

July 7, 1970

F. S. DEATH ET AL

3,519,259

FURNACE JET DEVICES

Filed May 6, 1968

3 Sheets-Sheet 1

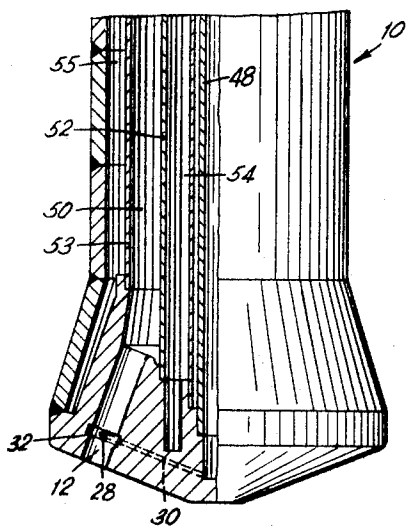


FIG. 1.

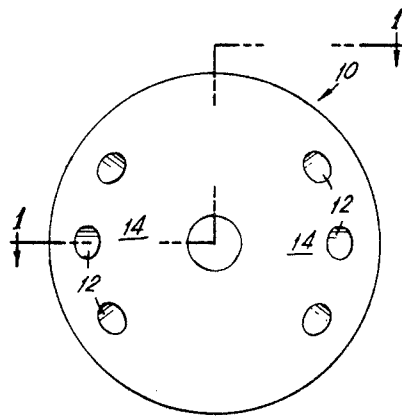


FIG. 2.

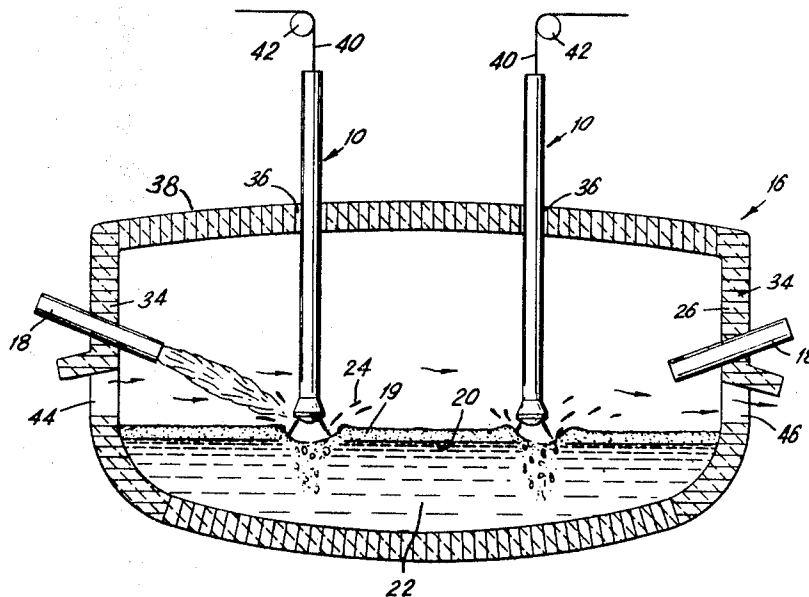


FIG. 3.

INVENTORS

FRANK S. DEATH

WALTER B. FARNSWORTH

BY *Lawrence S. Kastner*

ATTORNEY

July 7, 1970

F. S. DEATH ET AL

3,519,259

FURNACE JET DEVICES

Filed May 6, 1968

3 Sheets-Sheet 2

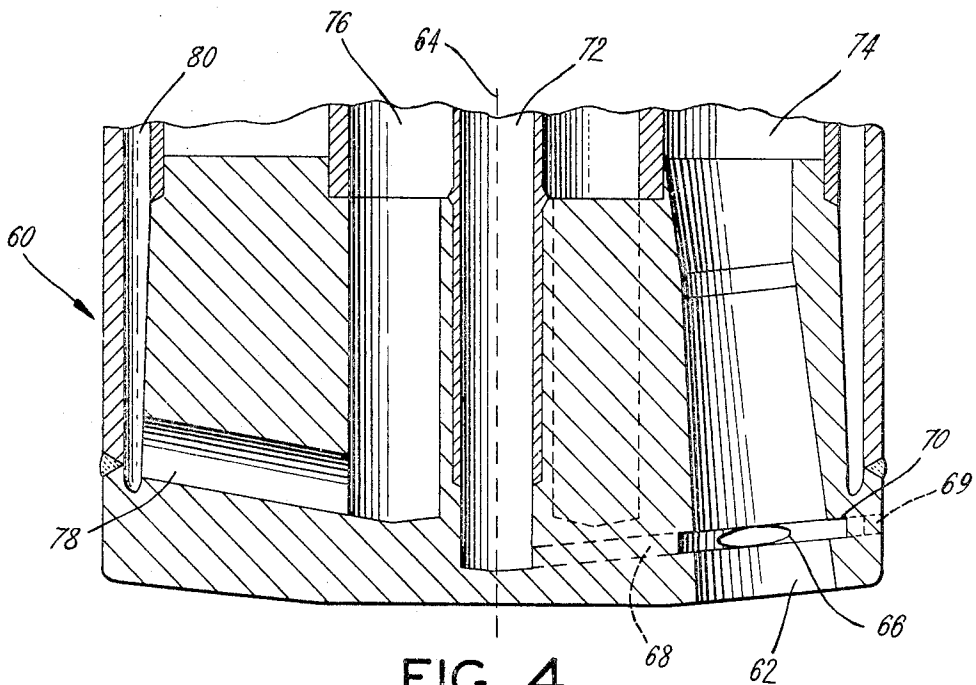


FIG. 4.

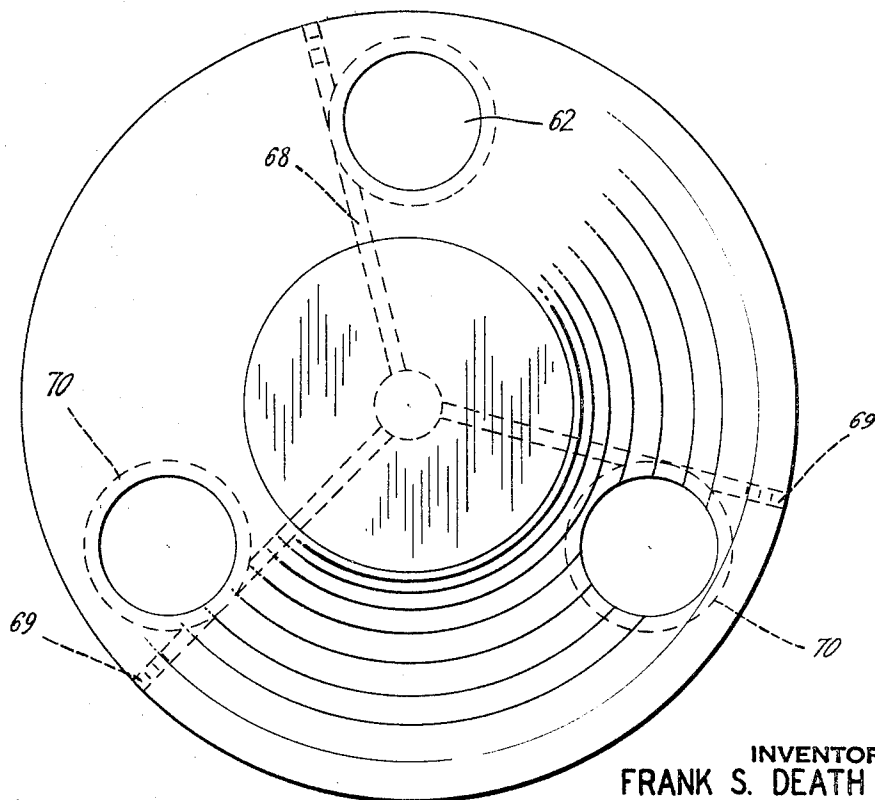


FIG. 5.

INVENTORS
FRANK S. DEATH
WALTER B. FARNSWORTH
BY *Lawrence S. Kastner*
ATTORNEY

July 7, 1970

F. S. DEATH ET AL
FURNACE JET DEVICES

3,519,259

Filed May 6, 1968

3 Sheets-Sheet 3

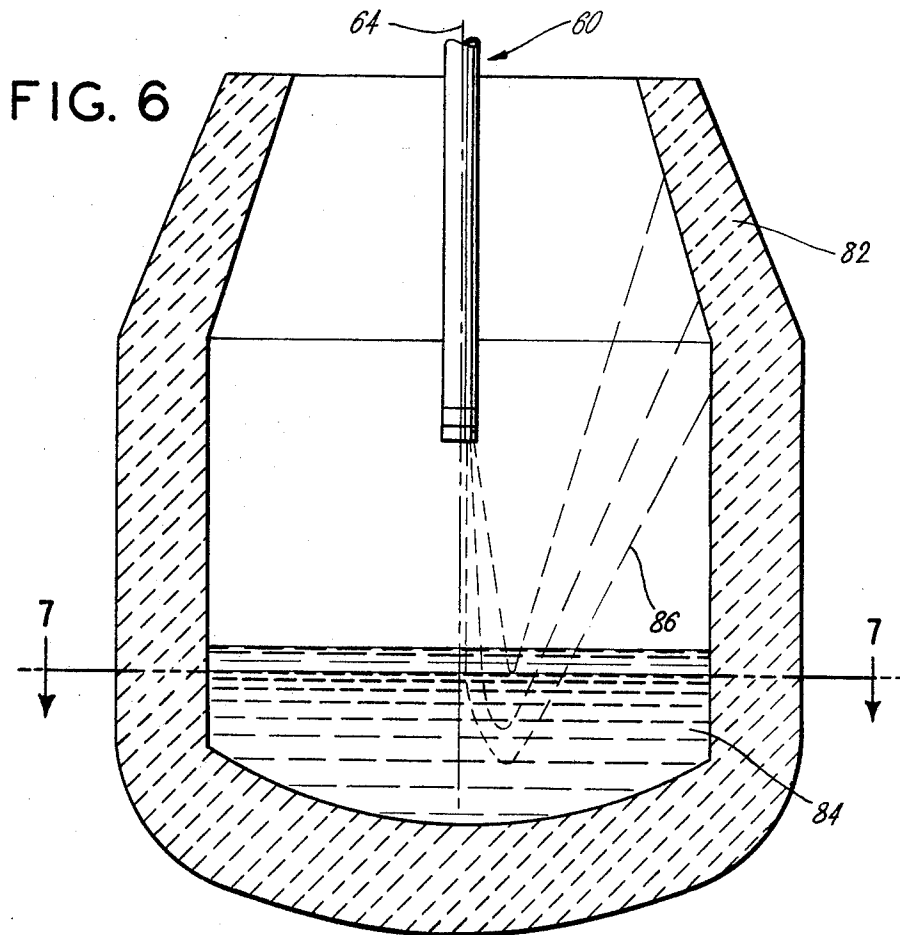
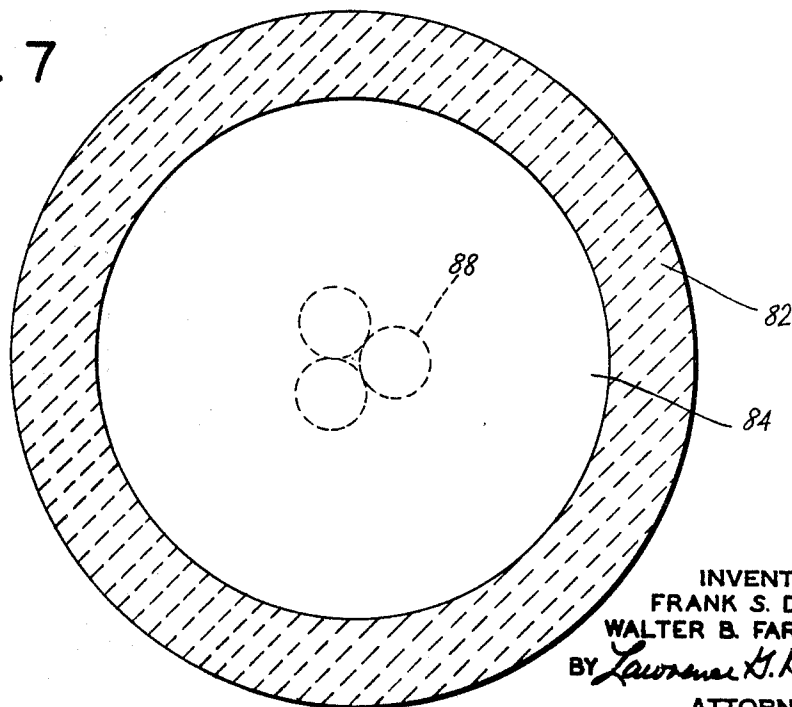


FIG. 7



INVENTORS
FRANK S. DEATH
WALTER B. FARNSWORTH
BY *Lawrence H. Kastner*
ATTORNEY

1

2

3,519,259

FURNACE JET DEVICES

Frank S. Death, Scotch Plains, N.J., and Walter B. Farnsworth, Kokomo, Ind., assignors to Union Carbide Corporation, a corporation of New York
Continuation-in-part of application Ser. No. 494,421, Oct. 11, 1965. This application May 6, 1968, Ser. No. 726,716

Int. Cl. C21c 7/04

U.S. Cl. 266—34

10 Claims

ABSTRACT OF THE DISCLOSURE

A furnace jet device for treating a bath of molten material in a furnace having a plurality of passages arranged for discharging a plurality of fluid jet streams downwardly and outwardly of said device against the top surface of the bath, each of said discharge passages being provided with an atomizer comprising an annular well formed in the discharge passage wall, a liquid fuel feed passage terminating tangentially in said annular well, and an oxygen supply passage connected to each discharge passage. The liquid fuel in the annular well is picked up by and atomized in the oxygen and discharged from the jet device against the bath as a fluid jet stream which acts to suppress undesirable fumes.

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of Application Ser. No. 494,421, filed on Oct. 11, 1965, now abandoned.

This invention relates to furnace jet devices, and more particularly to roof-jet means for making steel in an open-hearth furnace, or in a basic oxygen furnace.

In the past, decarburization by oxygen treatment in furnaces for making steel resulted in the production of undesirable fumes, as well as objectionable splashing of the melt against the furnace walls, thus shortening their life.

Open hearth furnaces are typically oblong, having end and side walls, so that the corresponding surface of the bath of molten material contained therein is also substantially oblong. In addition to the production of large amounts of undesirable fumes in such furnaces, the oxygen gas jets often cause excessive splash against the side walls of the furnace.

Similarly, in symmetrically shaped furnaces having a circular cross-section, such as a basic oxygen furnace, oxygen treatment of the melt also results in the production of undesirable fumes, as well as causing excessive splash against the walls of the furnace.

OBJECTS

It is an object of this invention to provide a furnace jet device for treating a bath of molten metal, which is capable of suppressing undesirable fumes, while minimizing splash on the walls of the furnace. It is another object to provide a furnace jet device which is simple, efficient, and highly effective.

SUMMARY OF THE INVENTION

These and other objects, which will become apparent from the detailed disclosure and claims to follow, are achieved by the present invention which provides a furnace jet device for treating a bath of molten material in a furnace, having means forming a plurality of passages arranged for discharging a plurality of fluid jet streams downwardly and outwardly of said device against the top of the surface of said bath, said passages also being arranged so that their axes extend at such angles from the

longitudinal axis of said jet device as to minimize splash reaching the furnace walls, means for supplying a stream of oxygen gas to each discharge passage, and means for atomizing liquid fuel in said oxygen stream comprising an annular well formed in each discharge passage wall and a liquid fuel feed passage terminating tangentially in said annular well for supplying the well with liquid fuel, whereby said liquid fuel is picked up by and atomized in said oxygen stream and discharged from said device against the bath as a fluid jet stream which acts to suppress undesirable fumes.

The jet device operates so that the melt is decarburized and refined by the oxygen substantially without the formation and emission of fumes. To accomplish this, the jet device is constructed so that non-gaseous fluidized fuels, such as oil, tar, etc., are combined with gaseous oxygen streams in such manner that an intimate mixture of fuel and oxygen is obtained in the jet streams. It is also constructed so that the fuel-oxygen streams are directed at the charge surface so that at different stages of the heat cycle the following additional benefits are obtained: (1) efficient scrap meltdown, (2) penetration of slag covering the melt to provide effective reaction of each gas stream with the underlying metal, and (3) minimum splash impingement on the furnace roof, banks, and walls.

THE DRAWINGS

FIG. 1 is a fragmentary view, half in side elevation and half in cross-section, taken on line 1—1 of FIG. 2 of a jet device illustrative of one embodiment of the invention;

FIG. 2 is a bottom plan view of the jet device shown in FIG. 1;

FIG. 3 is a view, mainly in vertical cross-section, of the jet device of FIGS. 1 and 2 shown in its operative position in an open-hearth furnace, according to the invention;

FIG. 4 is a view, in vertical cross-section, of a jet device illustrative of a second embodiment of the invention;

FIG. 5 is a bottom plan view of the jet device shown in FIG. 4;

FIG. 6 is a view, in vertical cross-section, of the jet device of FIGS. 4 and 5 shown in its operative position in a basic oxygen furnace, according to the invention;

FIG. 7 is a plan view taken on line 7—7 of FIG. 6, showing the area of impingement of the oil-oxygen jets of the jet device on the surface of the molten metal bath.

Referring to FIGS. 1 and 2, jet device 10 is shown provided with several oxygen orifices or passages 12, arranged and oriented according to the first embodiment. More specifically, these orifices 12 are separated into two clusters or groups 14 and each group is oriented so that in horizontal orientation it is directed opposite the other. When operated in an open-hearth furnace 16, as shown in FIG. 3, the jet device is oriented so that the overall firing direction of each jet stream group is parallel to the long axis of the furnace (aligned with the end burner 18 firing direction). Thus, the orifices 12 in each group are arranged so that the horizontal velocity components of the jet streams extend substantially only in the general direction of the major axis of the oblong surface of the molten metal bath.

It has been found that streams composed of oil or other fuels and oxygen (or their combustion products) impinging on molten slag 19 on metal surface 20 will tend to cause more splash than streams composed of pure oxygen, particularly if the jet is operated close to or within the liquid 22. Therefore, the jet orifices 12 are arranged so that the generated splash 24 has a relatively

long distance to travel before impinging on the furnace refractory 26 and, therefore, the major part of generated splash will fall back into the liquid before reaching such boundary.

Tests indicate that 4-hole and 6-hole jets of this type behave similarly. Preferably, the total number of orifices in the device is four or more, and the angle at which the orifice is tilted from the vertical is between 10° and 45°, for example 20°.

The horizontal angle between the centerline of the outermost orifices of each group is less than 90°, for example 72°. The minimum angle is determined by the water cooling requirements between orifices and the number of orifices for a particular jet.

Each orifice 12 is provided with an oil atomizer 28 that is supplied with fluidized fuel through a passage 30. This atomizer has given the best fume suppression results observed to date.

Atomization involves filling of annular channel 32 in each orifice wall with oil which is continually supplied to well 32 by the feed passage 30 which enters the annulus tangentially. The oil overflow is wiped off the downstream edge of the annulus by the oxygen flow and is broken up into a very fine mist as it leaves orifice 12. Intimate mixing of the mist and oxygen thus takes place in each oxygen stream.

In the first embodiment, shown in FIG. 3, two jet devices 10, are located about equal distances from each other and the end walls 34 of the furnace 16. It is, of course, readily apparent that fewer than two or a greater number of jets can be used. Such jets depend through holes 36 in the roof 38 of the furnace, being supported, by cables 40 that pass over pulleys 42 on the way to hoisting mechanisms, not shown. Air enters the furnace through opening 44 in the left wall, and combustion products leave through opening 46 in the right wall of the furnace. Of course, it is recognized in the furnace art that the direction of air flow is reversed on each furnace reversal.

Oil is supplied through a central pipe 48, in each jet 10, oxygen gas is supplied through annular passage 50 between pipes 52 and 53, while cooling water enters through annular passage 54 and leaves through passage 55.

In operation, a heat cycle in an open hearth furnace for producing steel is as follows. After the previous heat has been tapped, furnace preparatory operations are carried out, for example, banks are built up, the tap hole is cleaned out and rebuilt. During this period the jet devices 10 are normally raised to their uppermost position and a small flow of steam or other inert gas passed through the fuel passages to prevent fouling. Scrap, ore and limestone are then charged into the furnace and the burners 18 are operated alternately.

Thereafter, hot metal is added to the furnace hearth. Frequently, the hot metal charge requires several ladles full of hot metal. Usually, the fuel-oxygen jet devices are lowered and the blow begun after only part of the hot metal has been added. During this period the jet devices can be used to assist the burners 18 in melting the scrap. To initiate operation, the jet devices are lowered into the furnace until they are visible through an open door. The oxygen flow may be initiated either automatically when the devices are lowered or manually as they become visible. The fuel flow is begun, the steam or other purge shut off, and the flow stabilized. Flames issuing from the nozzle orifices are apparent. The jet devices are then lowered to a position such that the end of the device is between 4 in. and 24 in. above the scrap or liquid slag surface. As the scrap melts and the metal surface falls, the jet devices are lowered to maintain the required position. Since the heavy fuming common to prior oxygen blowing techniques is suppressed, the end of the jet device can be clearly observed and the jet device height

effectively maintained for fume suppression and minimum splash.

Refining of the charge is carried out according to conventional oxygen blowing practice. After the charge is refined to the desired carbon level, the jet devices are raised, the flow of oxygen and fuel terminated, and a small flow of steam, or inert gas, initiated to prevent plugging of the orifices. When other impurity and alloying elements have been brought to the desired levels of concentration and the proper bath temperature has been reached, the molten steel is tapped from the furnace.

There are several features of these jets which are different from straight oxygen jets. These include, (1) directional orientation of the orifices for splash control, and (2) incorporation of oil atomizers.

Standard oxygen jets are operated preferably with the nozzle immersed in the slag 19 or as close to the slag surface as possible. The fume suppression jets of the first embodiment of the invention, however, are preferably operated above the slag surface. Optimum operating ranges for the best splash control and fume suppression are from 4 in. to about 24 in. above the slag surface in an open hearth furnace. At oxygen flows of 30,000–70,000 c.f.h. per jet, oil/oxygen ratios of 1–3 gal. oil/1000 c.f. of oxygen are preferred. However, the invention is not limited in this respect, but includes any suitable oil/oxygen ratios that may be necessary or desirable.

A second embodiment of the invention comprises the jet device adapted for blowing oxygen-oil mixtures in steel melting furnaces having shapes other than the elongated open hearth shape, such as basic oxygen furnaces having a circular cross-section. In these symmetrically shaped furnaces, the oxygen discharge passages may be positioned to provide uniformly spaced impingement of the oxygen-oil jets on the molten metal surface, while minimizing the amount of splash deflected against the furnace walls. The second embodiment is shown in the FIGS. 4–7.

Referring to FIGS. 4 and 5, jet device 60 is shown provided with three discharge orifices or passages 62. The passages 62 are spaced apart at an angle of 120 degrees from each adjacent orifice. Also, passages 62 are directed at a small angle from the longitudinal axis 64 of jet device 60.

In each passage 62, there is provided an oil atomizer 66, similar to the oil atomizer 28, described and shown in the first embodiment. Briefly, each oil atomizer 66 is supplied with fluidized fuel through a fuel feed passage 68. In the construction of the jet device 60, feed passages 68 are formed by boring holes into the sides of such device 60 toward the longitudinal axis 64. The ends of the passages 68 are closed by plugs 69. Feed passage 68 terminates tangentially in an annular well 70 formed in the wall of each discharge passage 62. Fuel oil is continually supplied to well 70 through feed passage 68, entering the well tangentially. The oil overflow is wiped off the downstream edge of the well 70 by the oxygen stream passing through the discharge passage 62, and is broken up into a very fine mist as it exits from such passage 62.

Fuel oil is supplied through a central passage 72 which connects with fuel feed passage 68. Oxygen gas is supplied through an annular passage 74 which connects with each discharge passage 62. Also, a coolant fluid is supplied to the jet device 60 through annular passages 76 which connect with passages 78. The coolant fluid leaves the jet device 60 through an annular passage 80.

In the second embodiment shown in FIGS. 6 and 7, the jet device is in use in a 115 ton basic oxygen furnace 82 having an inside diameter of about 14 feet. The furnace charge, consisting of about 25 percent scrap steel and 75 percent molten pig iron, is blown to medium carbon steel using about 1½ to 2 gallons of oil per 1000 cu. feet oxygen. The jet device 60, comprises three oxygen discharge

5

passages 62 spaced 120 degrees apart which diverge at an angle of about $4\frac{1}{2}$ degrees from the longitudinal axis 64 of the jet device 60. The jet device was operated at a height of 72 inches directly above the molten metal bath 84. The use of oil atomized by atomizers 66 greatly reduced the amount of fume otherwise discharged from the furnace 82.

To avoid excessive splash 86 being directed from bath 84 against the side walls of the basic oxygen furnace 82, the direction of jet impingement should be kept at less than 10 degrees from the longitudinal axis of jet device 60, and preferably at about 5 degrees. Lines 88 indicate the area of impingement of three oil-oxygen jets on the surface of the molten metal bath 84.

While the FIGS. 4-7 show a jet device having three discharge passages, it is to be understood that the jet device can also be made to provide any suitable number of discharge orifices.

What is claimed is:

1. A furnace jet device for treating a bath of molten material in a furnace, having means forming a plurality of passages for discharging a plurality of fluid jet streams downwardly and outwardly of said device against the top surface of said bath, said passages also being arranged so that their axes extend at such angles from the longitudinal axis of said jet device as to minimize splash reaching the furnace walls, means for supplying a stream of oxygen gas to each discharge passage, and means for atomizing liquid fuel in said oxygen stream comprising an annular well formed in each discharge passage wall, and a liquid fuel feed passage terminating tangentially in said annular well for supplying the well with liquid fuel, whereby said liquid fuel is picked up by and atomized in said oxygen stream and discharged from said device against the bath as a fluid jet stream which acts to suppress undesirable fumes.

2. A furnace jet device as claimed in claim 1, in which said discharge passages are arranged with their axes extending at angles from the longitudinal axis of said jet device so that the fluid jet streams of said jet device, when used in an open hearth furnace, will be discharged more in the direction of the major axis of the oblong surface of the bath, than in the direction of the minor axis thereof.

3. A furnace jet device as claimed in claim 2, in which said individual discharge passages are arranged in two clusters each of which is composed of at least two of said passages for directing said fluid jet streams so that the horizontal component of flow of each cluster of jet streams is only in the general direction of the major axis of said

6

oblong surface of said bath to minimize undesirable splash in the general direction of the minor axis thereof.

4. A furnace jet device as claimed in claim 2, in which the angle of inclination formed between the axis of each of said discharge passages and the longitudinal axis of said jet device is between 10 and 45 degrees.

5. A furnace jet device as claimed in claim 3, in which the horizontal angle formed between the axes of the outermost passages within each cluster is less than 45 degrees.

6. A furnace jet device as claimed in claim 1, in which there are provided three or more discharge passages arranged in a ring around the longitudinal axis of the jet device and spaced apart at equal angles with respect to each adjacent passage.

7. A furnace jet device as claimed in claim 6, in which there are provided three discharge passages equally spaced apart at an angle of 120 degrees from each adjacent passage.

8. A furnace jet device as claimed in claim 6, in which the angle of inclination formed between the axis of each of said discharge passages and the longitudinal axis of said jet device is between 3 and 10 degrees.

9. A furnace jet device as claimed in claim 8, in which the angle of inclination formed between the axis of each of said discharge passages and the longitudinal axis of said jet device is about 5 degrees.

10. A furnace jet device as claimed in claim 6, in which each of said liquid fuel feed passages is formed by a long straight passage extending in from the side of the body of said jet device toward the longitudinal axis thereof, said passage being closed at its outer end by a plug inserted therein.

References Cited

UNITED STATES PATENTS

1,934,379	11/1933	Rudolph	239—399
2,566,040	8/1951	Simmons	239—403
2,838,105	6/1958	Eastman et al.	239—132.3
3,112,194	11/1963	Devries.	
3,239,205	3/1966	Metz	266—35
3,313,535	4/1967	Hopkins.	

J. SPENCER OVERHOLSER, Primary Examiner

J. S. BROWN, Assistant Examiner

U.S. Cl. X.R.

239—403; 261—118