July 9, 1974 E. T. C. JOHNSTONE ET AL 3,823,012

METHOD AND APPARATUS FOR FEEDING PARTICULATE MATERIALS TO FURNACES AND THE LIKE

Filed Nov. 16, 1970

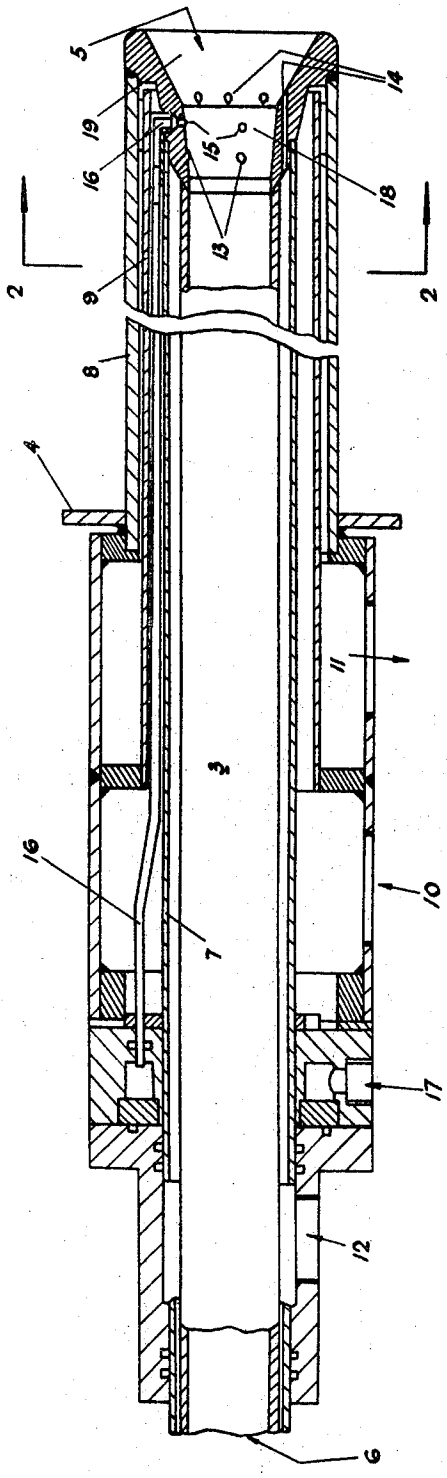


Fig. 1.

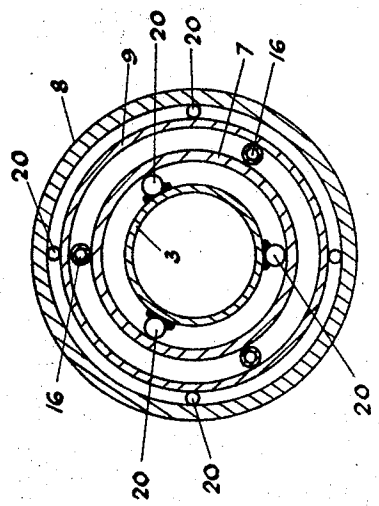


Fig. 2

United States Patent Office 3,823,012
Patented July 9, 1974

3,823,012

METHOD AND APPARATUS FOR FEEDING PARTICULATE MATERIALS TO FURNACES AND THE LIKE

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Filed Nov. 16, 1970, Ser. No. 89,997
Claims priority, application Great Britain, June 25, 1969, 16,614/69
Int. Cl. C21c 7/00
U.S. Cl. 75—51 7 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for feeding particulate material to a furnace using a conduit or "lance" having a nozzle for delivery of the material into the furnace. The conduit has a fuel supply duct and an oxygen supply duct designed so that the fuel, oxygen and particulates are uniformly mixed and heated before they reach the melt to increase the efficiency of combustion.

This invention relates to those conduits, commonly called "lances" by which a required particulate material is introduced into a treatment vessel operating at high temperature.

The vessel may be a furnace for smelting concentrates or for melting metals or the treatment of molten metals, or it may be a molten glass "tank," or a kiln or the like. For convenience such vessels are referred to herein simply as "furnaces."

Existing lances usually consist of a particulates feed-tube which ends in a delivery nozzle of copper or other material able to withstand the temperatures involved. Usually, both the feed-tube and its nozzle are water or otherwise cooled.

Where a lance follows a downward path to the furnace, the particulates feed may be purely gravitational; it is more usual, and more effective, however for the particulates to be "air-borne" by use of a high velocity gas stream as carrier.

A problem in the prior usage of lances is the difficulty of getting sufficiently rapid complete "digestion" of the particulates in the furnace melt. This is particularly so where the melting point of a particulate is greater than that required to obtain in the melt. In this connection, it will be appreciated that any particle which still remains discrete when treatment of the melt is finished, is detrimentally, or at best uselessly, present therein.

Expedients which have been adopted, in an endeavour to overcome the indicated disability, is to grind the particulates to extreme fineness, and alternatively or additionally (to hasten digestion) to heat the melt to a higher temperature than that merely sufficient for otherwise satisfactory furnace treatment thereof.

Both of the mentioned expedients are manifestly undesirable, and the main purpose of this invention is to render them unnecessary. This is largely achieved, according hereto, by causing intimate admixture of fuel, oxygen and the particulates, and substantially uniform dispersion and heating of the particulates, before they reach the melt; and this, if desired, without necessity for the particulates to be especially fine; indeed, in many cases the particulates may be granular (as distinct from being of powder fineness) and, in the case of metal particulates, even in the form of shavings, swarf or the like; provided, of course, the particles are suited for gravitational or "air-borne" conveyance through the lance.

The invention provides a method of feeding particulates to a furnace melt, comprising the steps of directing a stream of particulates towards the melt within a heating flame, and causing said particulates to be substantially uniformly dispersed throughout and within said flame prior to arrival of said particulates in said melt.

The method is best described in conjunction with lance apparatus suitable for performing it.

Broadly stated, this apparatus consists in a lance comprising: a particulates delivery tube having a downstream end directed into a furnace and an upstream end adapted for connection thereto of particulates supply means, a divergent delivery nozzle whereof the smaller upstream end is fixed to the furnace end of said tube, a fuel supply duct which opens to the interior of said nozzle and has an upstream end adapted for connection to a source of fuel, and an oxygen supply duct which opens to the interior of said nozzle and has an upstream end adapted for connection to a source of oxygen.

An example of the invention is illustrated in the drawings herewith.

FIG. 1 is a longitudinally medial cross-section of a lance; and FIG. 2 is a transverse cross-sectional end elevation taken on line 2—2 in FIG. 1, but on a larger scale.

The particulates delivery tube 3 has one end (the right hand end in FIG. 1) directed into a furnace (not shown) through a hole or port in the wall thereof. It is secured in position in any convenient way; for example, by way of a mounting flange indicated at 4. The furnace end of the tube has the smaller end of a generally frusto-conical delivery nozzle 5 secured to it by brazing, screwing or otherwise. The delivery tube is for the purpose of delivering a stream of particulates to the furnace through the nozzle, its other end (6) being adapted for connection to a conventional source of supply of such material.

As previously indicated, the particulates are preferably conveyed through the tube by a suitable carrier fluid, for example, hot air enriched with separated oxygen of greater than 50% purity.

If desired, the infeed tube or that part of it adjacent to the nozzle, may be made of an abrasion resistant material or alternatively the tube may be bushed with a sleeve which can be easily replaced when it becomes worn through the abrasion due to throughgoing particulates.

In most applications of the invention, it has been found suitable to employ carrier fluid and particulate velocities in the delivery tube of the order of 200 feet per second and it has been found practicable to feed concentrate particulates (e.g. at a rate of 5 tons per hour) through a 1½" internal diameter delivery tube. The carrier fluid, loaded with particulates, may be fed to the nozzle, along the delivery tube, in known manner.

The external surface of the nozzle is preferably stepped or otherwise formed for convenience of attachment thereto of a number of pipes or ducts.

The infeed tube is concentrically surrounded by a second tube 7 having its furnace end fixed to the nozzle, and the space between the delivery tube and the second tube constitutes an inlet duct for air or oxygen or preferably separated air comprising about or more than 90% oxygen. Any other oxygen-containing gas may be used, provided, of course, it does not contain material combustible with oxygen.

The second tube is concentrically surrounded by a water jacket or outer tube 8 whereof the furnace end is fixed to the rim portion of the nozzle. The space between the second tube and the outer tube constitutes a cooling jacket, and to provide for circulation of a cooling fluid, an open-ended ducting sleeve 9 is positioned within the

space between the second and outer tubes. The furnace end of this ducting sleeve extends closely to but does reach the rim of the nozzle thus permitting inflow of cooling fluid (from inlet **10**) between the ducting sleeve and the second tube and departure thereof (through outlet **11**) along the space between the ducting sleeve and the outer tube.

The annular duct between the central infeed tube and the second tube is for infeed of air or oxygen jets (through inlet **12**) and it communicates at its furnace end with the interior of the nozzle. Ports are provided to permit this communication, and these are preferably in the form of drillings through the wall of the nozzle. In a preferred arrangement, there are two forms of such drillings; some of these, **13** (herein called "mixer" ports) are directed (at an angle between 40° and 50° and preferably 45° to the axis of the nozzle) towards the centre point of the nozzle interior, that is to say towards a point at about the middle of the longitudinal axis of the nozzle. The other oxygen ports, **14** (herein referred to as "swirling" ports) are directed towards the large or downstream end aperture of the nozzle bore. The axes of the swirling ports **14** are preferably slightly mutually convergent towards the large or downstream end of the nozzle bore; to an extent, for example, such that the axes of the swirling ports are disposed at an angle relative to the longitudinal axis of the nozzle between 1° and 10° and preferably about 5°. These swirling ports are preferably straight but slightly helically directed (by only a few degrees relative to the nozzle axis) so that jets of air or oxygen entering the nozzle by way of them tends to have a component of rotary or swirling motion.

The mixer ports, providing "mixer" oxygen jets, may be three in number and the swirling ports, providing "swirling" oxygen jets, six in number. They are preferably evenly pitched about the periphery of the nozzle and, in further preference, they are arranged to be circumferentially spaced relative to each other, when the nozzle is viewed in end elevation; that is to say when viewed in end elevation it is preferable that none of the mixer ports has its axis intersecting or coincident with the axis of any one of the swirling ports.

Means are included for the conveyance of fuel for delivery as fuel jets to the nozzle interior. The fuel could be a powdered solid fuel or it could be gaseous, but for preference it is a liquid fuel. As one suitable way of bringing the fuel to the interior of the nozzle, a plurality of fuel admission ports **15** are drilled through the nozzle wall. These ports are preferably radial to the nozzle axis and three in number although some other number could be employed. Each of the fuel admission ports is connected (by pipes **16**) to a source of fuel supply (by way of inlet **17**) and these supply pipes may extend away from the nozzle within the cooling jacket space between the second tube **7** and the ducting sleeve **9**; alternatively, an additional tube may concentrically surround the second tube so that the space between the additional tube and the second tube then constitutes a fuel feed line of annular cross section; such feed line opening, at its furnace end to the interior of the nozzle by way of the mentioned fuel admission ports. Fuel may be force fed through the admission ports by means of a conventional fuel pump or the like. Oxygen or an oxygen mixture may be similarly force fed to the mixer and swirling ports.

The bore of the nozzle **5** may be frusto-conical (that is, of uniform taper) or it may be divergently flared, or bell-mouthed. For preference (and as shown) it is acutely tapered (at **18**) for about the first half of its length (from its upstream smaller or particulates entering end) and obtusely tapered (**19**) for the downstream remainder of its length; thus providing what may be called an upstream "acute" zone and a downstream "obtuse" zone. A suitable taper for the acute zone is from 0° to 10° (and preferably about 5°) between the zone wall surface and the nozzle axis, and a suitable taper for the obtuse zone is from 20° to 40° (similarly measured) with the preferred angle being about 30°.

Where two tapered zones are provided, as just described, the mixer and fuel admission ports, **13** and **15**, preferably open to the acute zone, and the swirling ports **14** to the obtuse zone.

The rod-like elements indicated at **20** in FIG. 2 are merely spacers to ensure concentricity of the several tubular parts.

When the above-described preferred embodiment of the lance is in use, streams of particulates-loaded carrier gas, oxygen (or oxygen mixture) and fuel are delivered to the interior of the nozzle. Experiment has indicated that the effect of the air stream jets arriving by way of the mixer ports is to break up the particulates stream and thus initiate uniform dispersion thereof, and also by augmentation of the carrier gas stream, assist in preventing aggregation of particulates in the nozzle end of the infeed tube. The effect of the air stream jets arriving by way of the swirling ports is to hold (or help to hold) the dispersed particulates within such confinement as may have been conferred on them within the acute zone, and at the same time impart to the particles a swirling or vortex rotary motion thus giving better assurance of the particulates remaining within the bounds of the flame.

At the start of a run, ignition of the fuel is effected in conventional manner; and, by suitable control of feed pressures, fuel proportions and the like it is foud that all or most of the particulates may be preconditioned for incorporation in the furnace melt either before they reach it or sufficiently soon after reaching it as to avoid slowing of the melt treatment merely to await digestion or melting of particulates.

We claim:

1. A method of feeding particulates to a furnace melt by way of a burner nozzle on the furnace end of a particulates delivery tube, and within a heating flame which emanates from said nozzle and is sustained by fuel and oxygen fed into said nozzle; said method comprising the steps:

(A) directing a stream of particulates along said tube towards and into said nozzle;

(B) making a first gaseous contribution to said stream, within an upstream portion of said nozzle, by directing a plurality of first gas jets penetratively into said stream in a first direction having a downstream component; and,

(C) making a second gaseous contribution to said stream from within a downstream portion of said nozzle, by directing a plurality of second gas jets envelopingly about said stream in a second direction having a downstream component greater than that of said first direction.

2. The method of Claim **1** which includes the step of feeding a fluid fuel into said nozzle at points lying, longitudinally of the nozzle, between the entry points into said nozzle of said first and second gaseous contributions.

3. The method of Claim **1** wherein said particulates are conveyed along said tube by use of a gaseous carrier stream.

4. The method of Claim **1** wherein said particulates are conveyed along said tube by use of an oxygen-enriched hot air carrier stream.

5. The method of Claim **1** wherein said first gas jets are directed towards the axis of said nozzle at an angle thereto of from 40° to 50°, and said second gas jets are directed towards said axis at an angle thereto of from 1° to 10°.

6. The method of Claim **5** wherein the said second gas jets are so directed as to cause them to execute a helical swirl movement.

7. The method of Claim **1** wherein a gas consisting of at least 90% oxygen is used as the material of said first and second gas jets.

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U.S. Cl. X.R.

75—60; 266—34