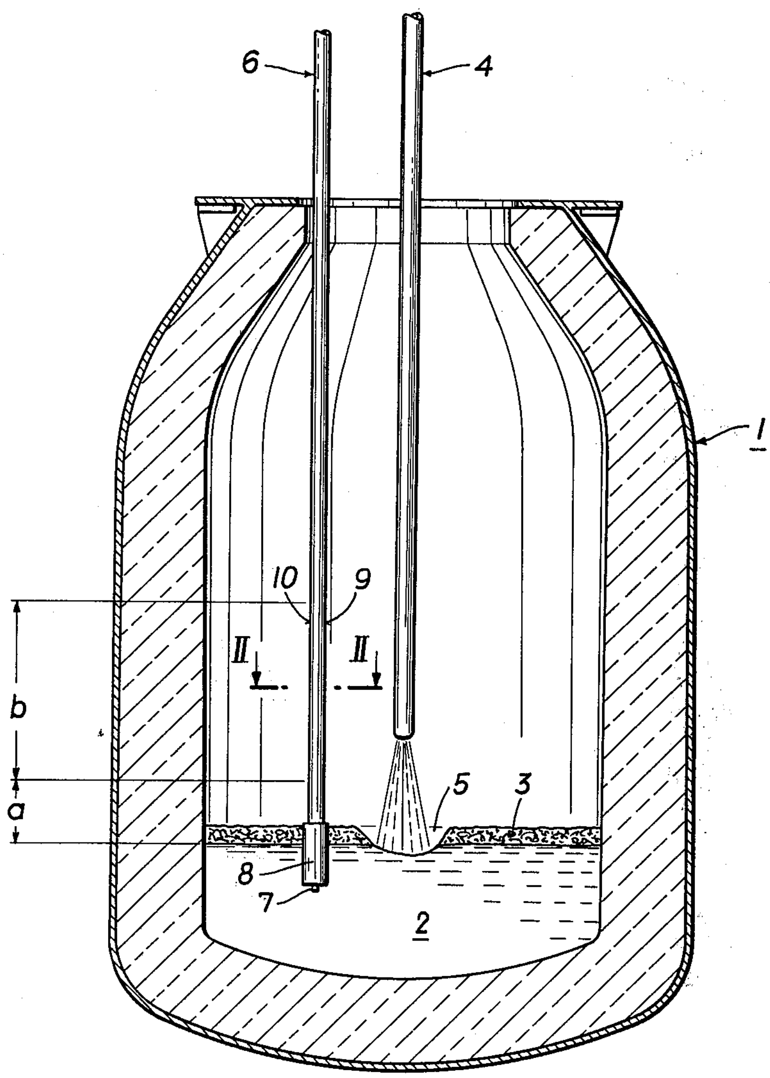
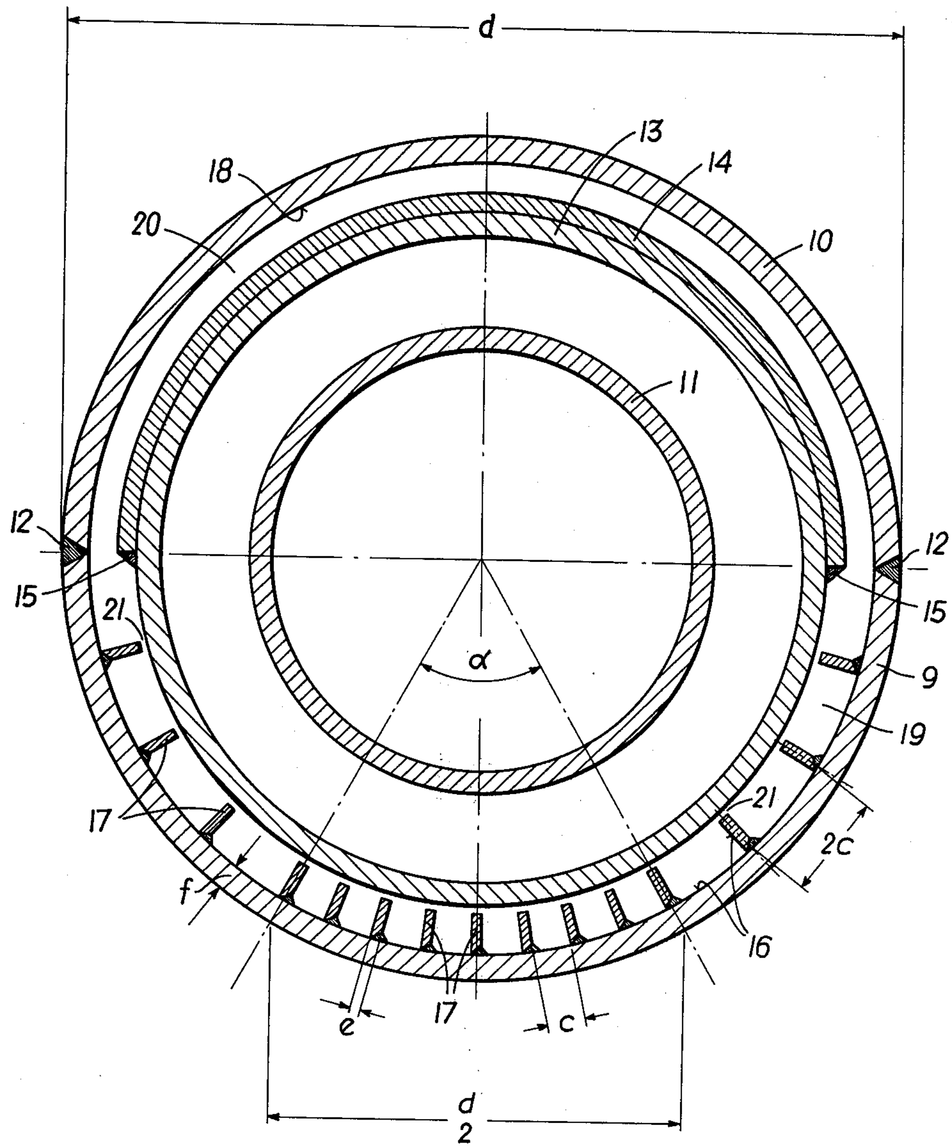


FIG. 2



WATER-COOLED LANCE OR PROBE DESTINED TO BE INSERTED INTO METALLURGICAL FURNACES

The invention relates to a water-cooled lance or probe destined to be inserted into metallurgical furnaces, comprising an inner tube, a concentrical tube and a guiding tube arranged between said inner and outer tubes for the formation of a coolant circulation.

In refining processes, such lances are used for blowing a gaseous refining agent, in particular pure oxygen, onto or into a hot liquid iron metal bath. With such lances also, missing heat can be supplied to the refining process. Such means for the supply of solid, liquid and/or gaseous fuel designed as burner lances have substantially the same construction as oxygen blowing lances. The group of lances that may be used in metallurgical technology also includes probes for continuously measuring the metal bath temperature, as described, for example, an Austrian Pat. No. 293,751 and No. 298,831. Measuring probes differ from blowing or burner lanches with regard to their head. While lances are provided with a jet or burner head, probes are provided with a probe head on which the measuring part containing a thermo-couple is releasably fixed. The measuring part is immersed into the melt. A compensating line is guided through the inner tube to connect the thermo-couple with an indicating means. Temperature measuring probes of this kind are further provided with a refractory protective brick (protective jacket) which is likewise releasably connected with the probe head. The jacket extends over the greatest part of the longitudinal extension of the measuring part and over the area where it is attached to the probe head. This protective brick protects the measuring part against the attacks of the slag.

When water-cooled lances are put to operation in melting furnaces, in particular in converters, great difficulties arise when part of the circumference of the lance is subjected to a greater exposure to heat for a short period or continuously. This is the case, for example, when in an oxygen blowing converter, at a distance from a centrally arranged blowing lance, a temperature measuring probe is arranged which immerses into the hot liquid bath. The strong heat radiation issuing from the so-called "burner spot" exerted onto one side of the outer tube of the temperature measuring probe, namely that turned towards the oxygen blowing lance, results in the distortion of the temperature measuring probe. Owing to this heat exposure of one side, that side of the external tube which is turned towards the blowing lance is expanded to a different degree than that side which is turned away from the blowing lance, so that the material is stressed beyond its yield point and will be disformed for ever. Thus, the temperature measuring probe is distorted in a manner that the measuring point — i.e. the lower end of the probe — slowly, from melt to melt, is moved in direction towards the blowing lance. This will lead to wrong measurements and, in case of greater distortions, lifting and lowering of the temperature measuring probe or driving into or out of the converter may provide difficulties. So, it has not been possible to overcome the difficulties caused by one-side heat exposure of the cooling jacket of lances or temperature measuring probes.

The invention is aimed at solving this problem and at creating a water-cooled lance or probe, in which the

material of the lance or probe will not be stressed excessively on one side by the influence of heat and in which bending and distortion of the lance or probe is avoided, without changing the outer form of the lance or probe. The invention shall be realized with simple means and without incurring greater costs.

In a lance or probe of the kind defined in the introduction, which over part of its circumference and part of its longitudinal extension is exposed to an increased influence of heat, the lance or probe is cooled, according to the invention, to a greater degree in the area of increased heat influence. In particular, the probe in this area is provided with a greater cooling area and a greater free current cross section than in its other parts.

For an increased cooling of the lance part which is exposed to increased heat influence, the lance or probe is preferably provided with ribs which are arranged in direction of the longitudinal axis of the lance to be heat conducting and integral with the inner side of the outer tube. If desired the lance is also provided with a shell-half which is arranged at that part of the lance which is turned away from the increased heat influence, at the outside of the guiding tube so as to reduce the current cross section for the cooling agent.

A preferred field of application of the invention is in a probe for continuously measuring the temperature of metal baths in converters, which may be inserted eccentrically from the top at a distance from a blowing lance into the hot liquid charge of the converter. A measuring part and a refractory jacket surrounding said measuring part to protect it against the influence of slag are fixed to the probe head. In such temperature measuring probes, that part of the outer tube of the probe which is turned towards the increased heat influence should have a cooling area which is twice as big as that of the part of the outer tube of the probe which is turned away from the increased heat influence.

A particular embodiment of such temperature measuring probes is characterized by the combination of the following features:

a. on the inner side of the outer tube half exposed to the increased heat influence ribs are arranged having a length of at least 1500 mm which are preferably fixed by welding;
b. in the measuring position of the probe, the lower edge of the ribs is at a distance of maximally 500 mm above the hot liquid metal;
c. the thickness of the ribs substantially amounts to $0.4 . f$, f being the wall thickness of the outer tube half;
d. the clear distance of the ribs in the middle area of the outer tube half, which corresponds to a central angle of 30° or to a width of $d/2$ of the outer diameter of the tube half, amounts to maximally $f . \sqrt{2}$ and is twice as much in the two marginal areas.

Preferably the ratio of the free current cross section for the cooling means in the area of the circumferential zone exposed to the increased heat influence to the free current cross section in the area of the remaining circumferential zone is 1.75 : 1.

In order that the invention may be more fully understood, an embodiment thereof shall now be further explained by reference to the accompanying drawings.

FIG. 1 is a vertical sectional view of an oxygen blowing converter with a centrally arranged blowing lance and a temperature measuring probe arranged at its side in measuring position.

FIG. 2 is a horizontal sectional view along the line II—II of the temperature measuring probe on enlarged scale. It illustrates the construction of the probe in an area where one of its sides is exposed to increased heat influence.

Numeral **1** denotes a refractory-lined, preferably tiltable oxygen blowing converter which contains a metal bath **2** covered with slat **3.** Above the metal bath, a water-cooled blowing lance **4** is positioned centrally so that by the oxygen blown onto the metal bath **2** a reaction zone **5** of increased temperature is formed which is called "burning spot." Eccentrically in the converter, parallel to the oxygen blowing lance **4,** a temperature measuring probe **6** is arranged to be liftable and lowerable. With its measuring part **7,** which is releasably fixed to the probe head, it is immersed into the melt **2.** A refractory protective brick **8** surrounds the measuring part **7** and protects the measuring part as well as the joining place at the probe head against the influence of the slag **3** and the intrusion of hot liquid metal **2.** That part of the water-cooled jacket of the temperature measuring probe **6** which is greatly stressed by heat radiation from the hot reaction zone **5** is denoted with **9,** while the opposite jacket part, which is less exposed to the heat, is denoted with **10.** In the area *b* of the probe, which area extends in upward direction, at a distance *a* from the surface of the hot liquid metal **2,** whereby *a* maximally amounts to 500 mm and *b* at least to 1500 mm, according to the invention the interior of the temperature measuring probe **6** is designed differently than the remaining probe part.

The probe is provided with an inner tube **11** which is connected with the outer tube, consisting of the tube halves **9** and **10,** at the lower end by means of the probe head. Concentrically between the inner tube and the outer tube, a guiding tube **13** is arranged, which ends at a distance from the probe head so as to provide in a known manner for a cooling agent circulation. In the annular space formed between the tubes **11** and **13,** the cooling water flows downwardly to the probe head, where it is deflected upwardly to flow back through the annular space formed by the outer tube **9, 10** and the guiding tube **13.** The outer tube half **9** turned towards the hot reaction zone **5** is connected to the opposite outer tube half **10** by means of welding seams **12.** In the area of the outer tube half **10,** which is less exposed to heat, a shell-half **14** is connected to the guiding tube **13** by means of welding seams **15.** According to the invention, the cooling effect is enhanced in the area of the outer tube half **9** which is more exposed to heat, which effect is achieved by welding ribs **17** onto the inner side of the tube half **9** so that in the annular space the cooling area **16** is increased to about twice the cooling area of the opposite side. The length *b* of the ribs extending in direction of the longitudinal axis of the temperature measuring probe **6** amounts to at least 1500 mm, as stated above. In the middle area of the tube half **9,** corresponding to a central angle α of 30° or to a width of $d/2$ (i.e. half of the outer diameter of the outer tube) the ribs **17** are arranged closely side by side. Their clear distance *c* depends on the wall thickness *f* of the tube half **9** and is to amount to maximally $f. \sqrt{2}$. The thickness *e* of the ribs **17** also depends on *f* and should amount to about $0.4 f$. In the two marginal parts of the tube half **9,** the clear distance between the ribs **17** is about twice as big as the area α, which means that it amounts to $2c$. The width of the ribs corresponds substantially to the clear distance between the guiding tube **13** and the tube half **9,** i.e. there is only a small gap **21** in between. Owing to this arrangement, the cooling area **16** on that side of the probe which is turned towards the reaction zone **5** or to the blowing lance **4** is twice as big as the cooling area **18** on the opposite side **10,** and the free current cross section **19** for the passage of the cooling water on that side which is greatly exposed to heat is about 1.75 times as big as the free passage cross section **20** on the opposite side. Thus, on that side of the probe which is exposed to heat, a substantially greater amount of cooling water is permitted to flow over the enlarged cooling area **16** so that any excessive heat stress is avoided there. Lances constructed according to the invention thus will no longer be distorted or bent.

What I claim is:

1. A water-cooled lance for use in metallurgical technology, such as a probe for continuously measuring the temperature of a metal bath, comprising an inner tube, a concentric outer tube, an intermediate guiding tube arranged between the inner and outer tubes so as to define inner and outer annular passages through which a coolant can be circulated, and means for effecting differential cooling of two different portions of a circumference of the lance along at least a part of the length of the lance, whereby a side of the lance exposed to a greater heat than an opposite side of the lance can be correspondingly cooled to a greater degree than said opposite side.

2. The lance set forth in claim **1,** wherein the differential cooling means includes surfaces bounding at least one of the annular passages, said surfaces having a greater cooling area adapted to be exposed to a coolant adjacent a portion of the circumference of the lance adapted to be exposed to a greater heat influence than adjacent other portions of said circumference, and said at least one annular passage, said passage having a greater free current cross section for a coolant adjacent that portion of the circumference of the lance adapted to be exposed to a greater heat influence than adjacent other portions of said circumference.

3. The lance as set forth in claim **2,** wherein the ratio of the free current cross section for a coolant in at least one of the annular passages adjacent a portion of the circumference of the lance adapted to be exposed to a greater heat influence to the free current cross section in said at least one of the annular passages adjacent other portions of the lance having a corresponding circumferential extent is 1.75 : 1.

4. The lance set forth in claim **1,** wherein the differential cooling means includes a plurality of ribs extending in the direction of the longitudinal axis of the lance and located adjacent a portion of the circumference of the lance adapted to be exposed to a greater heat influence, the ribs being heat conducting and integral with an inner side of the outer tube.

5. The lance set forth in claim **1,** wherein the differential cooling means includes a shell-half arranged around the exterior of the guiding tube so as to reduce the free cross section for a coolant in a portion of the outer annular passage adjacent a portion of the circumference of the lance generally opposite a portion of the circumference adapted to be exposed to a greater heat influence.

6. The lance set forth in claim **1,** wherein the lance is a probe for continuously measuring a temperature of a metal bath in a converter, the probe being insertable into the metal bath vertically and also eccentrically relative to the vertical central axis of the converter at a distance from a blowing lance, the probe having a probe head and fixed to the probe head a temperature measuring element and a refractory jacket surrounding said measuring element to protect it against slag influence, the differential cooling means including surfaces bounding the radially outer periphery of the outer annular passage adjacent a portion of the outer circumference of the outer tube adapted to be exposed to a greater heat influence than other portions of said outer circumference, said surfaces having a cooling area adapted to be exposed to a coolant in the outer annular passage which is twice as large as a cooling area that is also adapted to be exposed to a coolant in the outer annular passage, that is located opposite said portion of the outer tube adapted to be exposed to a greater heat influence, and that has a circumferential extent equal to the circumferential extent of said portion of the outer tube.

7. The lance set forth in claim **6**, wherein the differential cooling means includes a plurality of ribs extending longitudinally of the lance and attached to an inner surface of the outer tube adjacent the portion of the outer circumference of the outer tube adapted to be exposed to a greater heat influence, said portion of the outer circumference being equal to one-half the outer circumference of the outer tube, the ribs being heat conducting and each having a length of at least 1500 mm., the ribs also having a thickness of substantially $0.4.f$, where f is the thickness of the wall of the outer tube, and being circumferentially spaced apart a maximum distance of $f\ \sqrt{2}$ adjacent a central section of said portion of the outer circumference of the outer tube, said central section having a circumferential extent defined by an arc subtended by a central angle of 30°, the ribs being circumferentially spaced apart adjacent marginal sections of said portion of the outer circumference of the outer tube on either side of said central section a distance equal to twice the corresponding circumferential spacing of the ribs in said central section, the lance being adapted to assume a measuring position in a converter such that the lower ends of the ribs are at a maximum distance of 500 mm. above the surface of the liquid metal in the metal bath of the converter.

8. The lance set forth in claim **7**, wherein said ribs are attached by welding to the inner surface of the outer tube.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,882,726

DATED : May 13, 1975

INVENTOR(S) : Hellmuth Smejkal

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

Col. 1, line 7, after "concentrical" insert --outer--;

Col. 1, line 22, "lanches" should read --lances--;

Col. 1, line 62, after "So" insert --far--;

Col. 3, line 8, "slat 3" should read --slag 3--; and

Col. 3, line 54, "of the opposite" should read --on the opposite--.

Signed and Sealed this

fifth **Day of** *August 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
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