

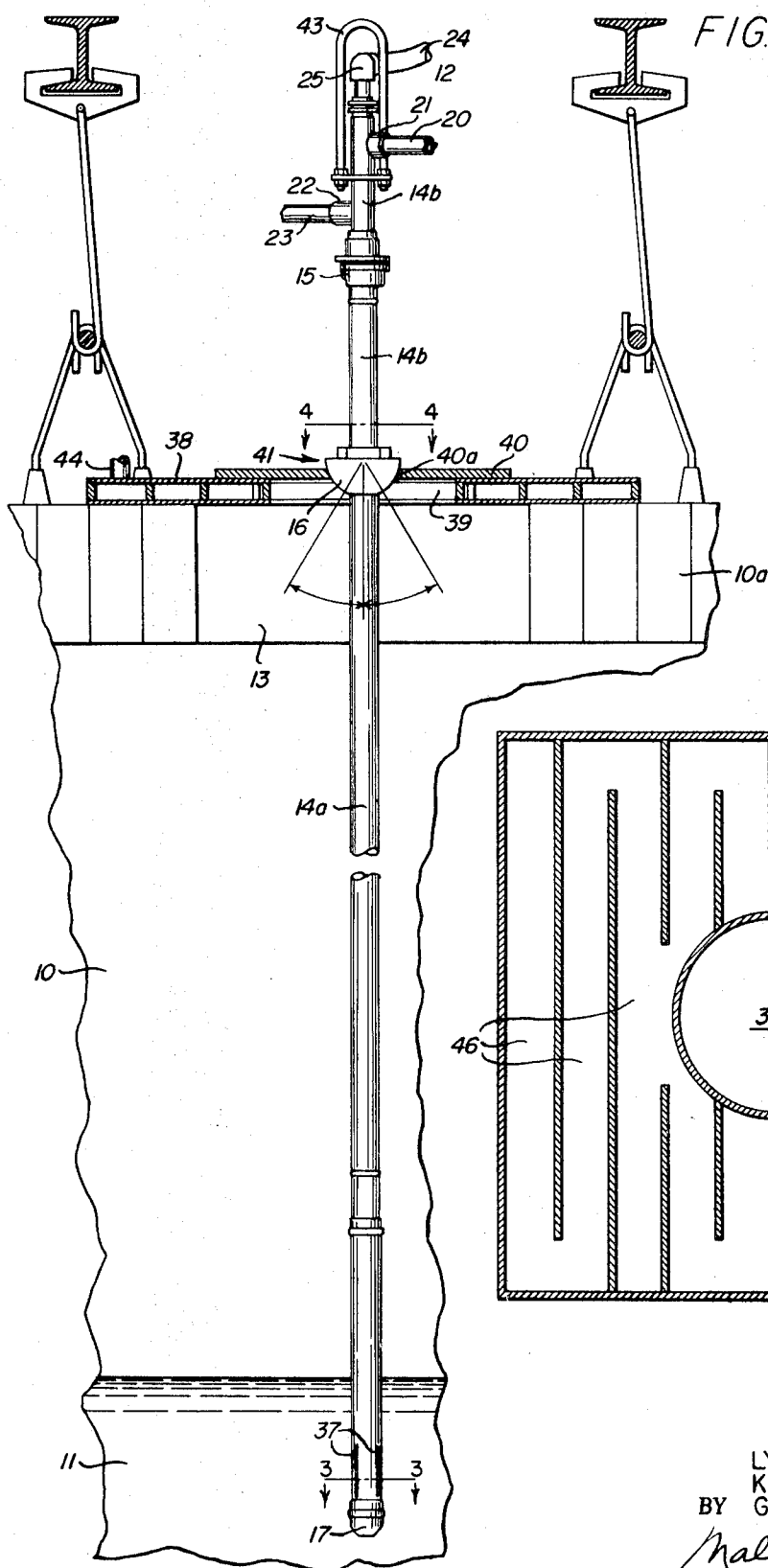


FIG. 1.

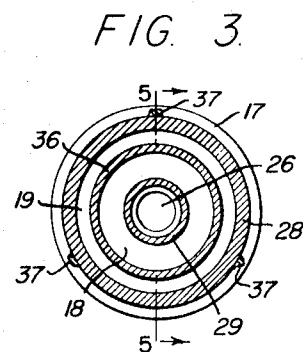


FIG. 3.

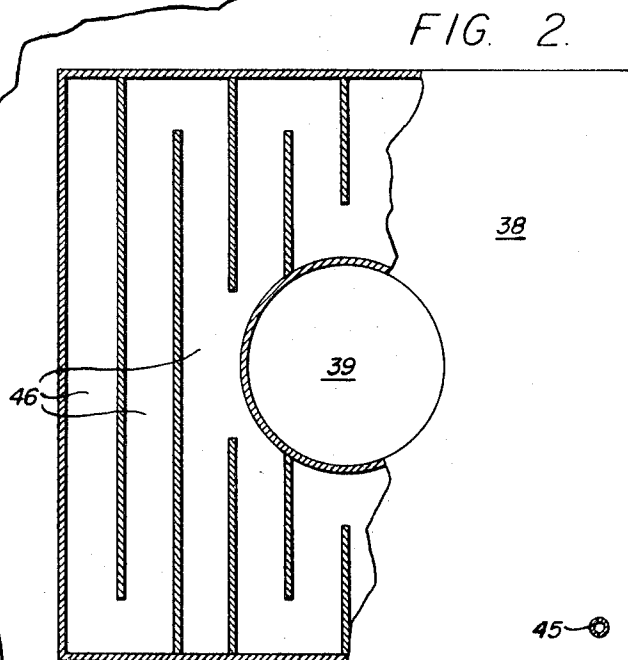
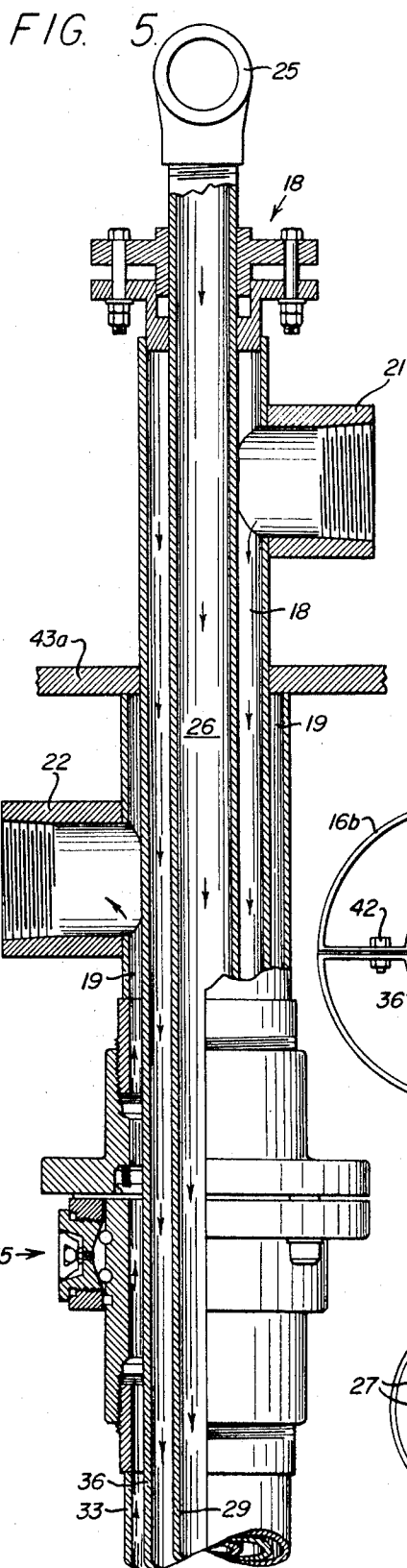
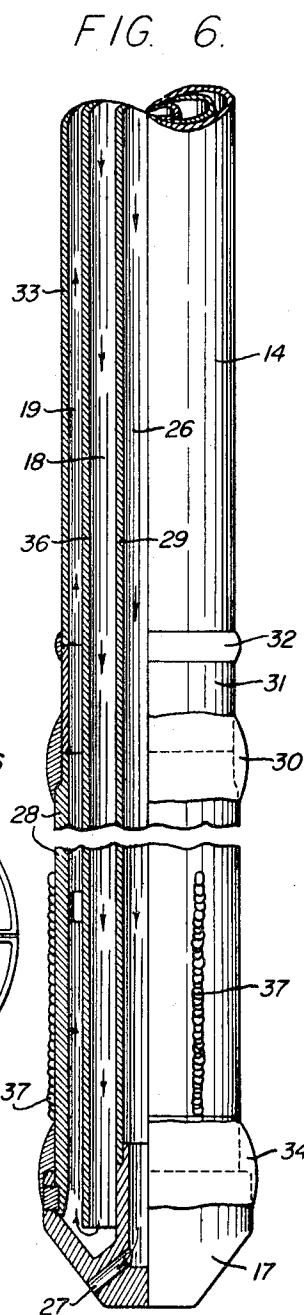
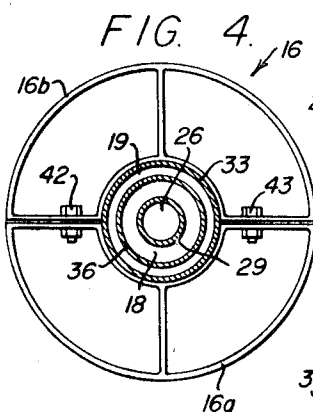
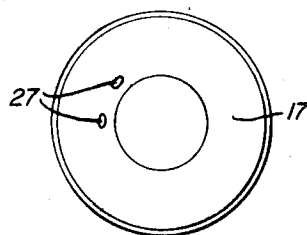


FIG. 2.

INVENTOR.
 LYLE E. MULHOLLAND
 KENDAL M. OGILVIE
 BY GEORGE C. BEALS

Mallinckrodt and
Mallinckrodt
 ATTORNEYS



INVENTOR.
 LYLE E. MULHOLLAND
 KENDAL M. OGILVIE
 BY GEORGE C. BEALS

*Mallinckrodt and
 Mallinckrodt*
 ATTORNEYS

OXYGEN LANCE

This invention relates to lances for the introduction of gases into molten materials. It is particularly concerned with the construction of lances for the introduction of oxygen or oxygen-enriched air into molten metallic materials during copper-smelting operations in reverberatory furnaces. The present application is a division of our copending application Ser. No. 496,119, filed Oct. 14, 1965, now U.S. Pat. No. 3,436,068, dated Apr. 1, 1969.

In copending application Ser. No. 273,767 filed on Apr. 17, 1963, jointly BY George C. Beals, John Kocherhans, and Kendall M. Ogilvie, entitled "Reverberatory Matte-Smelting Process," now U.S. Pat. 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 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.

THE INVENTION

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 nonreactive 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 al-

loys 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 fluidtight seal. A "Chiksan DS Series" type of swivel joint manufactured by the Chiksan Company, Brea, California, 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 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 embodiment 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 plane 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 joint 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 setscrew 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 upflow passage 19 through a nipple connection 22 and a flexible hose 23 for flow through a heat exchange (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 nonferrous 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 joint 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 nonreactive 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 lance shank 14 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.

It is claimed:

1. A lance for the introduction of a gas into a molten material held in a furnace having a roof, said lance comprising an elongate tubular shank having a gas-injection passage extending longitudinally therethrough and a gas-injection tip at its lower end, at least the lower portion of said shank proximate said tip being cylindrical; said shank being of sufficient length that its said lower portion is held immersed in the molten material when the lance is positioned for use in the vessel; longitudinal, solid formations projecting outwardly from the external surface of said cylindrical lower portion of the shank for anchoring frozen portions of the otherwise molten material thereto; universal pendulous means supportable from the furnace roof so as to hang said shank as a pendulum, said pendulous means being secured to said shank for holding it with a lower portion thereof projecting into the molten material and with an upper portion thereof extending above the furnace roof; and flexible means secured to the upper portion of said shank in communication with the gas-injection passage thereof for supplying gas to said passage for delivery to the molten material.

2. A lance in accordance with claim 1, wherein the shank includes an upper shank portion and a lower shank portion, said lower shank portion including a cylindrical outer tube of nonferrous metal forming a separate lower part of said lower shank portion rigidly joined to an upper part thereof and adapted for immersion in the molten material.