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LIQUID ATOMIZER NOZZLE

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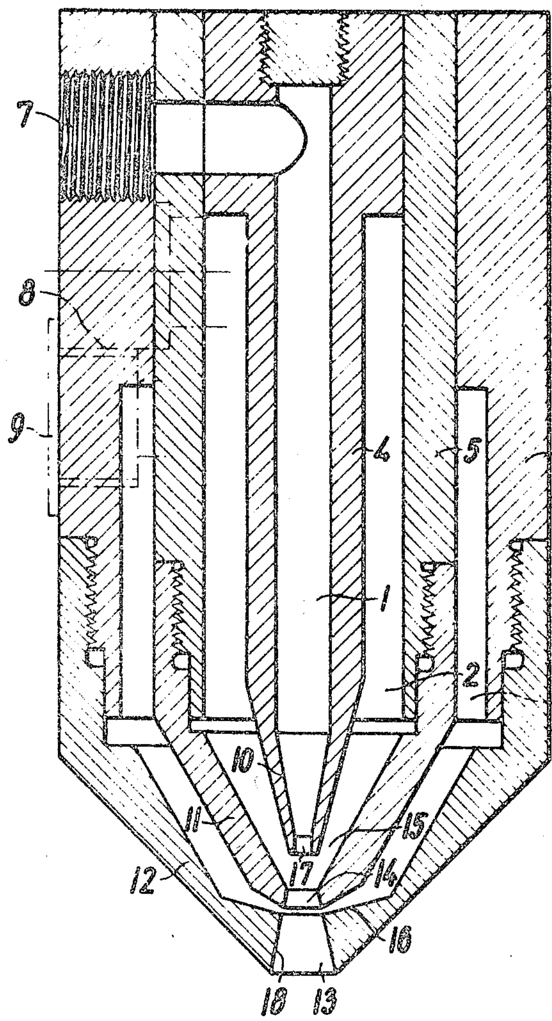

FIG. 1

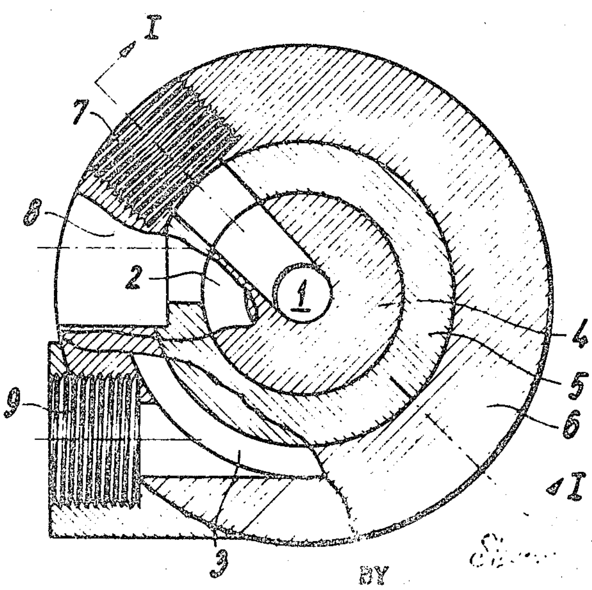

FIG. 2

INVENTOR

KEITH MASTERS

BY

ATTORNEYS

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LIQUID ATOMIZER NOZZLE

Keith Masters, Copenhagen, Denmark, assignor to Aktieselskabet Niro Atomizer, Soborg, Denmark, a company of Denmark

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ABSTRACT OF THE DISCLOSURE

A liquid atomizer nozzle comprising three concentric channels, the inner and the outer one for the supply of gas and the intermediate one for the supply of liquid, means being provided for obtaining opposite rotating currents of the air and the liquid in the outer and the intermediate channels, respectively.

This invention relates to a liquid atomizer nozzle, especially for highly viscous liquid, of the kind having a number of concentric annuli for gas, for instance air, and liquid so arranged that there are gas passages both outside and inside the chamber for the liquid and that the outer gas passage is provided with means to produce a swirling movement of the gas.

It is connected with the considerable difficulties in achieving an efficient atomization into droplets having a narrow size distribution and the more so with highly viscous liquid.

The object of the present invention is to provide a nozzle of the kind described above which is able to yield satisfactory atomization even with highly viscous liquid and according to the invention this is achieved through the liquid chamber having means to produce a rotation of the liquid in opposite direction of the gas in the surrounding passage.

As in the known designs the gas fed into the inner chamber causes the liquid to adopt the shape of a thin film and the rotation of the liquid brought about by the invention is maintained in this film which is broken up by surrounding gas passing through the outer passage and circulating in a direction opposite to that of the liquid.

Experiments with the nozzle designed according to the invention have shown that more efficient atomization can be obtained than with the known nozzles, particularly with highly viscous liquid, which fact may be explained by assuming that the rotation of the liquid in the film stabilizes this film so that the gas through the inner chamber is hardly able to break up the film, although the gas itself would normally tend to break up the liquid in comparatively large particles. Due to this stabilizing effect the film may be thinner without partial disintegration so that the particles which are formed by the influence of the outer gas stream become smaller and of uniform size. Besides, since the liquid rotates in one direction and the gas current in a direction opposite hereto the outer gas current impinges upon the liquid film against its direction of movement and there will therefore be little tendency for the liquid to break up into strings.

In a preferred embodiment of the invention the means for producing the rotation of the liquid and the surrounding gas stream comprise tangential inlet pipes to these chambers, whereas the central chamber is supplied with gas from centrally mounted inlet pipe giving the gas an axial movement, same chamber having its exit passage at a distance from and inside the exit passage of the liquid chamber, this exit passage again placed at a distance from and inside the exit passage of the outer gas chamber. The choice of tangential inlet ducts for obtaining a rotation of

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the liquid and the gas respectively offers a nozzle of simple design, easy to assemble and disassemble which is particularly advantageous when the nozzle must be cleaned, and a very high efficiency of the swirling movement may be achieved by easy adjustment of velocity and pressure. A further advantage of the spacing of the exit passages as described above is that the exit passages may be dimensioned independently of each other regards only being paid to the function as opposed to the known designs where the exit passages are spaced so that the extreme parts of the walls separating the various passages project more or less into the exit of the surrounding passage or passages. Besides the simplicity of design another advantage of the described spacing of exit passages lies in an improvement of the atomization probably due to the fact that the gas stream from the outer chamber impinges upon the liquid in a direction which is more or less perpendicular to the direction of spray.

According to the invention a further advantage is obtained when the annular exit passages of the liquid chamber and the outer gas chamber are spaced so as to approximately form a conical surface the base of which is the exit of the nozzle and the top of which is inside or close to the exit passage of the inner gas chamber, whereby a further improvement of the atomization is obtained.

In this case it is particularly desired that the top angle of the above mentioned conical surface be less than 45° preferably 30° to 40° thus making the nozzle particularly suitable for atomization of highly viscous liquid and furthermore it is preferred that the exit passage of the nozzle coincides with the above mentioned conical surface.

In a further preferred embodiment of the invention the distance of the nozzle exit from the exit passage of the outer gas chamber exceeds the largest diameter of the nozzle exit, a spacing which yields particularly good flow conditions for successful atomization and a similar effect is obtained according to the invention when the distance between the lower edge of the liquid exit passage and the upper edge of the outer gas chamber exit passage is less than half of the diameter of the exit passage formed by the wall separating these two passages, when referred to the nozzle pointing vertically downwards. Here, "upper" and "lower" refer to the nozzle when positioned vertically with its mouth downwards but of course the nozzle may be applied in every desired position.

A further increase in the limit of the viscosity of liquids that may be advantageously sprayed in the nozzle can be achieved according to the invention if the angle between the nozzle axis and the direction of the exit passage of the outer gas channel inside the mouth of the nozzle is at least 45° preferably 55° and a further increase of the viscosity limit may also be obtained according to the invention when the angle between the nozzle axis and the direction of the exit passage of the liquid channel is less than 35° preferably about 30°.

In the following the invention is explained in more detail with reference to the drawing which in FIG. 1 shows schematically in an axial view an embodiment of the nozzle according to the invention, and FIG. 2 a cross-sectional view of the same.

The nozzle shown contains three concentric chambers **1**, **2** and **3**, which are limited by the cylindrical walls **4**, **5** and **6**. The chamber **1** has an inlet **7** which is shown with its axis in the plane of the drawing so that air or another gas which is supplied through this inlet to the chamber **1** is introduced radially, and will therefore move axially without rotation through the chamber. The chamber **2** has an inlet **8** which in the embodiment shown is parallel to chamber **7** and with its axis behind the plane of the drawing so that it is connected tangentially to the chamber **2**, causing the liquid which is supplied to the chamber **2** to rotate. Similarly, the chamber **3** is in connection with the inlet **9**, the axis of which, however, is in front of the plane of the drawing, so that the air or gas which is supplied to the chamber **3** is caused to rotate in the opposite direction of that of the liquid in the chamber **2**.

The wall **4** ends in the conical narrowed part **10**, and on the walls **5** and **6** conical end parts designated **11** and **12** respectively are mounted, inside which the chambers **1**, **2** and **3** continue.

The parts **10**, **11** and **12** are shaped so that inside the outer exit passage **18** of the nozzle is a chamber **14**, the walls of which lie on a conical surface and in which the exit passages of the three chambers **1**, **2** and **3** terminate.

The exit passages of the chamber **2** and **3**, designated **15** and **16** respectively, which form annuli therefore lie in the same conical surface, the top of which is above and close to the exist passage **17** of the chamber **1**.

The exit passage **17** of the central chamber **1** is consequently placed at a distance from and inside the exit passage **15** of the surrounding liquid chamber **2**, and this exit passage **15** again lies at a distance from and inside the exit passage **16** of the outer gas chamber **3**.

The wall **18** of the nozzle exit passage **13** is frusto conical and forms the lower part of the above-mentioned conical surface in which the exit passages **15** and **16** terminate. The top angle of this conical surface in the embodiment shown is approximately 30° but may be as high as 45°. The length of the exit passage **13**, i.e. the projection of the wall **18** on the axis, is longer than the largest diameter of the exit passage **13**, while the part of the conical surface which separates the terminations of the exit passages **15** and **16**, i.e. the lower inner surface of the part **11**, has a length dimension which is less than half of the diameter at this level.

The parts **11** and **12** are placed near the exit passage **16** and so designed that the direction of the air in the plane of the drawing forms an angle of 55° with the axis, while the direction of the liquid stream in the same plane forms an angle of somewhat more than 30° with the axis.

The liquid streaming with a rotating movement from the chamber **2** out into the chamber **14** is blown downwards into the chamber by the gas passing out through the exit passage **17** hereby causing the liquid to adopt the shape of a thin film particularly able to maintain film stability. The gas which passes through the exit **16** in a direction more or less perpendicular to that of the liquid and rotating in the opposite direction impinges upon the liquid film, and when the pressure of the gas is adjusted so that a very high gas velocity is produced—usually approaching sonic velocity or more—the liquid film is broken up into fine particles passing through the exit **13** where the gas expands and distributes the particles into a cloud.

As an example it should be mentioned that it has been possible to atomize satisfactorily materialys with very high viscosities such as pregelatinized corn starch with a viscosity higher than 200,000 cp. using a nozzle as shown on the drawing with the largest diameter of the exit passage **13** of 8 mm. and applying a feed rate of 600 kg./h. at a pressure of 3.9 kg./cm.^{2} approximately, and with a gas pressure of 4 kg./cm.^{2}.

What is claimed is:

1. An atomizer nozzle especially adapted for highly viscous liquids, defining a tubular first conveying passage for gas; an annular second conveying passage for liquid concentrically disposed around said first conveying passage; an annular third conveying passage for gas, concentrically disposed around said first and second conveying passages; means in said second and third passages to produce oppositely directed swirling movements of their respective liquid and gas streams; first, second, and third exit passages; said first exit passage being positioned within and spaced from said second exit passage, and said second exit passage being positioned within and spaced from said third exit passage; a single outlet chamber to which said exit passages lead, the walls of said outlet chamber being on a cone such that said first exit passage terminates near the apex of said cone, and the base of said chamber forms the mouth of said nozzle, with the distance between the nozzle exit and said third exit passage exceeding the largest diameter of said outlet chamber, the apex angle of said cone being less than 45°.

2. Atomizer nozzle as claimed in claim **1** in which the angle at the apex of said outlet chamber is 30° to 40°.

3. Atomizer nozzle as claimed in claim **1**, wherein, measured at the ends of said exit passages in said outlet chamber, the distance between the outermost edge of said second exit passage and the innermost edge of said third exit passage, is less than half the diameter of said chamber measured at a point half way between said passages.

4. Atomizer nozzle as claimed in claim **1**, wherein the angle between the longitudinal axis of said nozzle and the direction of said third exit passage is at least 45°.

5. Atomizer nozzle as claimed in claim **4**, wherein the angle between the longitudinal axis of said nozzle and direction of said third exit passage is 55°.

6. Atomizer nozzle as claimed is claim **1**, wherein the angle between the longitudinal axis of said nozzle and the direction of said exit passage is less than 35°.

7. Atomizer nozzle as claimed in claim **6**, wherein the angle between the longitudinal axis of said nozzle and the direction of said second exit passage is about 30°.

8. An atomizer nozzle especially adapted for highly viscous liquids defining a tubular first conveying passage; an annular second conveying passage concentrically disposed around said first conveying passage; an annular third conveying passage concentrically disposed around said first and second conveying passages; a first inlet pipe for gas axially connected to said first conveying passage; a second inlet pipe for liquid tangentially connected to said second conveying passage in order to cause said liquid to swirl in one direction; a third inlet pipe for gas connected to said third conveying passage in a manner which induces said gas to swirl in a direction opposite to the swirl of said liquid; first, second, and third exit passages concentrically disposed at the respective exit ends of said first, second, and third conveying passage; said first exit passage being positioned within and spaced from said second exit passage, and said second exit passage being positioned within and spaced from said third exit passage; a single outlet chamber to which said exit passages lead, the walls of said chamber being on a cone such that said first exit passage terminates near the apex of said cone and the base of said chamber forms the mouth of said nozzle, with the distance between the nozzle exit and said third exit passage exceeding the largest diameter of said outlet chamber, the apex angle of said cone being less than 45°.

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SAMUEL F. COLEMAN, Primary Examiner

H. S. LANE, Assistant Examiner

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