

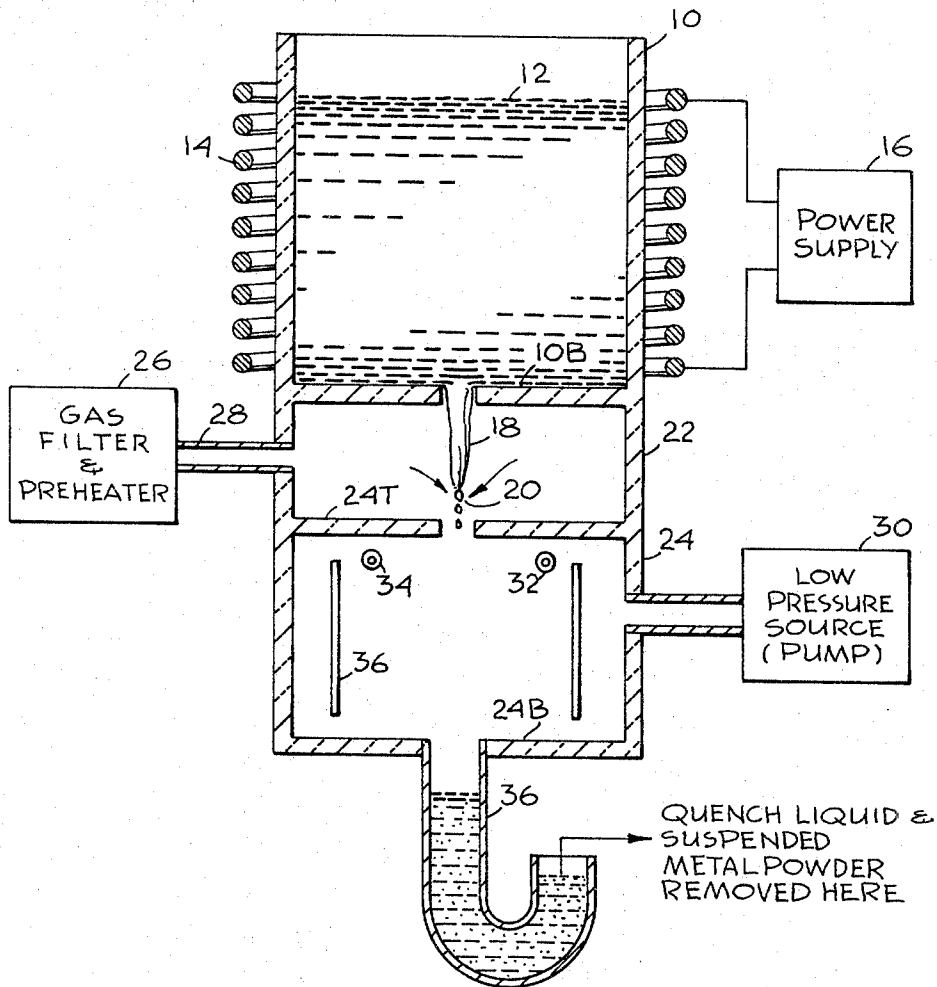
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VACUUM ATOMIZATION

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VACUUM ATOMIZATION

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ABSTRACT OF THE DISCLOSURE

Apparatus for metal atomization is provided wherein liquid metal is atomized by an incoming flow of gas. Metal and gas are drawn together into a mixing region and then into a vacuum chamber wherein the atomized molten metal is quenched and thereafter is collected.

This invention relates to apparatus for metal atomization and more particularly to improvements therein.

A convenient and economical way in which materials such as metals may be subdivided is to convert them into liquid and then to convert the liquid into a spray by contacting with a high velocity gas stream. This type of atomization is known as "pneumatic" atomization. There are two generic types of pneumatic atomization. One of these is designated as external-mix atomization and the other as internal-mix atomization. The external-mix atomization is accomplished by applying the gas and the liquid metal to two separate pipes which terminate in nozzles. The two nozzles of these pipes are then directed at one another to cause the liquid metal to break up. In the case of the internal-mix atomization, the gas and the liquid metal are caused to mix before being ejected through a nozzle.

It is known that pneumatic atomization with an internal-mix nozzle can be more effective than atomization with an external-mix nozzle. Because of structural problems, the application of atomization to very refractory materials (including high-melting point metals) has been limited to the use of external-mix atomizing arrangements which in turn limit the extent of atomization that can be realized, in those cases under practical operating conditions. This arises because of the fact that with internal-mix nozzles and in order to enable the gas to atomize the liquid, it is customarily necessary to pressurize the gas in order to attain a certain velocity relative to the liquid. Then, in order to effectuate the mix it is also necessary to apply a pressure to the liquid. It will be appreciated that if the liquid is at a high temperature, problems in the pressurization of the liquid can and do arise with respect to a crucible.

An object of the present invention is the provision of an arrangement for atomizing liquids which realizes the advantages of an internal-mix nozzle for handling high melting materials, which now can only be handled with external-mix nozzles.

Another object of the present invention is the provision of a novel and useful method and means for atomizing high temperature liquids.

Still another object of the present invention is the provision of a structure for atomizing high temperature liquids which do not require the application of pressure to such liquids above the pressure of the atmosphere.

These and other objects of the present invention are achieved by an arrangement wherein an internal-mix nozzle is employed. However, this nozzle empties into a container which effectively is a vacuum chamber. Thus, the pressurization of the liquid refractory material, which was heretofore necessary before the material could be atomized by gas under pressure, is eliminated. Further-

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more, it is now made possible to use an internal-mix nozzle for the purpose of atomization.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawing, which is a cross-section of an embodiment of the invention.

The drawing is schematic and is a cross-section of an embodiment of the invention which may be employed for the atomization of refractory materials such as metals. It should be appreciated, however, that this drawing is shown by way of illustration of the application of the principles of the invention and is not to be construed as the only way in which these principles may be employed. assuming now, that it is desired to atomize a material such as a metal, there is provided a container 10 which is made of a suitable material, so that it may withstand the high temperatures of the metal melt. The manner of obtaining the container of melted metal 12 or of keeping it molten may be done in any of the various ways well known in the art. By way of illustration, and not as a limitation, there is shown an induction coil 14, which surrounds the container 10, and which has power supplied thereto from a power supply 16. The metal 12 is melted and maintained liquid by induction heating. The bottom 10B of the container has an opening into which a nozzle 18 is inserted. Thus, the molten metal passes through the nozzle into a region thereunder which may be termed the mixing region 20.

The side walls and bottom of the chamber 10 rest upon walls 22 which in turn can rest upon a vacuum chamber 24. A gas under atmospheric pressure is supplied to the mixing region 20. This may be a low molecular weight gas, such as helium or hydrogen, or the atmospheric air. In any event the gas is drawn through a gas filter and preheater 26, which heats the gas up so that it will not cool the molten metal with which it is mixed. The gas filter and preheater 26 is coupled to the mixing region through a pipe coupling 28 which passes through the wall 22.

The vacuum chamber 24 has an opening in the top wall 24T, just below the nozzle 18 so that the mixture of liquid metal and gas can fall into it. A low pressure air source which may be a pump applies a vacuum to the vacuum chamber whereby the gas and molten metal which are supplied at atmospheric pressure, may mix at the end of nozzle 18 for the purpose of atomization, and then fall into the vacuum chamber.

The vacuum spray chamber may, if desired, have water spray openings 32, 34 around the top, to spray and quench the atomized molten metal as it drops through the opening in the vacuum chamber. A cylindrical baffle 36 may be provided, if desired, to keep most of the water spray from mixing with the gas in the center of the chamber.

In order to remove the quenching liquid and the atomized metal a barometric leg 36, or if desired a sump pump, is connected to an opening in the bottom 24B of the vacuum chamber. The atomized metal is suspended as a powder in the quench liquid in the barometric leg 36 shown. If a low molecular weight gas is used, then the pump 30 may be coupled through a filter, so that the gas may be purified and returned to the gas filter and reheater 26 for use again.

It has been found that one of the most important factors that govern the effectiveness with which a given material is atomized is the relative velocity that is set up between the gas and the bulk liquid to be atomized.

This relative velocity becomes less as atomization proceeds. However, by the time the relative velocity is radically lower, atomization is essentially as complete as it will be.

Since the linear velocity of the gas flowing through a nozzle is actually a function of the pressure ratio across the nozzle rather than of the initial gas pressure alone, essentially the same gas velocity can be achieved by letting a gas flow through an opening from atmospheric pressure into a vacuum chamber as would be the case if the same gas flowed through the same opening from some corresponding super atmospheric pressure tank to the atmosphere. Where high liquid to gas mass flow-rate ratios are involved, it may be necessary to increase the hole size to improve the atomization which is achieved. It should be noted, however, that with the system which has been described, no pressurization of the metal is necessary in order to cause it to mix with the gas, as is the situation with systems which were employed heretofore. The gas which is employed for atomization may be recovered from the low pressure air source and used again, as desired. The process described may be made a continuous one, since it is not necessary to pressurize the molten material with this invention. Additional molten material may be added during operation.

Since, as has been indicated, one of the most important factors governing the effectiveness of pneumatic atomization is the relative velocity that is set up between the gas and the bulk liquid that is to be atomized, the use of low molecular weight gases, such as helium or hydrogen, is preferred since they provide a greater velocity for a given vacuum than other gases and can provide ultrafine atomization.

There has accordingly been described and shown herein a novel, useful, simple and unique arrangement for effectuating atomization of liquid materials employing gases which, by the simple expedient of enabling the atomized material to fall into a vacuum chamber allows the use of internal-mix techniques and eliminates the requirement for pressurization of the molten material being atomized.

What is claimed is:

1. Apparatus for effectuating pneumatic atomization of a liquid comprising a container for said liquid, said container having a base therein with an opening in said base through which said liquid can flow, a vacuum chamber, means for supporting said container of liquid above said vacuum chamber, means for guiding liquid flowing through the opening in the base of said liquid chamber

into said vacuum chamber, means coupled to said vacuum chamber for evacuating the air therefrom, a source of gas at atmospheric pressure, and means for directing gas from said source at the liquid flowing from the base of said liquid container into said vacuum chamber whereby said liquid is atomized in said vacuum chamber.

2. Apparatus as recited in claim 1 wherein said gas in said source has a low molecular weight.

3. Apparatus for atomizing a liquid comprising a vacuum chamber, means for evacuating air from said vacuum chamber, said chamber having an opening therein, a supply of a liquid to be atomized, said liquid being at atmospheric pressure, a supply of a gas from atomizing said liquid, said gas supply being at atmospheric pressure, and means for coupling said supply of liquid and said supply of gas to said vacuum chamber opening for bringing them together prior to their entry into said vacuum chamber.

4. Apparatus for atomizing refractory material comprising a liquid container into which said refractory material is placed, means for heating said refractory material within said container until it is molten, an opening in the base of said container through which said molten refractory material can flow, a supply of gas at atmospheric pressure, an enclosed vacuum chamber having an opening in a top wall thereof, means supporting said liquid container over said vacuum chamber with the opening in the bottom thereof over the opening in the top of said vacuum chamber, nozzle means connected to the opening in the base of said liquid chamber for directing said molten refractory material at said opening in said vacuum chamber, means for evacuating said vacuum chamber, and means for directing gas from said source at said molten refractory material as it falls through the bottom of said nozzle means and before it enters said vacuum chamber.

5. Apparatus as recited in claim 4 wherein said gas is a low molecular weight gas.

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