

April 1, 1969

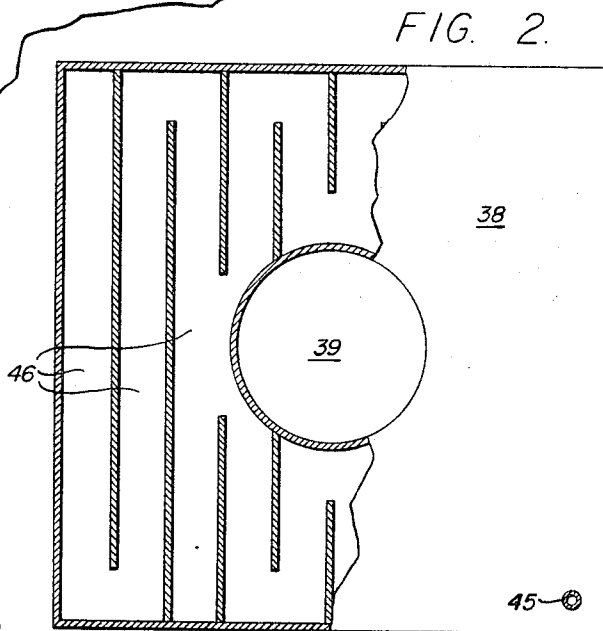
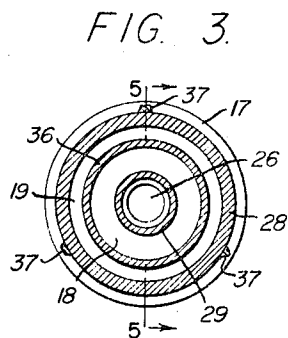
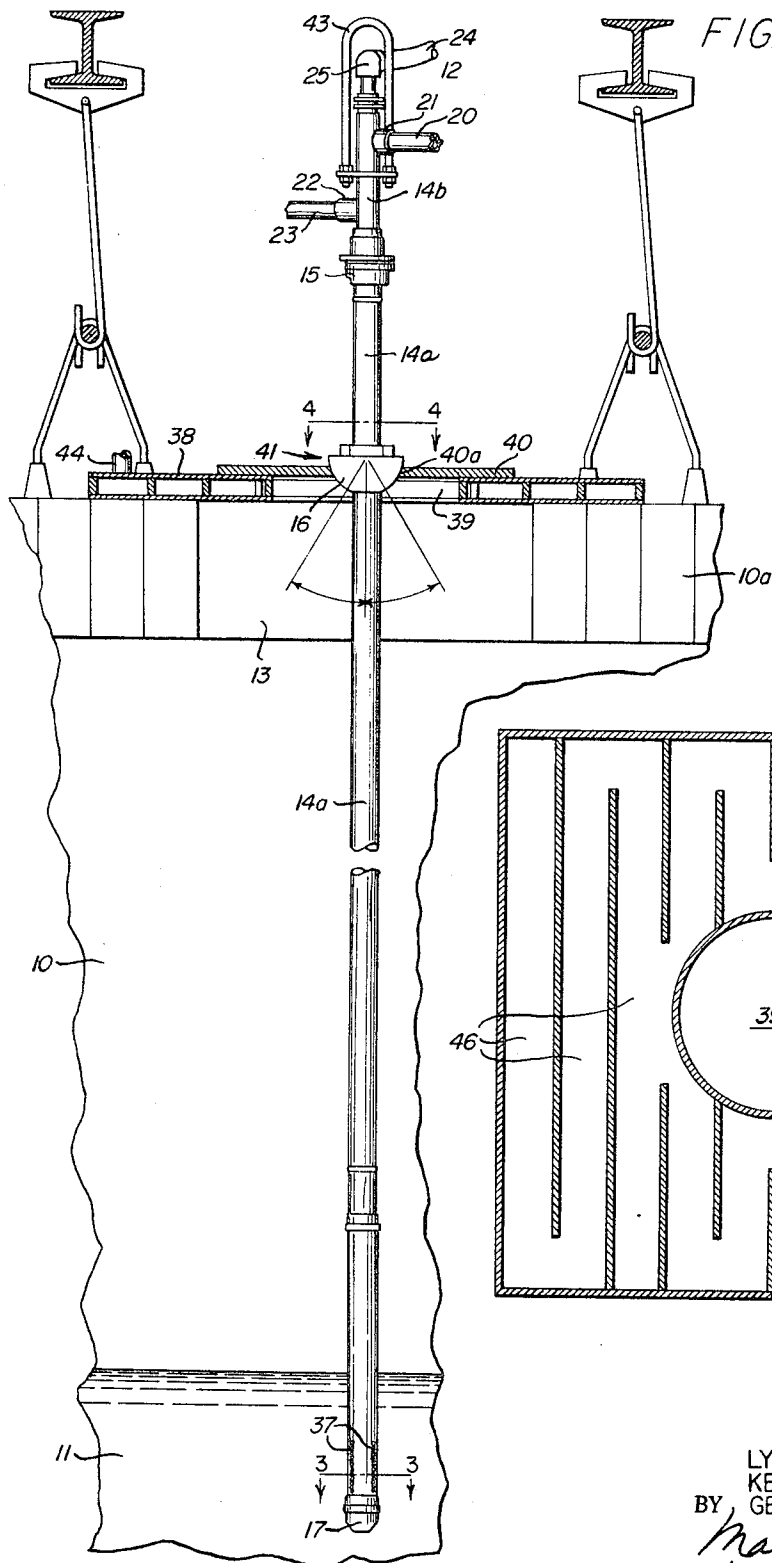
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3,436,068

OXYGEN LANCE

Filed Oct. 14, 1965

Sheet 1 of 2



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FIG. 5

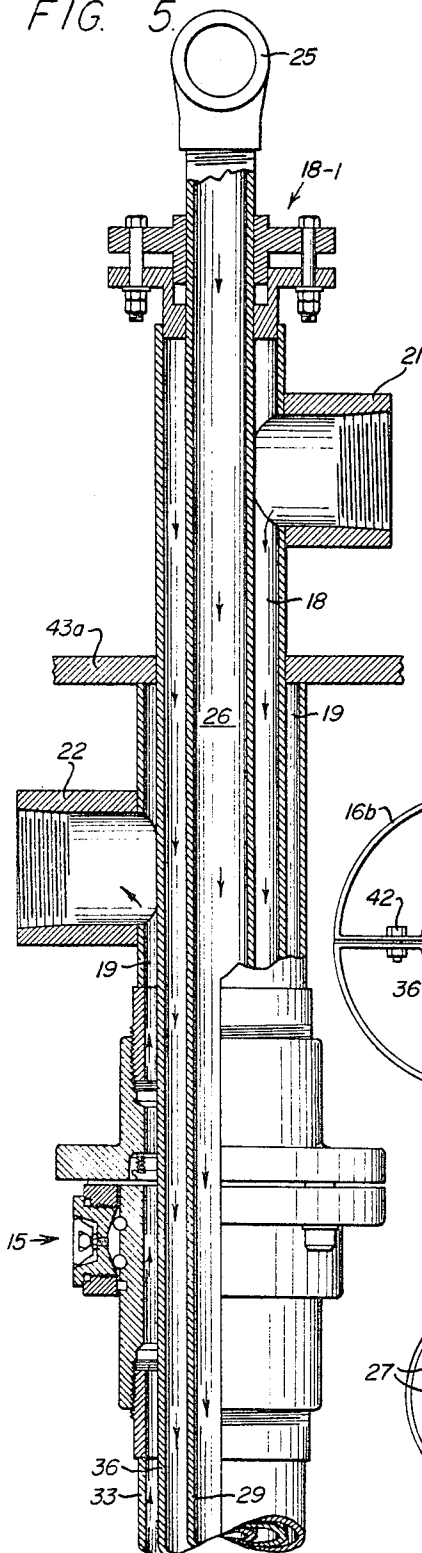


FIG. 6

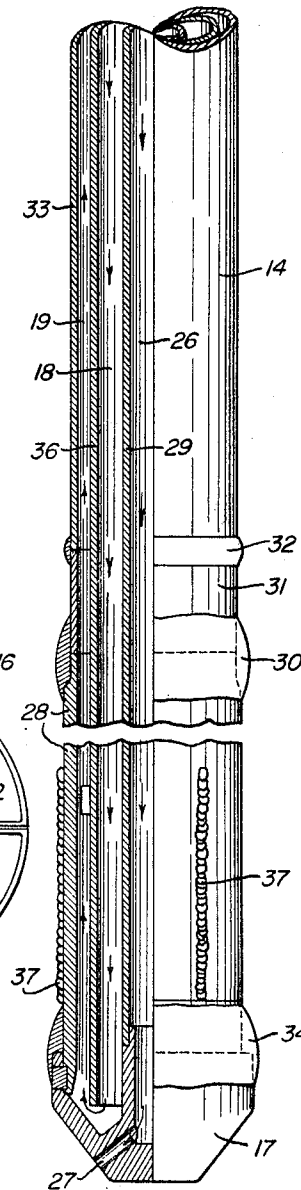


FIG. 4

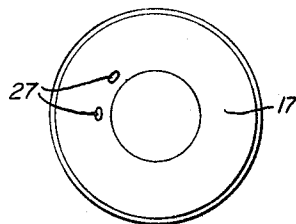
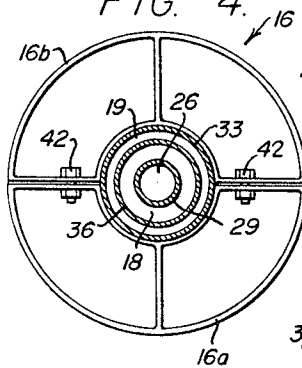


FIG. 7

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OXYGEN LANCE

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U.S. Cl. 266—34

13 Claims

ABSTRACT OF THE DISCLOSURE

An oxygen lance for the injection of oxygen into a molten material. The lance is of concentric tubular construction and includes a non-ferrous immersible lower portion, including a gas-injection tip, a universal pendulous mounting to support the lance from a furnace roof and a swivel joint connecting the upper and lower portions of the outer tube of the lance shank. The universal pendulous mounting permits the lance to swing when contacted by solid masses floating in the molten material. The swivel joint permits the direction of the discharge of oxygen into the molten material to be changed while the lance remains in place.

This invention relates to lances for the introduction of gases into molten materials. It is particularly concerned with the construction of liquid-cooled lances for the introduction of oxygen or oxygen-enriched air into molten metallic materials during copper smelting operations.

In copending application Ser. No. 273,767 filed on Apr. 17, 1963, jointly by George C. Beals, John Kocherhans, and Kendal M. Ogilvie, entitled, "Reverberatory Matte-Smelting Process," and now Patent No. 3,222,162, granted Dec. 7, 1965, a method of reverberatory smelting of copper ore materials is disclosed which involves the splashing of molten matte and slag onto charge piles of finely divided ore concentrate by means of streams of oxygen or oxygen-enriched air injected into or onto the molten bath. In the carrying out of such method, it is highly advantageous that the oxygen lances used to supply the gas to the bath be capable of quick and easy change from time to time in direction of discharge, so as to control the direction of splash of the molten material, and thereby control the temperature of the molten bath. If splashing at any given location causes an excessive amount of unfused material to be washed into the bath, it is imperative that the direction of lance discharge be changed for a time to prevent bath temperature from being unduly lowered by the washing of additional unfused material thereinto.

An object in the making of this invention was to provide for the desired change in direction of lance discharge, without removing the lance from the furnace.

In the carrying out of the aforesaid method, it has been found that often there are masses of unmelted materials that float on the surface of the molten bath and tend to bend the slender shank of a lance if and when they come in contact with it, that the immersed portion of the lance is subject to rapid deterioration, and that the cooling effect of the injected gas tends to freeze a portion of the molten material in the area immediately surrounding the injection tip and the adjacent shank portion to produce a capping of solidified material that deflects the injected gas upwardly between it and the lance shank and greatly accelerates lance deterioration.

Accordingly, other objects were to provide adequate support for the lance, while enabling it to accept pressure from floating masses of unmelted material without breaking or bending; to minimize burning and erosion of the lance, especially the immersed portion thereof; and to safeguard the operation.

Outstanding features of this invention for the accomplishment of the foregoing objects are the provision of a swivel mounting for an outer tubular portion of the lance shank that carries a gas-injection tip at its lower end, so such outer tubular portion and tip can be conveniently rotated as a unit to different gas-injection positions; the provision of a universal pendulous mounting for the lance through the heat-reflective arch that forms the top of the furnace, so the lance shank will swing in any direction when pushed by floating masses of solids; the proper selection of materials for the lance, both externally and internally; and the provision of formations on the outer surface of the lance shank adjacent to the gas-injection tip for anchoring the ring or collar of solidified material to the lance shank as the material freezes therearound and for thereby preventing upward flow of injected oxygen in proximity to the lance shank.

The injection tip of the lance and the adjacent lower shank portion must be made of a nonferrous metal, so as to be relatively non-reactive with the injected oxygen and so as to have high heat conductivity for transmitting heat from the surrounding bath, via the outer walls of the shank, to a coolant circulated internally of the lance. Copper or copper base alloys have been found to be very satisfactory, but, when the coolant is a liquid hydrocarbon, such as oil, as it should be for safety considering the explosive reaction of water with molten copper matte, the inside surfaces contacted by the circulating coolant should be nickel or chrome plated or protected by a coating of some other suitable material from direct contact with the oil, to prevent decomposition of the oil due to catalytic action of copper at high temperature.

The swivel mounting of the injection nozzle and the lower outer portion of the lance shank to which it is fastened is preferably accomplished by utilization of a swivel joint of standard construction providing a fluid-tight seal. A "Chiksan DS Series" type of swivel joint manufactured by the Chiksan Company, Brea, Calif., has proven satisfactory. It should be adjusted or modified to have considerable resistance against rotation, so there is no swivel movement except during intentional change from one position to another, which is normally accomplished manually by the use of wrenches.

For the universal pendulous mounting of the entire lance relative to the furnace structure, the upper portion of the lance shank is preferably provided with a supporting collar of upwardly and outwardly flaring formation, that is adapted to be received by and rest freely on the rim of an opening in the support structure through which the lance is passed. Such support structure advantageously includes a liquid-cooled entry block, having an opening therethrough sufficiently large to permit wide swings of the lance from side to side, and a slide plate resting freely on the entry block over the opening and itself having a receiving opening for the lance, with a rim against which the supporting collar of the lance rests to provide for the desired universal pendulous movement.

As so constructed, it is not only possible for the lance to swing on its supporting rim or seat when floating masses of the charged solid materials press against it, but it is also possible to freely move such rim or seat from place to place within the limits of the opening in the entry block by merely sliding the plate from place to place. The slide plate additionally serves to seal the opening through the entry block against significant infiltration of air into the furnace.

There are instances other than copper smelting operations where it is desirable to inject oxygen, oxygen-enriched air, or other gases into a bath of molten metal or other material. It is apparent that various features of this invention are also applicable to these instances.

In the accompanying drawings is shown a specific em-

bodiment of the invention constituting what is presently regarded as the best mode of carrying it out in actual practice. From the detailed description of this presently preferred form of the invention, other more specific objects and features will become apparent.

In the drawings:

FIG. 1 represents a fragmentary vertical section taken through a reverberatory smelting furnace equipped with an oxygen-injection lance constructed and mounted in accordance with the invention, the lance being shown in elevation;

FIG. 2, a top plan view of the entry block with slide plate and lance removed;

FIG. 3, an enlarged horizontal section taken on the line 3—3 of FIG. 1;

FIG. 4, a similar section taken on the line 4—4, FIG. 1;

FIG. 5, a fragmentary, axial, vertical section taken through an upper portion of the lance, including the swivel joint between upper and lower shank parts, the view being partially in elevation;

FIG. 6, a fragmentary, vertical section taken on the line 5—5 of FIG. 3; and

FIG. 7, a bottom plan view of the gas-injection tip, showing directional orientation of the discharge orifices.

Referring to the drawings:

The illustrated embodiment of the invention is applied to reverberatory furnace 10, FIG. 1, for the smelting of copper sulfide concentrates to provide a molten bath 11 of matte and slag, into which oxygen or oxygen-enriched air is injected by an oxygen lance 12. The lance extends through a receiving hole 13 specially provided in the suspended arch roof 10a of the furnace, and is itself suspended from such roof by means of a universal pendulous mounting so as to be fully yieldable under pressure from floating masses of unmelted ore materials (not shown) charged into the furnace.

The oxygen lance 12 has a shank 14, whose lower portion 14a is rotatably connected to its upper portion 14b by means of a swivel joint 15, which, as previously mentioned, is advantageously of "Chiksan DS Series" type. At a convenient distance below such swivel joint, the lower shank portion 14a is provided with a suspension collar 16 of upwardly and outwardly flaring formation as part of the universal pendulous mounting. Thus, the lower shank portion of the lance, which has rigidly secured thereto a directional injection tip 17, can be easily and quickly adjusted to a new directional setting by a workman using a wrench. In this connection, it should be noted that a swivel point of the type specified is normally adjusted so as to strongly resist rotation of one part relative to the other and can ordinarily be used without a special set screw or removable-pin locking device.

As is customary with oxygen lances, the lance 12 is constructed for forced cooling by a circulating liquid. For this purpose, it is provided with internal passages, 18 and 19, FIGS. 5 and 6, extending longitudinally of its shank. The liquid coolant is supplied to downflow passage 18 from any suitable source through a flexible hose 20, FIG. 1, and a nipple connection 21 and is discharged from up-flow passage 19 through a nipple connection 22 and a flexible hose 23 for flow through a heat exchanger (not shown) before being recirculated back to and through the lance. The gas to be injected is supplied from any suitable source through a flexible hose 24 and pipe fitting 25 to a central flow passage 26 that extends through the length of the lance and terminates in the injection tip 17 in direct flow communication with injection passages 27.

As shown, see especially FIG. 7, these injection passages are located on respective radii that make an acute angle, so gas injection will be directional. In other instances of use, where directional injection is not necessary or desired, the injection passages can be symmetrically arranged and the swivel joint can be eliminated.

The lance is fabricated for maximum durability. To this end, the lower outer portion of the shank is a tube 28,

FIG. 6, of a non-ferrous metal, preferably copper or a copper-base alloy. It should be as long as the maximum depth of immersion of the lance in the molten bath. The injection tip 17 is of the same or similar material.

It is convenient and entirely satisfactory from an operational standpoint that tube 28 be brazed with a wide and thick band of brazing metal, as at 30, to a relatively short collar 31 of steel, and that this collar, in turn, be welded, as at 32, to an elongate tube 33 of steel, which extends up to the swivel joint 15. In this way, the brazing can be done conveniently without the necessity of handling the relatively long tube 33. Tip 17 is advantageously similarly brazed, as at 34, to tube 28, and connects with internal tube 29 in a close overlap joinder 34 that permits essentially sealed rotation of such tip relative to such tube 29 when the direction of gas injection is changed from time to time. Partition tube 36, that defines coolant flow channels 18 and 19, need not be of any special material. A packing gland 18-1, FIG. 5, seals the top of channel 18.

As previously indicated, the coolant should not be water, because of its explosive reaction with copper matte should it accidentally escape the confines of the lance. A hydrocarbon liquid of low volatility, such as oil, has been found to be a very satisfactory coolant when the internal surfaces of copper or copper base alloy which it contacts are protectively coated, as by plating with a non-reactive metal (not shown).

Anchoring formations externally of the immersion tube 28, for preventing relative displacement of the ring or collar (not shown) of material of the bath 11 that tends to freeze about the lance shank by reason of the cooling action of the injected gas, are provided in this instance by longitudinally extending beads 37 of metal applied by brazing at intervals circumferentially of such tube 28.

The universal pendulous mounting for the lance, of which suspension collar 16 forms a part, includes an entry block 38, FIGS. 1 and 2, adapted to rest on the suspended arch roof 10a over hole 13. An opening 39 centrally of such block accommodates the lance 12, which is supported by a slide plate 40 resting freely on the entry block over opening 39. The lance extends through an opening 41 centrally of the slide plate, and suspension collar 16 rests freely on the defining rim 40a of such opening, which is of downwardly convergent contour mated with the external contour of collar 16 as a seat to accommodate universal pendulous movement of the lance. The lance itself advantageously serves as a limit stop against the seat 40a. If necessary, plate 40 will slide to further accommodate floating masses impinging against the lance shank. As shown in FIG. 4, suspension collar 16 is conveniently fabricated in two sections 16a and 16b, which are clamped to the tube 33 of the lance shank by means of bolts 42.

A lifting yoke 43 enables a crane to conveniently install or remove the lance 12 with respect to the furnace 10. As shown, its plate member 43a, FIG. 5, serves to close the upper end of coolant flow channel 19.

The entry block is liquid cooled. Since there is little danger of leakage, it may be water cooled. Water is run into and discharged from the block through respective pipes 44, FIG. 1, and 45, FIG. 2, and flows back and forth along a sinuous passageway 46 internally of the block.

Whereas there is here illustrated and specifically described a certain construction of apparatus which is presently regarded as the best mode of carrying out the invention, it should be understood that various changes may be made and other constructions adopted without departing from the inventive subject matter particularly pointed out and claimed herebelow.

We claim:

1. A lance for the injection of a gas into a molten material below the surface thereof, comprising an elongate tubular shank having upper and lower parts and walls formed with internal passages for the circulation of a liquid coolant therethrough; a gas-injection tip at

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the lower end of the shank having discharge passages at one side thereof, said tip and an elongate portion of said lower part of said shank adjacent said tip being of non-ferrous metal and adapted for immersion into said molten material; a normally rigid, swivel joint joining said upper and lower parts of the shank and enabling the lower part to be rotated relative to the upper part to change the direction of discharge from the nozzle when desired; means for introducing a gas into the upper part of the shank for flow to and out of said tip; and means for circulating a liquid coolant through said internal passages.

2. A lance according to claim 1, wherein the non-ferrous metal includes copper; the internal passages extend through the lower portion of the lower part of the shank into the tip; and the internal wall surfaces of said passages are coated with a protective material to prevent direct contact of the coolant by copper.

3. A lance according to claim 2, wherein the walls of the shank include a tubular outer wall formed of mutually independent upper and lower parts connected to upper and lower parts of the swivel joint, respectively; a continuous tubular inner wall forming a central passage for gas flow; and a continuous tubular partition wall between said outer and inner walls, forming downflow and upflow passages for the liquid coolant.

4. A lance according to claim 1, wherein at least the lower portion of the lower part of the shank is cylindrical and is provided externally with formations for anchoring frozen portions of the otherwise molten material when the tip of the lance is immersed in said molten material.

5. A lance according to claim 1, additionally including a universal pendulous mount for support on the heat-reflective arch of a reverberatory furnace above a hole therein through which the lance shank extends.

6. A lance according to claim 5, wherein the universal pendulous mount includes a liquid-cooled entry block for covering the hole through the heat reflective arch of the furnace, said block itself having a smaller hole therein through which the lance shank extends.

7. A lance according to claim 6, wherein the universal pendulous mount further includes a slide plate adapted to freely rest on the entry block over the hole therein and itself having a smaller hole therein through which the lance shank extends and forming a seat as part of said mount.

8. A lance for the injection of a gas into a molten material beneath the surface thereof, comprising an elongate, liquid cooled, tubular shank having a non-ferrous gas-injection tip at its lower end; and a universal pendulous mount attached to said shank in position to support said lance on the heat reflective arch of a reverberatory furnace above a hole therein when said shank is inserted through said hole to immerse the lower portion thereof into said molten material.

9. A lance according to claim 8, wherein the universal pendulous mount includes a liquid-cooled entry block for covering the hole through the heat reflective arch of the furnace, said block itself having a smaller hole therein through which the lance shank extends.

10. A lance according to claim 9, wherein the universal pendulous mount further includes a slide plate adapted to freely rest on the entry block over the hole therein and itself having a smaller hole therein through which the lance shank extends and forming a seat as part of said mount.

11. A lance according to claim 1, wherein the shank walls include an upper outer tubular wall portion of steel and a lower outer tubular wall portion of copper or a copper base alloy forming the outer immersion portion of the lance; and an intermediate tubular portion of steel between said upper wall portion and the lower, non-ferrous metal part of the shank, said intermediate portion being brazed to said lower part and welded to said upper portion.

12. A lance according to claim 4, wherein the anchoring formations are longitudinal beads of metal brazed to the outer portion of the lance, externally thereof and extending upwardly from the gas-injection tip.

13. In combination, a furnace adapted to hold a bath of molten material and having a roof with a hole therein; a lance extending through said hole for the introduction of gas into said furnace, said lance comprising an elongate tubular shank having an immersible, gas-injection tip, and means for introducing a gas into and through said shank and tip; and universal pendulous means supported by the furnace roof and secured to the upper portion of said lance in position holding said shank with its tip immersed in said bath of molten material.

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U.S. Cl. X.R.

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