PROCESS AND APPARATUS FOR OXIDIZING MATERIALS

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Fig. 1.

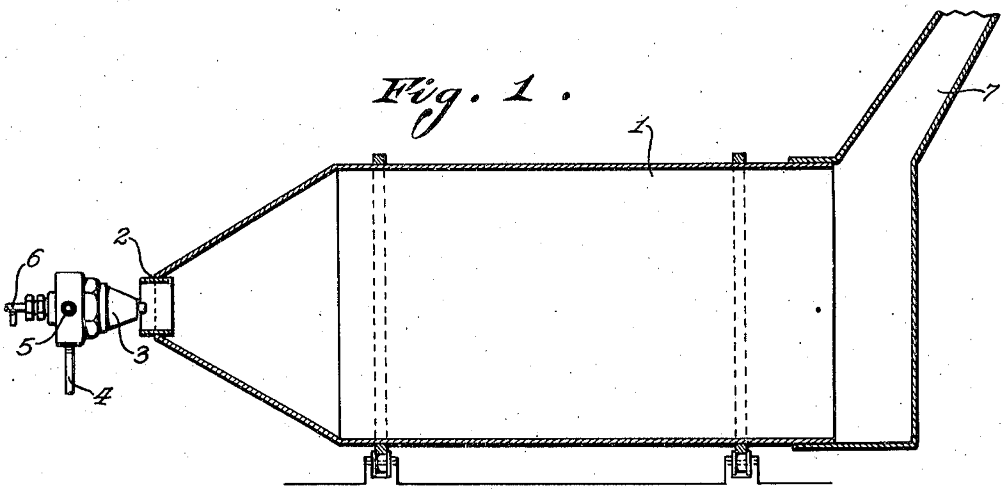


Fig. 2.

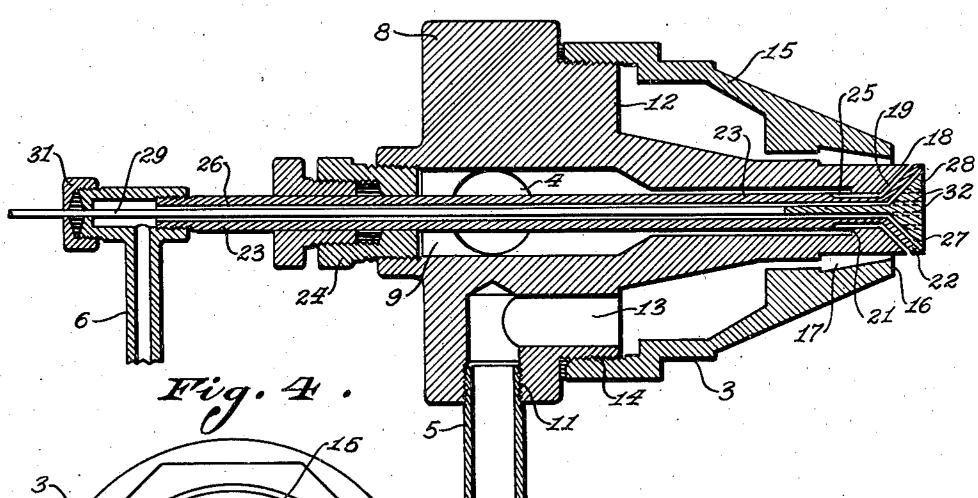
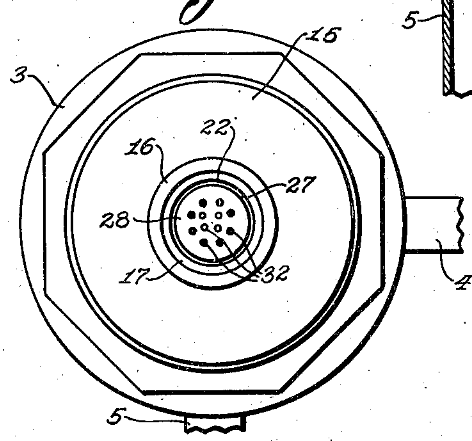


Fig. 4.



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March 2, 1937. J. McCALLUM 2,072,375

PROCESS AND APPARATUS FOR OXIDIZING MATERIALS

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Fig. 3.

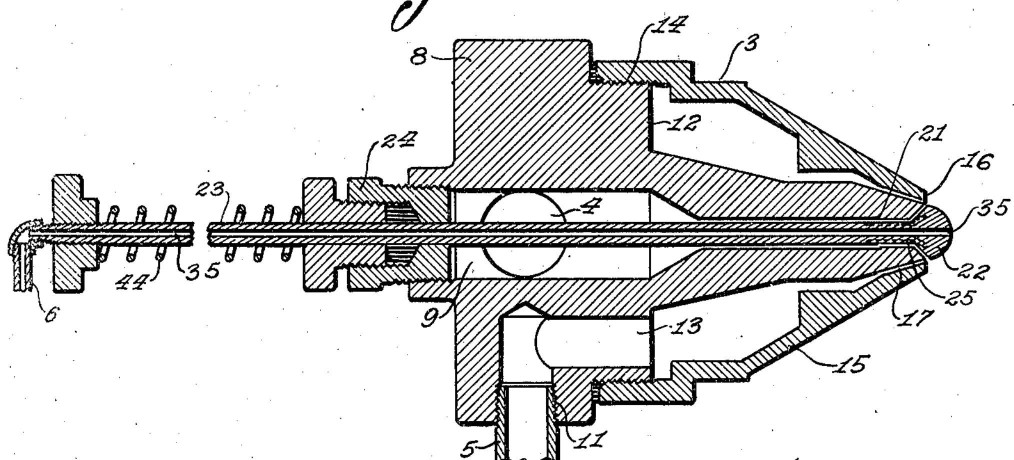


Fig. 6.

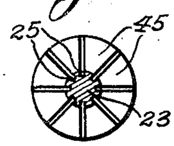


Fig. 5.

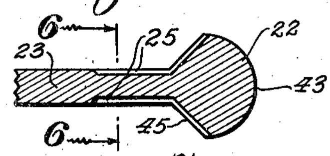


Fig. 8.

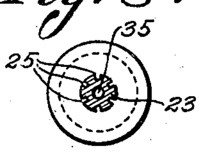


Fig. 7.

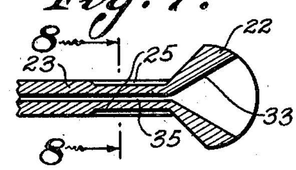
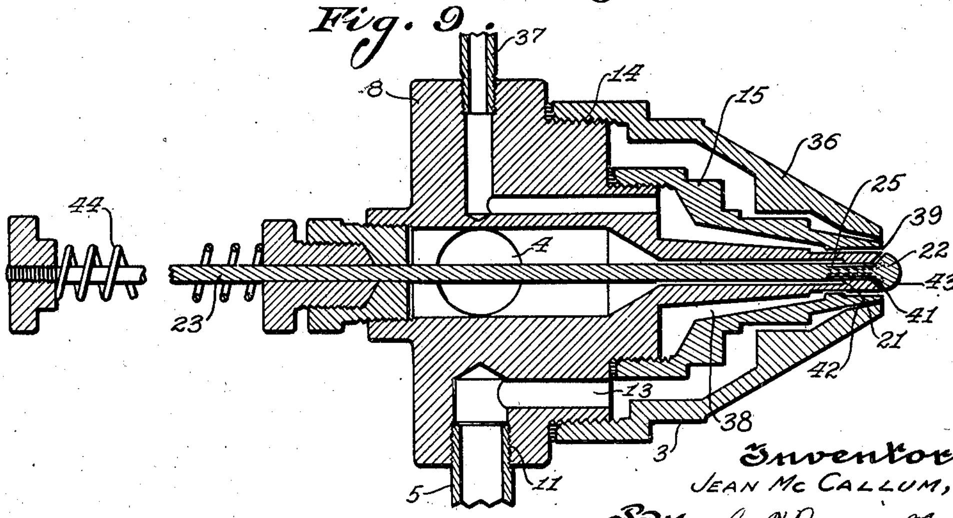


Fig. 9.



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2,072,375

UNITED STATES PATENT OFFICE

2,072,375

PROCESS AND APPARATUS FOR OXIDIZING MATERIALS

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Application June 26, 1931, Serial No. 546,952

12 Claims. (Cl. 23—1)

This invention relates generally to the atomization or sub-dividing materials and particularly to the oxidation of sub-divided molten lead for the formation of fumed litharge.

In the various processes which have heretofore been employed for atomizing molten metals, such as, lead, in the formation of fumed litharge, and in which it is desired to oxidize the atomized material, it has been recognized that in order to secure a high fume production or in other words to oxidize a substantial proportion of the atomized material, the atomization must be extremely fine. Again it has been heretofore recognized that in order to secure fine atomization, it is desirable that the stream to be atomized be of relatively small size. Various processes and apparatuses have heretofore been proposed for atomizing molten materials for various purposes, including oxidation, and these prior processes have followed generally the principle of impinging a fluid blast, such as for instance, air upon a stream of molten metal or the material. In the processes of the prior art, however, it has been impossible to secure high fume production or in other words to oxidize substantially all of the atomized material. Perhaps the reason for this inability of the prior art process to accomplish thorough oxidation is principally the fact that it has been heretofore impossible to sufficiently sub-divide the molten stream before the fluid blast has been impinged upon it. Although it has been possible to reduce the size of the stream of molten material by directing it through a relatively small orifice, it has been found, and particularly in processes where the molten stream is to be oxidized, by the impinging blast, that when a small orifice is employed for projecting a small stream, continuous operation of the apparatuses or processes is impossible for the reason that such small orifices readily clog or "dross" so that it becomes necessary for an attendant to stop the operation of the apparatus and open the clogged orifice, which necessitates in any event the discontinuance of operation, so that the attendant might place himself in a position which would permit working upon the nozzle.

The object of this invention, generally stated, is to provide a process and apparatus suitable for atomizing molten metal, particularly for oxidation.

Another object of this invention is to provide an atomizing nozzle which will be efficient in its operation.

A further object of this invention is to provide an atomizing nozzle which will mechanically divide the stream of molten material into relatively small jets.

Another object of this invention is to provide an atomizing nozzle, which may be readily cleaned without discontinuing the operation thereof.

A further object of this invention is to provide an apparatus for efficiently atomizing and oxidizing molten material.

A more specific object of this invention is to provide a process and apparatus for oxidizing molten lead to form fumed litharge.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawings in which:

Figure 1 is a view somewhat diagrammatical in form, of an apparatus for producing fumed litharge, provided with an atomizing nozzle constructed in accordance with this invention.

Figure 2 is a longitudinal, sectional view of an atomizing nozzle, constructed in accordance with one embodiment of this invention.

Figure 3 is a longitudinal, sectional view of an atomizing nozzle, constructed in accordance with another embodiment of this invention.

Figure 4 is a view in end elevation of the nozzle shown in Figure 2.

Figure 5 is a detail view in side elevation, illustrating a suitable form of valve for sub-dividing the stream of molten metal.

Figure 6 is a detail, sectional view, in end elevation, of the valve, illustrated in Figure 5.

Figure 7 is a detail view in side elevation of a modified form of valve.

Figure 8 is a detail, sectional view in end elevation of the valve shown in Figure 7.

Figure 9 is a longitudinal, sectional view of a slightly modified form of an atomizing nozzle.

In accordance with this invention as adapted particularly for the atomizing of lead for the production of fumed litharge, and with particular reference to which the invention will be described herein, a stream of molten metal may be mechanically sub-divided into a plurality of thin jets, or into a continuous relatively thin sheet, and a fluid blast then impinged upon the thin sheet or jets. In accordance with the usual practice, the lead is introduced to the atomizing nozzle in a molten condition and a blast of air or other fluid, pre-heated to a temperature above the melting point of the lead prior to its introduction into the nozzle, impinged thereagainst. In the nozzle of the present invention the stream of molten lead or other material is first mechanically sub-divided, as pointed out above, and projected axially under pressure into the path of a fluid blast, which may be either pre-heated or cold air or any suitable raw or inert gas. When the stream of molten material is first mechanically sub-divided and thence impinged by fluid blast, it has been found that more efficient atomization is accomplished. In accordance with one embodiment of the present invention, the stream of molten material, after being subdivided, is projected in a conical form and the fluid blast impinged thereupon from the exterior of the cone. Under some circumstances, it has been discovered, however, even though complete atomization of the molten material takes place at the point of impingement, the stream tends to contract a short distance from the point of impingement so that the so-called "vena contracta", well known to those skilled in the art of hydraulics is formed. In accordance with the present invention a second fluid blast may be introduced axially of the conical stream of molten material, thus relieving the negative pressure on the interior of the cone and preventing the formation of the "vena contracta", the effect of which it will be understood is to flocculate the atomized particles of molten material and thus defeat the purpose of efficient and complete atomization.

Referring now to the drawings for an illustrative embodiment of this invention, the usual apparatus for the production of fumed litharge is illustrated diagrammatically in Figure 1. The conventional apparatus for fuming lead comprises generally a revolving retort 1, having a restricted mouth 2. Adjacent the mouth 2 of the retort, an atomizing nozzle 3 is provided. In accordance with the usual practice, the atomizing nozzle 3 delivers a stream of molten lead or other suitable material to the retort and also delivers a stream of oxidizing fluid, which may be either pre-heated or cold air or any suitable gas. The lead may be introduced into the nozzle 3 by a suitable pipe or conduit 4, while the oxidizing gas may be introduced through a suitable pipe or conduit 5. In accordance with one embodiment of the present invention an additional supply of oxidizing gas or fluid may be introduced to the nozzle through a second conduit 6. In the operation of the apparatus just described, the lead is atomized at the nozzle 3, which will be more particularly described hereinafter with reference to the several embodiments thereof shown in the drawings. Oxidation of the lead then takes place while in its atomized condition within the retort 1 and the fumes thus produced are removed from the retort 1 and conveyed through any suitable type of conduit 7 to the usual cooling flues. After the fumes thus produced have been sufficiently cooled, they are collected in the form of an impalpable powder and may then be prepared for the market.

In accordance with the present invention, the atomizing nozzle 3 is made up of a plurality of parts as is illustrated in Figures 2, 3 and 9, and between each of the respective parts a recess or passageway is left, thus defining a conduit for conducting either the stream of molten material or one of the fluid blasts. Referring now particularly to Figure 2, one embodiment of a nozzle constructed in accordance with this invention is shown and comprises a core piece 8, having a central tubular opening 9 extending therethrough and adapted in the particular embodiment illustrated to conduct the stream of molten material. The core piece 8 is generally cylindrical in form and is provided with a threaded opening 11 adapted to receive the conduit 5 for transmitting a fluid blast to the nozzle. As is clearly illustrated in Figure 2, the core piece 8 is so machined as to provide a number of off-sets longitudinally thereof, thus forming a plurality of shoulders, such as 12. At one side of the core piece 8 an opening 13 connects the shoulder 12 with the threaded opening 11, so that a passageway for conducting the fluid delivered by conduit 5 is thereby provided. The core piece 8 is preferably provided with a threaded part 14, adapted to engage a shell 15. The shell 15 is generally cylindrical in shape and is internally machined to provide a plurality of off-sets adapted to co-operate with the off-sets on the core piece 8 so that a passageway between the shell 15 and the core piece 8 is thereby defined. In the particular embodiment illustrated, the shell 15 is provided at its outer end 16 with an internal opening 17 of a diameter slightly in excess of the diameter of the outer end 18 of the core piece 8. It is thus apparent that when the shell 15 is assembled upon the core piece 8, a passageway is defined between its two parts which will conduct a fluid delivered by the conduit 5 therethrough and emit the same at the open end of the nozzle through the orifice which exists between the end 18 of the core piece 8 and the opening 17 in the shell 15. In the embodiment illustrated in the drawings, the shell 15 is preferably so machined internally that the velocity of a blast issuing therefrom is relatively high and the direction thereof is substantially parallel to the axis of the core piece 8 for a purpose which will be more fully described hereinafter.

At the outer end 18 the tubular opening 9 which extends through the core piece 8 terminates in a valve seat 19, which in the embodiment illustrated is frusto-conical in shape, being continuous from the outer circumference at the end 18 to the inner opening 9 therethrough. Near the end 18 the tubular opening 9 which extends through the core piece 8 is constricted as illustrated at 21 so that the diameter of the opening between this point and the valve seat 19 is less than the diameter of the remainder of the tubular opening. A valve 22 is provided for co-operating with the valve seat 19 and is adapted to be moved relative to the valve seat 19 to vary the opening between the seat 19 and the valve 22. The valve 22 is provided with a stem 23 extending through the tubular opening 9 and guided at the end thereof opposite the valve 22 by a suitable packing gland 24, connecting to the core piece 8 or any other suitable connection. It will be understood that the stem 23 is slidable axially, relative to the packing gland 24 in order to axially adjust the valve 22 with reference to the valve seat 19. The diameter of the stem 23 is preferably substantially equal to the diameter of the constricted portion 21 of the tube 9 so that a substantially snug fit is obtained between the stem 23 and the constricted portion 21 of the tube 9 in the embodiment illustrated. In the region of the constricted portion 21, however, the stem 23 is provided with a plurality of axially extending grooves 25, clearly illustrated in Figures 5 to 8 inclusive for sub-dividing the stream of molten material in the opening 9 and conducting the same past the constricted portion 21 to the opening between the valve seat 19 and the valve 22. It will be understood that the grooves 25 may extend from the stem part 23 to the flared portion of the valve 22, as is illustrated in the embodiment shown in Figures 5 and 6, and in which instance the stream of molten material will be projected in the form of a plurality of radial jets. In the embodiment illustrated in Figures 7 and 8, however, it is apparent that the grooves 25 terminate adjacent the flared part of valve 22, so that the stream of molten material is projected in the form of a sheet, which is continuous in the form of a cone, and the thickness of which may be determined by the position of the valves 22 relative to the seat 19. It will be understood that under some circumstances and conditions of operation, it is preferable to project the molten stream in the form of a conical sheet in which case the valve shown in Figures 7 and 8 will be preferably employed. While under such circumstances that it is desirable to project the molten material in the form of radial streams, the form of the valve in Figures 5 and 6 is preferably employed. In the embodiment illustrated in Figure 2, the stem 23 of the valve 22 is provided with a central passageway for conducting an additional blast of fluid for assisting in the atomization of the molten fluid as well as maintaining the dispersion of the material previously atomized by the blast issuing from opening 17 by preventing the so-called "vena contracta" which would tend to form in the event that the negative pressure within the jet was not overcome. In the embodiment illustrated in Figure 2, the stem 23 terminates at the outer end thereof, adjacent the valve 22, with a flared mouth 27, which may be of any suitable shape, preferably adapted to spread the blast flowing through the passageway 26 in the stem 23, outwardly against the stream of atomized metal flowing from the opening between the valve seat 19 and the valve 22, so as to further disperse the atomized material, it being apparent that when the blast is directed outwardly as illustrated by the direction of mouth 27 in Figure 2, that the stream issuing from the mouth 27 will impinge upon the already atomized material and further disperse the particles thereof. Moreover this internal blast issuing from the mouth 27 relieves the negative pressure created within the jet and thus prevents the flame from contracting a short distance from the nozzle, so that the tendency for the "vena contracta" to form is thus eliminated and the dispersion of the particles is maintained.

In the embodiment illustrated in Figure 2, the mouth 27 is provided with a valve 28, adapted to seat thereon and movable to control the blast issuing from the mouth 27. In the embodiment illustrated the valve 28 is provided with a stem 29, extending axially through the opening 26 of the stem 23, and being guided at the end thereof and opposite the valve 28, by a suitable packing gland 31, mounted upon the stem 23 and forming a fluid tight connection between the stem 29 and the passageway 26. The packing gland 31 permits relative movement of the stem 29 and the stem 23, so that the stem 29 may be moved to adjust the position of valve 28, relative to the mouth 27, and thus control the fluid blast issuing from the mouth 27. In the embodiment illustrated the mouth 27 is provided with a plurality of openings 32, extending outwardly from the region of the vertex thereof so that an outlet for the fluid blast from opening 26 is provided although the valve 28 may be seated against mouth 27. It will be understood, however, that such openings may be dispensed with in many cases without affecting the operation of the nozzle.

In the operation of the nozzle just described, a supply of molten material, such as for instance, lead, is admitted to the passage 9 through the conduit 4 and a supply of fluid, such as for instance, pre-heated air, is admitted to the passageway 13, through the conduit 5 and is emitted at the opening 17. It will be understood that the molten material in the opening 9, as well as the pre-heated air in the recess between the core piece 8 and the shell 15, is under sufficient pressure to cause the respective streams thereof to issue from the corresponding orifices with substantial velocity. Similarly a supply of fluid such as for instance pre-heated air, is admitted to the passage 26 from the conduit 6. It will be understood, of course, that the various conduits 4, 5 and 6 may be suitably controlled with valves for discontinuing or regulating the operation of either when so desired. Assuming, however, that the valve controlling each of the conduits 4, 5 and 6 is open, and that a stream of molten material is being forced through the recess 9, it will be apparent that the stream is sub-divided upon contact with the constricted portion 21 into a plurality of smaller streams, the number of which will be determined by the number of grooves 25 in the stem 23. The sub-divided streams of molten material will be conducted past the constricted portion 21 and delivered to the opening between the valve seat 19 and the valve 22. Assuming that the valve 22 is formed as illustrated in Figures 7 and 8, the sub-divided streams of molten material will be forced outwardly and projected in the form of a conical sheet from the opening of the valve seat 19 and the valve 22. At the same time a blast of fluid, such as for instance, pre-heated air, is issuing at a relatively high velocity from the orifice 17, it being recalled that the direction of the blast issuing from the orifice 17 is substantially parallel to the axis of the nozzle, it is apparent that the blast issuing from the orifice 17 will impinge upon the sheet of molten material being projected from the opening between valve seat 19 and the valve 22, so that the stream is completely nebulized. When the blast issuing from the orifice 17 strikes the sheet of molten material, it is apparent that the direction of travel of the metal particles will be changed, and they will be projected in a direction substantially axially to the nozzle. It is apparent, therefore, that the flame thus produced is in its entirety substantially cylindrical and the tendency will be for such a flame to contract a short distance from the nozzle. In accordance with the present invention, however, a second fluid blast is being supplied through the passage 26 and issues on the interior of the flame created by the blast from opening 17 and the stream of molten material so that the internal pressure of the conical flame is counteracted and contraction thereof thus prevented. Furthermore when the blast from passage 26 is spread outwardly, it is apparent that this second blast will also be effective to further disperse the nebulized particles of molten metal.

As has been hereinbefore pointed out, when a stream of molten material, such as for instance, molten lead, is oxidized at a relatively small opening, a dross will usually form about the opening, building up in the form of a cylinder about the opening, and thus prevent proper operation of the nozzle. In accordance with the present invention, however, as illustrated in Figure 2, it becomes impossible for such a formation of dross to build itself up around the orifice which delivers the molten material, in view of the fact that the fluid blast is being directed in such a direction as to continuously impinge the metal at the time it issues from the orifice, and in view of the fact that there is a continuous force in the region of the orifice, it is impossible for any formation to build itself up around the orifice. In the use of the nozzle of this invention, however, it becomes necessary at times to clean the orifice for the molten material as well as a part of the grooves **25**, since there is a slight tendency for oxidation or drossing along this area. In accordance with the present invention, however, it will be observed that the valve **22** may be moved relative to the valve seat **19** by a manipulation of the stem **23**, so that when it becomes necessary for an attendant to remove the dross from the valve and the grooves **25**, this may readily be accomplished without even interrupting the operation of the nozzle by moving the valve **22** away from the valve seat **19** for a short distance. With a nozzle constructed and arranged as illustrated in Figure 2, it is apparent that a workman may view the portions to be cleaned from the rear, after the valve has been moved outwardly for a short distance, so that any suitable cleaning device may be readily employed without dismantling the nozzle as has been necessary in the cleaning of nozzles constructed in accordance with the prior art. When the cleaning operation has been completed the stem **23** may then be moved back to its original position or moved to the desired position, so that the stream of molten material issuing from the orifice controlled by the valve **22** may be adjusted in order to accomplish complete and efficient atomization.

It may be pointed out that the mouth of passage **26** may be formed to any desired shape depending upon the conditions of operation. The passage **26** may or may not be provided with a controlling valve such as **28**, as is desired. If no controlling valve is provided the mouth **27** may be conically shaped as shown at **33** in Figure 7 or cylindrical as indicated in Figure 3, or the passage **26** may be eliminated as shown in Figures 5 and 6.

Referring now particularly to Figure 3, an atomizing nozzle constructed in accordance with another embodiment of this invention is shown. The nozzle illustrated in Figure 3 is substantially the same as that illustrated in Figure 2 with the exception of the valve controlling the internal fluid passage. In the embodiment illustrated in Figure 3, the valve **22** and stem **23** are provided with a continuous axial opening **35**, extending therethrough for supplying a continuous fluid blast from a suitable conduit such as **6**. In the embodiment illustrated in Figure 3, it is apparent, therefore, that all the features of the embodiment illustrated in Fig. 2 are present with the exception of the valve for controlling the internal fluid blast, which as pointed out above, is, under some circumstances, unnecessary.

Referring now particularly to Figure 9, another and further embodiment is illustrated in which the nozzle is provided with a plurality of external orifices for directing fluid blasts against the stream of molten metal. In the embodiment illustrated in Figure 9, the core piece **8** is substantially the same as the core piece provided in the embodiments hereinbefore described, and the core piece is provided with a shell **15** in threaded connection therewith, but spaced therefrom in order to define a passageway between the two pieces, and in addition thereto is provided with an additional outer shell **36** in threaded connection with the core piece **8** and so machined as to define a passageway between the exterior of shell **15** and the interior of shell **36** when in the assembled position illustrated in Figure 9. In the use of the embodiment illustrated in Figure 9, it is intended to supply a blast of gas which may be either raw gas or any suitable fuel gas which may be controlled in order to secure either a reducing, neutral or oxidizing flame. Such gas may be supplied from a suitable conduit **37** and conducted through the passageway **38** existing between the shell **15** and the core piece **8** to the annular orifice **39** adjacent the orifice **41** from which the molten metal issues in the manner described with reference to the embodiments previously described. An additional annular orifice **42** is provided for delivering another fluid blast which may be a stream of air supplied from conduit **5** and transmitted through the recess defined between the shells **15** and **36**. With the various orifices arranged as illustrated in Figure 9, it is apparent that the raw gas issuing from orifice **39** impinges upon the sheet or plurality of jets of metal issuing from the orifice **41** so that the stream of molten metal is first broken up by the impingement of the fluid blast issuing from orifice **39**, which may be for instance a blast of raw or fuel gas. In the embodiment illustrated in Figure 9 the direction of the fluid blast issuing from orifice **42** is preferable at an angle to the blast which issues from orifice **39** in order that further atomization of the particles of molten metal may be accomplished by impingement of the blast issuing from orifice **42** upon the blast issuing from **39** containing the inital atomized particles. In the nozzle illustrated in Figure 9 the central opening for supplying a fluid blast on the interior of the flame which was present in the embodiments previously described has been dispensed with and it will be noted that the outer end of the valve **22** is formed into the shape of a hemisphere **43**. With the end of the valve **22** so arranged and the blast issuing from orifice **42**, directed at an angle to the flame, there is little tendency for the "vena contracta" to form since a spherical formation of the valve **22** substantially fills that area within the blast wherein there is a tendency for a negative pressure to be set up, and furthermore, the fact that the blast issuing from orifice **42** is directed at an angle, tends to maintain the dispersion initially created by impingement of the blast issuing from orifice **39** upon the jet or sheet of molten metal issuing from the orifice **41**.

In each of the embodiments which has been described, it is apparent, however, that the valve **22** may be moved away from its seat for a sufficient distance to permit the stream controlling surfaces thereof to be cleansed without dismantling the nozzle, and, under ordinary circumstances, without interfering with the operation thereof. When any one of the nozzles is provided with a valve, such as that illustrated in Figures 5 and 6, in which the grooves extend outwardly on to the flared portion of the valve and thus cause the stream of molten material to be projected in a plurality of radial jets, a suitable spring, such as **44**, may be provided for maintaining the valve **22** in such a position that the area **45** between the grooves **25** on the flared portion of the valve **22** is in contact with the valve seat **19** so that the various grooves **25** in the valve are separated and the flow of molten material, except through the grooves **25** in the flared portion of the valve, is thus prevented. If, however, the stem 23 be manipulated to increase the distance between the valve 22 and the seat 19, it is apparent that the valve illustrated in detail in Figures 5 and 6 will then cause the molten metal to be projected in the form of a sheet.

From the foregoing description, it is apparent that in accordance with the present invention an atomizing nozzle is provided which accomplishes, first, a mechanism sub-divided of a stream of molten material, such as for instance, lead, and so projects the sub-divided stream either in the formation of a plurality of jets or a thin conical sheet that they become impinged by an annular fluid blast, which may, in a process of making fumed litharge, be air, oxidizing the lead so that a fine state of atomization is accomplished, it being understood that the degree of oxidation is dependent almost entirely upon the degree of atomization, since the more finely divided the lead particles, the greater the surface thereof, which is exposed to the action of the oxygen. In accordance with the present invention, the lead stream is completely and efficiently atomized into fine particles so that oxidation thereof is complete. Moreover in accordance with the present invention, means is provided for preventing the flame from contracting, thus maintaining the dispersion and atomization which was created upon impingement of the blast against the thin jet of metal.

It is apparent that many modifications of the process and apparatus hereinbefore described and illustrated in the accompanying process will become apparent to those skilled in the art, which will not depart from the spirit of this invention.

Furthermore, it is apparent that the arrangement of passages and orifices may be varied to any extent and without departing from the spirit of this invention, and it is to be distinctly understood, therefore, that the nozzle of this invention is not limited to the specific configuration of passages and orifices and the arrangement thereof, nor is it limited to use in connection with the fuming of metals to which the foregoing description has been confined. It is to be distinctly understood, therefore, that such modifications or the use of such individual parts or subcombinations of parts in other relations and for other purposes than the fuming of lead, which do not depart from the spirit of this invention, are, although not specifically described herein, contemplated by and within the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. In the art of oxidizing molten materials, the process comprising projecting a stream of material in the form of a hollow conical jet, directing an annular blast of air against the jet, and surrounding the jet with an envelope of preheated gas.

2. A nozzle for atomizing molten material, comprising, a tube for conducting a stream of molten material, a spreader disposed in the tube and adapted to spread the stream in the form of a conical sheet, a conduit having an orifice adjacent the exterior of said conical sheet, and a second conduit having its orifice on the interior of said conical sheet.

3. A nozzle for atomizing molten material, comprising, a tube for conducting a stream of molten material, a spreader disposed in the tube and adapted to spread the stream in the form of a conical sheet, a conduit having an orifice adjacent the exterior of said conical sheet, and a second conduit having an orifice adapted to deliver a conical blast on the interior of the conical sheet.

4. A nozzle for atomizing molten material, comprising, a tube for conducting a stream of molten material, a spreader disposed in the tube and adapted to spread the stream in the form of a conical sheet, and means for impinging a fluid blast against the conical sheet from the exterior and interior thereof.

5. A nozzle for atomizing molten material, comprising, a tube for conducting a stream of molten material, the mouth of said tube being formed to provide a valve seat, a valve for cooperating with said seat having a stem extending through said tube and movable relative thereto to adjust the valve, said stem having a passage therethrough adapted to conduct a fluid blast, adjustable means for spreading the blast, and means for directing a second blast centrally of said first blast.

7. In the art of oxidizing materials the process, comprising, projecting a stream of molten material in the form of a conical jet, directing a blast of air against the jet, and surrounding the jet with an envelope of reducing gas.

7. In the art of oxidizing materials the process comprising, projecting a stream of molten material in the form of a conical jet, directing a blast of air against the jet, and surrounding the jet with an envelope of neutral gas.

8. A nozzle for oxidizing liquids comprising, a tube for conducting the liquid, a spreader at the end of said tube for directing the liquid stream in directions diverging outwardly from said tube, said spreader having a spheroidal surface extending outwardly substantially beyond the end of said tube to counteract the vena contracta tendency of said diverging stream, and a conduit for delivering an atomizing blast against the stream issuing off said spreader.

9. A nozzle for oxidizing liquids comprising, a tube for conducting the liquid in the form of an annular stream, means in the tube for subdividing the annular stream, a spreader at the end of said tube for directing the subdivided liquid stream in directions diverging outwardly from said tube, said spreader having a spheroidal surface extending outwardly substantially beyond the end of said tube to counteract the vena contracta tendency of said diverging stream, and a conduit for delivering an atomizing blast against the stream issuing off said spreader.

10. A nozzle for oxidizing liquids comprising, a tube for conducting the liquid, a stem extending axially through said tube, said tube terminating in a flaring mouth, a spreader on the end of said stem having a surface substantially complemental to the flaring mouth of said tube, said spreader having a spheroidal part outwardly beyond the mouth of said tube to counteract the vena contracta tendency of a diverging stream issuing between said flaring mouth and spreader, and a conduit for delivering an atomizing blast against the stream issuing off said spreader.

11. A nozzle for oxidizing liquids comprising, a tube for conducting the liquid, a stem extending axially through said tube, said tube terminating in a flaring mouth, a spreader on the end of said stem having a surface substantially complemental to the flaring mouth of said tube, said spreader having a rounded part outwardly beyond the mouth of said tube, a passage extending axially through said stem and opening into the surface

of said rounded part, and a conduit for delivering an atomizing blast against the stream issuing off said spreader.

12. In the art of oxidizing liquid materials the process comprising, mechanically subdividing and spreading a stream of liquid into a diverging conical stream, impinging a fluid blast against the conical stream from the exterior thereof, and directing a second fluid blast interiorly of and codirectionally with said conical stream.

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