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[54] SELF-COOLING LANCE FOR OXYGEN BLOWING

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[52] **U.S. Cl.** .... **266/34 L**, 239/488
[51] **Int. Cl.** **C21c 7/00**
[58] **Field of Search** .... 239/132.5, 483, 488; 266/34 L, 34 LM

[56] **References Cited**
UNITED STATES PATENTS

481,088	8/1892	Chaney et al.	239/488
1,494,675	5/1924	Ehrhart	239/483
3,076,607	2/1963	Cordier	239/488
3,213,919	10/1965	Calzolari	239/488
3,269,829	8/1966	Belkin	266/34 L
3,353,808	11/1967	Norburn	266/34 L
3,645,520	2/1972	Acre	266/34 L
3,321,139	5/1967	DeSaint Martin	266/34 L
3,706,549	12/1972	Knuppel et al.	266/35
3,397,878	8/1968	Holmes et al.	266/41
3,504,856	4/1970	Hinkeldey et al.	266/34 L
3,608,880	9/1971	Gombert	266/41
3,703,279	11/1972	Saccamano et al.	266/41

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Attorney, Agent, or Firm—Connolly and Hutz

[57] ABSTRACT

An oxygen blowing lance has a narrow annular or ring-shaped channel formed between a pair of spaced tubes having a relatively small flow area. This accelerates the speed of flow enough to generate a cooling effect which eliminates the need for any extraneous cooling, such as water cooling. A speed of oxygen flow between 400 and 900 meters per second (at standard conditions of 760 mm Hg. and 0°C) limits the wall temperature of the lance at the nozzle outlet to about 500°C and prevents spalling and burning off. The hollow or ring-shaped oxygen channel makes the lance remarkably strong and rigid. The ring-shaped channel may be elliptical, triangular or rectangular as well as circular. A ring-shaped or circular annular cross-section having a thickness of from about 3 to 10 mm and preferably from 4 to 7 mm is particularly advantageous. The cooling effect of the oxygen in the annular or ring-shaped channel is enhanced by installing a helical coil in the annular channel. This increases the rate of flow and cooling effect of the oxygen and the spiral path of flow also provides cooling. The helical pitch of the coil may vary along the length of the lance to provide any desired control of speed of flow and resistance. The cooling effect of the oxygen may be further improved by adding small quantities of water into the oxygen stream.

10 Claims, 2 Drawing Figures

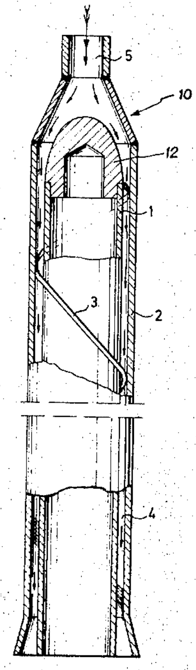
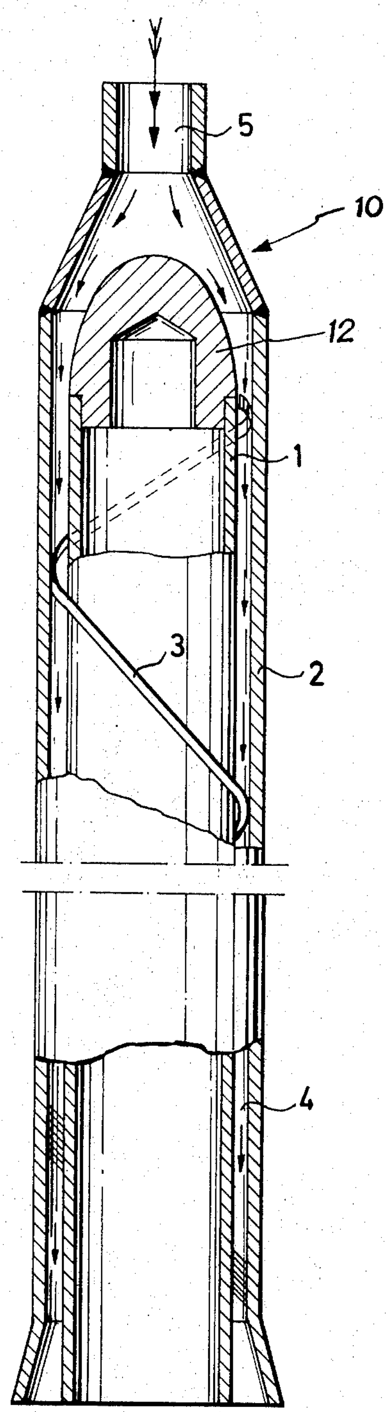


Fig.1.



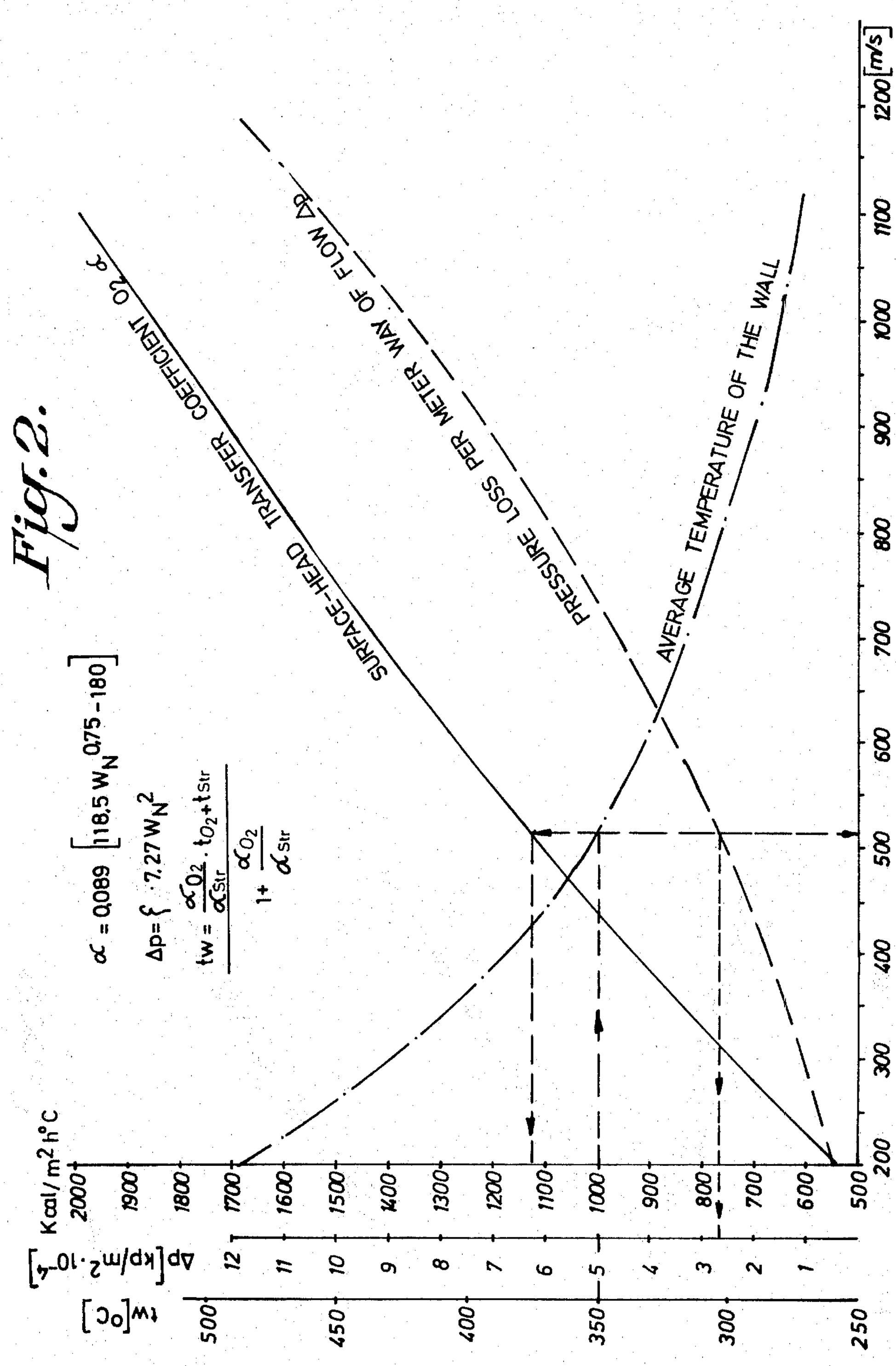

SURFACE-HEAD TRANSFER COEFFICIENT O2 α
PRESSURE LOSS PER METER WAY OF FLOW Δp
AVERAGE TEMPERATURE OF THE WALL
α = 0,089 [118,5 W_N^0.75 - 180]
Δp = ξ · 7,27 W_N^2
Kcal/m² h°C
Δp[kp/m²·10⁻⁴]
tw[°C]
[m/s]

Fig. 2.

SELF-COOLING LANCE FOR OXYGEN BLOWING

BACKGROUND OF THE INVENTION

This invention relates to a self-cooling lance for oxygen blowing. Presently used oxygen blowing lances are either consumable or permanent. Consumable lances are immersed in the molten bath and advanced into it as the blowing proceeds until they are too short for useful operation. Their short lance life is tolerated in order to inject oxygen under the surface of the molten metal. Attempts have been made to lenghthen the service life of immersed lances by suitable selection of materials and protective coatings. The extremely drastic thermal attack on the lance when it is immersed however prevents these measures from effectively lenghthening the life of such lances. This leaves remaining the cooling capacity of the oxygen blowing through the lance, which is not very successful in protecting it, and any other special cooling methods are disregarded or avoided.

Permanent oxygen blowing lances are used for refining molten steel by blowing oxygen into it. For these lances the relatively lower heat conditions permits various measures taken to preserve and protect the lance to result in an appreciable increase in service life. Extensive protective measures are therefore applied to permanent lances including the use of heat resistant, refractory, ceramic or flame-proof materials. Permanent lances are also provided with cooling conduits including single or multiple cooling canals, special coolants and oxygen conduits. All of these protective steps, particularly water cooling, are very complicated and expensive. They require circulating systems, pumps and in some instances heat exchangers for the coolant and the like. An object of this invention is to provide a simple and economical method to prevent the rapid consumption of oxygen blowing lances. Another object is to provide a self-cooling lance having a simple and economical structure.

SUMMARY OF THE INVENTION

In accordance with this invention oxygen is conducted through a channel having a ring-shaped cross-section adjoining the outer surface of the lance.

This novel process and corresponding lance structure cools the lance enough to eliminate the need for any extraneous cooling, such as water cooling. The channel is narrow enough to accelerate the speed of oxygen flow, for example, between 400 and 900 meters per second (at standard conditions of 760 mm Hg. and 0°C). This unexpectedly limits the wall temperature of the lance at the nozzle outlet to about 500°C. At this temperature neither spalling nor burning off of the lance occurs. If oxygen were conducted at the aforementioned flow rate through a channel having a circular cross-section, its diameter would be so small that a lance of effective length, which must extend in most instances about 2 or 3 meters into the furnace, would not be strong enough to be structurally rigid. The hollow or ring-shaped oxygen channel of this invention is however remarkably strong and rigid. The ring-shaped channel may be elliptical, triangular or rectangular as well as circular. A ring-shaped or circular annular cross-section having a width of from about 3 to 10 mm and preferably from 4 to 7 mm is particularly advantageous. The cooling effect of the oxygen in the annular or ring-shaped channel may be enhanced by installing a helical coil in the annular channel to divide it into a pair of parallel spiral or helically shaped conduits. This increases the rate of flow and cooling effect of the oxygen and the spiral path of flow also provides additional cooling. The helical pitch of the coil may vary along the length of the lance to provide any desired control of speed of flow and resistance. The cooling effect of the oxygen may be further improved by adding small quantities of water into the oxygen stream.

BRIEF DESCRIPTION OF THE DRAWINGS

Novel features and advantages of the present invention will become apparent to one skilled in the art from a reading of the following description in conjunction with the accompanying drawings wherein similar reference characters refer to similar parts and in which:

FIG. **1** is a cross-sectional view in elevation, broken in length, of an oxygen blowing lance which is one embodiment of this invention; and

FIG. **2** is a graph of various operating characteristics of the lance shown in FIG. **1**.

In FIG. **1**, is shown a self-cooling oxygen blowing lance **10** including an elongated inner tube **1** within outer tube **2** which forms between them a narrow ring-shaped annular slot **4** about 5 mm wide for conducting a flow of oxygen. Helical coil **3** having an angular pitch of 25.4° is installed in slot **4**. Outer tube **2** is made of a heat resistant material, such as a refractory or ceramic material or a specially heat-resistant steel, to protect it from penetration by the agitated molten metal.

The blowing oxygen is introduced into the lance through upper inlet connection **5** and about curved plug **12** at the top of inner tube **1** into annular slot **4** in the direction of the illustrated arrows. Spiral or helical coil **3** further increases the speed of the flow of oxygen and channels it in a spiral path. This increase in speed and spiral flow provide cooling effects which limit the temperature of the lance to about 500°C and therefore effectively protect it against burning, spalling and scaling. The following computation illustrates the conditions obtained by a lance operated and made in accordance with this invention and it corresponds to the conditions shown on the graphic illustration provided in FIG. **2**.

FIG. **2** shows conditions for a lance **10**, having a length, L=2 m., operating in a 30-ton electric furnace having a wall radiating temperature of 1,300°C and a heat transfer factor of $\alpha Str = 240$ kcal/m²h°C. The oxygen throughput was taken on the basis of volume, $V = 1{,}000\ Nm^3/h$. N means at standard conditions. The slot width of the narrow annular slot is 5 mm with an outer tube **2** having an inside diameter of 70 mm. The predetermined average wall temperature, $t_w = 350$°C. The O_2 speed, referring to standard conditions, W_N is 515 m/s (see diagram). The heat transfer factor $\alpha O_2 = 1{,}125$ kcal/m²h° C (see diagram). The flow resistance coefficient per running meter of flow length, $\Delta\ p = 2.7 \cdot 10^4$ kg/m² (see diagram). These parameters result in the following calculations:

1. Heat absorption

$Q = F \cdot \alpha \cdot t$

$Q = 0.08 \cdot \pi \cdot 1{,}000 \cdot 240 = 120{,}000$ kcal/h

F is area in m^2

2.

a. Oxygen heating

$\Delta t = Q/V \cdot C_p = 388°C$
Cp is specific heat at constant pressure.
b. Final Oxygen Temperature
t_E 330° C
3. Annular slot measurements
$F = V/C = 1,000/\mathbf{3,600} \cdot 515 = 0.54 \cdot 10^{-3}\ m^2$
C is O_2 speed
4. Angle of pitch of the coil
$\sin \alpha = 108/\pi \cdot 80 = 0.43 = 25.4°$
5. Pressure loss
$P = \Delta p \cdot L = 2.7 \cdot 4.65 = 12.6$ atmospheres absolute pressure.
6. Composition
a. lance length: $L = 2$ m
b. O_2 — throughput: $V = 1,000\ Nm^3/h$
c. Slot outer diameter: $D_a = 80$ mm ϕ
d. Slot inside diameter: $D_i = 70$ mm ϕ
e. Slot width: $s = 5$ mm
f. Average wall temperature: $t_w = 350°$ C
g. Angle of pitch of the spiral coil: $\alpha = 25.4°$
h. Pressure loss: $P = 12.5$ atmospheres absolute pressure
i. Wall temperature at the nozzle outlet: $t_{wE} = 500°C$

Note: ϕ here means approximately.

I claim:

1. A process for protecting a gaseous fluid blowing lance particularly a blowing lance for an industrial metal melting furnace characterized in that the gaseous blowing fluid is conducted through a ring-shaped zone in the lance contiguous with the outer surface of the lance, the zone being relatively thin on the order of from about 3 to 10 mm., the distance across the ring-shaped zone being substantially greater than the cross section of the zone, and the gaseous blowing fluid being provided to the zone under sufficient pressure to cause a flow of gaseous blowing fluid through the zone from about 400 to 900 meters per second at standard conditions sufficient to cool the wall of the lance at its outlet to prevent spalling and burning.

2. A process as set forth in claim **1** wherein the flow of gaseous blowing fluid is channeled in a helical path through the ring-shaped zone.

3. An oxygen blowing lance comprising an outer tube, an inner tube disposed within and spaced a short distance from the outer tube to provide a ring-shaped channel between them, an inlet connection on the lance, flow channeling means adjacent the inlet connection of the lance for conducting a flow of oxygen through the ring-shaped channel, the ring-shaped channel having a width of from about 3 to 10 mm whereby the flow of oxygen is increased to a rate from about 400 to 900 meters per second at standard conditions which is high enough to effectively cool the lance.

4. An oxygen blowing lance as set forth in claim **3** wherein the width of the ring-shaped channel is from about 4 to 7 mm.

5. A lance as set forth in claim **3** wherein the flow channeling means includes a plug in the end of the inner tube disposed adjacent the inlet connection.

6. A lance as set forth in claim **3** wherein a spiral element is disposed in the ring-shaped channel to cause the oxygen flowing through it to flow in a spiral path whereby its cooling effect is enhanced.

7. A lance as set forth in claim **6** wherein the spiral element has a varying pitch whereby the cooling effect of the oxygen flow along the length of the lance is controlled.

8. A lance as set forth in claim **3** wherein the outer tube is a heat resistant material.

9. A lance as set forth in claim **8** wherein the outer tube is a refractory material.

10. A lance as set forth in claim **9** wherein the outer tube is a ceramic material.

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