Title: A NOZZLE AND A DISPENSER HAVING SUCH A NOZZLE

Abstract: A nozzle for generating a spray of liquid has an outlet with a tapered protrusion (12) and two or more outlet orifices (14) which open through a sloping side wall region of the tapered protrusion (12). The tapered protrusion (12) and the orifices (14) are configured so that a portion of the liquid (15) emitted from each outlet orifice atomises to form a spray (15A) whilst a further portion of the liquid emitted from each orifice flows along the tapering surface towards a distal end of the protrusion where the liquid from all the orifices combines to form a core jet (15B) which streams from the distal end of the protrusion for a distance before atomising (15C). The tapered protrusion (12) has an angle of inclination in the range of 40 degrees to 80 degrees and the axis of each of the outlet orifices diverges outwardly from a longitudinal axis of the protrusion by no more than 10 degrees and preferably by no more than 5 degrees. A liquid dispenser comprising the nozzle is also described and claimed.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
A NOZZLE AND A DISPENSER HAVING SUCH A NOZZLE

This invention relates to a nozzle for producing an atomised spray of liquid. The invention also relates to a dispenser which incorporates such a nozzle arrangement.

Atomising nozzles are often used to provide a means of generating atomised sprays of various fluids, usually liquids. In particular, nozzle arrangements are commonly fitted to the outlet valves of pressurised fluid-filled containers, such as so-called “aerosol canisters”, to provide a means by which the fluid stored in the container can be dispensed in the form of an atomised spray or mist. A large number of commercial products are presented to consumers in this form, including, for example, antiperspirant sprays, deodorant sprays, perfumes, air fresheners, antiseptics, paints, insecticides, polish, hair care products, pharmaceuticals, water and lubricants. In addition, nozzle arrangements are frequently used with manual pump type dispensers where the release of fluid from a non-pressurised container is achieved by the operation of a manually operable pump or trigger to generate an atomised spray or mist of certain fluid products. Examples of products that are typically dispensed using manually actutable pump or trigger devices include various lotions, insecticides, and various garden and household sprays. Nozzle arrangements can also be used in industrial apparatus to control the ejection of pressurised fluids in many different applications.

Nozzle arrangements typically comprise a fluid flow passageway which leads from an inlet to an outlet orifice and are configured so that a fluid stream flowing through the nozzle under pressure is caused to break up or “atomise” into numerous droplets as it is passes through the nozzle and is ejected through the outlet orifice to form a spray or mist. It is also known to provide a swirl chamber next to the outlet to cause the fluid to spin as it passes through the outlet.
The optimum size of the droplets required in a particular spray depends primarily on the product concerned and the application for which it is intended. For example, a pharmaceutical spray that contains a drug intended to be inhaled by a patient (e.g. an asthmatic patient) usually requires very small droplets, which can penetrate deep into the lungs. In contrast, a polish spray preferably comprises spray droplets with larger diameters to promote the impaction of the aerosol droplets on the surface that is to be polished and, particularly if the spray is toxic, to reduce the extent of inhalation.

It has been found that the size and/or the size distribution of the droplets produced at the outlet orifice can be controlled by incorporating a number of different control features into the fluid flow passageway between the inlet and the outlet which modify the characteristics of the fluid as it flows through the passageway. For example, it has been found to be particularly beneficial to form two or more expansion chambers along the fluid passageway, each chamber having a constricted inlet opening arranged so that the fluid is sprayed into the chamber. This and other suitable control features are disclosed in WO 01/89958 A1, the content of which is incorporated in its entirety. Similar effects have also been found by the use in the fluid flow passageway of expansion chambers which are shaped so as to modify the characteristics of the fluid passing through. A number of such shaped expansion chambers are described in WO 2005/005055 A1, the content of which is also incorporated herein in its entirety.

Whilst the use of shaped expansion chambers and other known control features have been shown to be effective in modifying the droplet size/size distribution, there is a need to develop other arrangements that can be introduced into a nozzle to affect the droplet size/size distribution in order that nozzle performance can continue to be improved.
To assist in the break up of liquids at the nozzle outlet, it is known to mix a gas into the liquid stream so that as the liquid and gas mixture exits the nozzle outlet orifice, the gas expands helping to break the fluid into smaller droplets. In the case of aerosol canisters, certain propellants are present in the canister in the form of a liquefied gas in suspension in the liquid product as well as a gas above the liquid product. When the liquid product is dispensed, the liquefied gas held in suspension will expand as it passes through the nozzle outlet orifice into the atmosphere, breaking up the liquid product into small droplets. Typical liquefied gas propellants include propane, butane, isobutene, n-butane, and dimethyl ether, all of which are volatile organic compounds (VOCs). VOCs are harmful to the environment and there is increasing pressure to reduce the amount of VOCs used in aerosol canisters. Reduced VOC aerosols often have lower operating pressures and reduced amounts of propellant in suspension in the liquid. As a result, it can be difficult to achieve effective sprays for certain products such as air fresheners and insecticides in particular.

Where a propellant is present in an aerosol canister as a vapour or compressed gas above the liquid, it is known to use a vapour phase tap to bleed some of the propellant gas into the liquid as it is passes through the aerosol valve or the nozzle to be dispensed. The propellant gas is mixed with the liquid in the aerosol valve and/or the nozzle and helps the break up the liquid stream as it passes out through the outlet orifice. This arrangement may be required where there is no or only a small amount of propellant in suspension, as may be the case with a reduced VOC formulation or where an alternative non-VOC propellant such as carbon dioxide is used. The problem with this arrangement is that the propellant gas is depleted more quickly resulting in the pressure in the canister dropping as the contents are used up, adversely affecting the quality of the spray.
In other applications, such as manually actuated trigger or pump dispensers, it is known to mix a gas, usually air, with a liquid as it is being dispensed so that the gas expands as the mixture passes out of the nozzle into the atmosphere to break up the liquid into very small droplets. Such manual dispensers usually have at least one pump chamber for the liquid product to be dispensed and at least one further pump chamber for pressurising the gas. When the dispenser is actuated, the pressurised gas is mixed with the pressurised liquid to aid in the atomisation of the liquid at the nozzle.

A problem with known nozzle and dispenser arrangements is that fine droplets in the spray tend to fall away fairly close to the nozzle so that the average size of the droplets in a spray naturally increases with distance from the nozzle. This is a major problem with many products and in particular with products such as an air freshener and insecticides, where it is desirable to fill a room with fine droplets which tend to stay in the air longer and thus increase the effectiveness of the product.

Nozzles having multiple final orifices are also known and these tend to generate finer droplets than a single orifice. In the known arrangements, the outlet orifices are arranged to direct the fluid along divergent paths so as to create a separate spray plume at each orifice. The individual spray plumes merge as they spread outwardly to form a single combined spray plume having a very wide angle. However, the known multi-outlet orifice nozzle arrangements do not address the problem of increasing the reach of the spray.

It is an objective of the present invention to provide an improved nozzle in which the above problems are overcome or at least reduced.

It is a particular objective of the present invention to provide an improved nozzle arrangement that produces a spray having fine droplets which are carried further from the nozzle than a conventional nozzle under similar circumstances.
It is a further objective of the present invention to provide an improved nozzle arrangement for use with a reduced VOC aerosol canister.

It is a further objective of the present invention to provide an improved nozzle arrangement for use with a manually actuated dispenser in which air or another gas is mixed with a liquid product.

It is a further objective of the present invention to provide a liquid dispenser having an improved nozzle arrangement.

It is a further objective of the present invention to provide an aerosol canister having an improved nozzle which produces an effective spray with reduced VOCs.

It is a further objective of the present invention to provide a manually actuated dispenser in which air or another gas is mixed with a liquid product having an improved nozzle arrangement.

In accordance with a first aspect of the invention, there is provided an atomising nozzle as defined in claim 1.

Further features of the first aspect of the invention are to be found in the claims dependent on claim 1.

In accordance with a second aspect of the invention, there is provided a nozzle as defined in claim 30.

Further features of the second aspect of the invention are to be found in the claims dependent on claim 30.

In accordance with a third aspect of the invention, there is provided a liquid dispenser comprising a nozzle in accordance with either or the first and second aspects of the invention, as set out in claim 41.

Further features of the third aspect of the invention are to be found in the claims dependent on claim 41.
Several embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1A is a side elevation of part of a nozzle arrangement in accordance with a first embodiment of the invention;

Figure 1B is a cross sectional view through the nozzle arrangement of Figure 1A, taken on line A-A;

Figure 1C is a side elevation of a distal end part of a protrusion forming part of the nozzle arrangement of Figure 1A, illustrating the spray pattern produced by the nozzle in use;

Figure 2A is longitudinal cross sectional view through part of a nozzle arrangement in accordance with a second embodiment of the invention;

Figure 2B is plan view of the nozzle arrangement of Figure 2A, taken on arrow B;

Figure 3 is a side elevation of part of a nozzle arrangement in accordance with a third embodiment of the invention;

Figure 4 is a side elevation of part of a nozzle arrangement in accordance with a fourth embodiment of the invention;

Figure 5A is a longitudinal cross sectional view through part of a nozzle arrangement in accordance with a fifth embodiment of the invention;

Figure 5B is a cross sectional view through the nozzle arrangement of Figure 5A, taken on line C-C;

Figure 6A is a longitudinal cross sectional view through part of a nozzle arrangement in accordance with a sixth embodiment of the invention;

Figure 6B is a cross sectional view through the nozzle arrangement of Figure 6A, taken on line D-D;
Figure 7A is a side elevation of part of a nozzle arrangement in accordance with a seventh embodiment of the invention;

Figure 7B is a plan view from above of the nozzle arrangement of Figure 7A;

Figure 8 is a longitudinal cross sectional view through part of a nozzle arrangement in accordance with an eighth embodiment of the invention;

Figure 9 is a view similar to that of Figure 8 but showing a nozzle arrangement in accordance with a ninth embodiment of the invention;

Figure 10 is a view similar to that of Figure 8 but showing a nozzle arrangement in accordance with a tenth embodiment of the invention;

Figure 11 is a cross sectional view through an outlet region of part of a nozzle arrangement in accordance with an eleventh embodiment of the invention;

Figure 12 is a plan view of the nozzle arrangement of Figure 11;

Figure 13 is a cross sectional view through a protrusion insert adapted for use with the nozzle arrangement of Figure 11;

Figure 14 is a plan view of the insert of Figure 13;

Figure 15 is a cross sectional view through an outlet region of part of a nozzle arrangement in accordance with a twelfth embodiment of the invention;

Figure 16 is a plan view of the nozzle arrangement of Figure 15;

Figure 17 is a cross sectional view through a protrusion insert adapted for use with the nozzle arrangement of Figure 15;

Figure 18 is a plan view of the insert of Figure 17;

Figures 1A to 7B of the accompanying drawings illustrate outlet portions of various nozzle arrangements in accordance with the invention. It will be appreciated that these nozzle arrangements will also comprise a body defining
fluid inlet means and fluid passageway means for fluidly connecting the inlet means with the outlet portion. The nozzle arrangements may each be an integral part of a liquid dispenser such as a manual pump or trigger dispenser or they may each be part of an actuator for attachment to an aerosol canister. However, other nozzle arrangements can also be adapted in accordance with the invention, including industrial and agricultural nozzles.

Figures 1A and 1B show an outlet portion of a nozzle arrangement 10 which includes a tapered projection or protrusion 12. In the present embodiment, the tapered protrusion 12 is conical but, as will be discussed in more detail later, other configurations of tapered protrusion can be used. The protrusion is outwardly tapering, that is to say it tapers in a direction away from the nozzle so that the distal end 12A of the protrusion is its narrowest point. In the embodiment shown in Figures 1A and 1B the protrusion is 2mm in length and has an internal angle of inclination \( \alpha \) of 60 degrees relative to a plane which extends perpendicularly to the axis 12D of the protrusion (i.e. a generally horizontal plane as shown in Figure 1A).

The nozzle arrangement 10 includes three final outlet orifices 14 formed by means of elongate bores that extend through a base region 12B of the protrusion and which open through the sloping side wall 12C of the protrusion. The inner, upstream, ends of the orifices 14 are in fluid connection with one or more fluid passageways through which liquid can flow from the inlet means of the nozzle arrangement to the outlet and so through the outlet orifices 14. The orifices 14 are all aligned with their axis 14A parallel to the longitudinal axis 12D of the protrusion 12. The nozzle 10 may comprise further flow passageway means (not shown) though which a gas is introduced into the nozzle to mix with the liquid before it flows through the outlet orifices. The gas may be a mixture of gases such as air. Where the nozzle is used with an aerosol canister, the gas may be a propellant gas which is bled into the nozzle from the canister.
As shown in Figure 1C, the protrusion 12 and outlet orifices 14 are arranged so that when liquid 15 is forced through the outlet orifices of the nozzle under pressure, some of the liquid exiting each orifice 14 will form a very fine spray plume 15A at each orifice 14 but the majority travels along the protrusion 12 towards its tip 12A, where the liquid from all three orifices combines to form a core jet of liquid 15B. The core jet of liquid 15B flows from the end 12A of the tapered protrusion and creates a pressure differential, which draws the separate spray plumes from the three outlet orifices 14 in towards the core to form a single spray plume. Some of the finer droplets from the three spray plumes may also coalesce at the centre to add to the core jet. After the core jet has travelled for a distance from the end of the protrusion it also atomises, as indicated at 15C, so that the whole spray becomes atomised.

In tests, using a nozzle as shown in Figures 1A and 1B, the core jet was found to form at a distance of 25mm from the outlet orifices with the three spray plumes being drawn in towards the core jet at a distance of between 25mm and 100mm. The core jet 15B was found to fully atomise at a distance Z of between 100 to 150mm. The nozzle 10 was found to produce a full spray angle of 30-40 degrees. This wider than the 20-30 degree full spray angle that a typical single orifice nozzle would produce but is much narrower than the prior art multi-orifice nozzles which produce separate, divergent spray plumes that mingle together to form a wide angle spray.

Some atomisation of the liquid 15 flowing along the protrusion 12 towards the distal end 12A takes place as indicated at 15D. This is due to the liquid being stretched and stripped from the angled surface. However, the majority remains liquid and forms the core jet 15B. Since the core jet 15B is heavier than the atomised droplets 15A, it has greater momentum and travels faster than the atomised droplets. This causes the pressure in the central region to drop, which draws the spray plumes containing the finer droplets in toward the central core. The presence of the central core jet 15B increases the
momentum of the overall spray so that it travels much further than it would ordinarily, carrying the finer droplets further. Also, because the pressure differential generated draws the finer droplets in towards the centre, there is a reduced tendency for them to fall away so that the spray not only travels further but has a much lower average droplet size at any given distance from the outlet orifices 14 than would be achieved with an equivalent conventional nozzle arrangement.

For simplicity, the fluid flowing through the outlet orifices of the nozzle is referred to herein, including in the claims, as being a "liquid" but it should be understood that this term is intended to cover not only a pure liquid of any type, including a liquor, but also a mixture of two or more liquids and a mixture of one or more liquids with one or more gases.

A nozzle 10 in accordance with the invention can be manufactured from any suitable materials or combinations of materials including metals and/or plastics. However, for use in many applications it is expected that the nozzles will be injection moulded from plastics materials such as polypropylene, nylon, acetyl or PVC, for example.

The nozzle 10 can have any number of outlet orifices 14 from two upwards but in preferred embodiments the nozzle has three or four outlet orifices. Where the nozzle is injection moulded, the outlet orifices are formed by pins in the mould. Since small diameter pins are more susceptible to breakage, it is preferable to use three larger outlet orifices rather than four smaller ones.

Protrusions in which the sloping side wall region has an internal angle of inclination $\alpha$ of 60 degrees have been found to be particularly effective. However, the angle of inclination $\alpha$ of the side wall region can be anywhere in the range 40 degrees to 80 degrees but is preferably in the range of 50 degrees to 70 degrees and even more preferably in the range of 55 degrees to 65. The
length of the protrusion can also be varied as required but it is expected that the
 tapering part of the protrusion will be 0.5mm to 10mm in length, with 2mm
 being typical. However, in certain applications a protrusion having a tapering
 length outside of the above range can be used.

For ease of manufacture it is preferred that the axes 14A of the outlet
 orifices 14 are parallel with the longitudinal axis 12D of the protrusion but they
 can be angled away from the longitudinal axis 12D of the protrusion 12 by a
 small amount, provided this does not disrupt the formation of the core jet. In
 practice, it has been found that the axis 14A of each outlet orifice can be angled
 outwardly from the longitudinal axis of the protrusion by up to 10 degrees,
 though in preferred embodiments they are angled outwardly by no more than 5
 degrees.

Maintaining the axes 14A of the outlet orifices 14 parallel with the
 longitudinal axis 12D of the protrusion is particularly beneficial where the
 nozzle is injection moulded. This is because the longitudinal axis 12D of the
 protrusion is usually either coincidental with, or parallel to, the longitudinal
 axis of the nozzle. Hence, maintaining the axes 14A of the outlet orifices
 parallel with the longitudinal axis 12D of the protrusion enables the outlet
 orifices to be moulded using pins with no side action required on the moulding
 tool.

A conical protrusion 12 that narrows to a relatively fine point has been
 found to give particularly good results, but the shape of the protrusion can be
 varied. For example, other shapes which taper to a fine point can be used,
 including flat sided shapes which taper in the form of a pyramid. These may
 have three, four, or more sides. Furthermore, whilst protrusions which taper to a
 fine point are preferred, protrusions which have a flattened or otherwise shaped
 distal end can be used. For example, the protrusion 12 could be frusto-conical
 for frusto-pyramidal. It should also be understood that the terms “taper” and
“tapered” are used here in a general sense to mean that the protrusion narrows towards its distal end from a wider proximal base region. Thus the protrusion may curve from the wider base towards the narrow distal end rather than having a generally straight, angled surface. For example, the protrusion may be parabolic or elliptical in the manner of a nose cone of an aircraft. What is important is that the liquid is able to flow along the protrusion to its distal end to form the core jet without too much of the liquid being stripped off. Those skilled in the art will be able to configure different shapes and angles of protrusion to perform this function. Also, the angle at which the protrusion narrows can vary along its length so that the protrusion could be bi-conic for example. When describing a curved taper, it will be appreciated that the angle of inclination refers to a general or average angle of inclination of the protrusion. The surface of the protrusion is preferably smooth but it could be textured.

A nozzle arrangement 10 in accordance with the invention may have more than one tapered protrusion 12, with each protrusion having two or more outlet orifices 14 as described above. Each protrusion 12 will create its own core jet and spray but the sprays from adjacent protrusions will mingle at a distance from the nozzle to form a wider combined spray angle.

Figures 2A to 7B illustrate nozzle arrangements 10 having a variety of different protrusion arrangements. These are provided as examples only and should not be considered limiting. Individual features in each embodiment can be combined with other individual features of any one or more of the other embodiments in any way, including the embodiment shown in Figures 1A and 1B.

Figures 2A and 2B illustrate a hollow protrusion 16 having a distal end 16A, a circular base region 16B with parallel sides and a tapered conical portion 16C leading from the base region to the distal end. The interior of the
protrusion has a cavity 18 with a first portion 18A with parallel sides and which is circular in cross section, a second, frusto-conical portion 18B which tapers inwardly and a third portion 18C which is similar to the first portion but is of a smaller diameter. Three final outlet orifices 14 extend from the second portion of the 18B of the inner cavity to the outer surface of the conical portion 16C of the protrusion 16. Each outlet orifice 14 is stepped, having a first larger diameter portion 14B and a second smaller diameter portion 14C. The inner cavity 18 is connected with a fluid flow passageway (not shown) of the nozzle arrangement via an inlet opening 20.

The axes 14A of the final outlet orifices are arranged parallel to a longitudinal axis 16D of the protrusion. As can be seen from Figure 2B, the three final outlet orifices 14 are equi-spaced about a circle drawn concentrically with the axis 16D of the protrusion.

This embodiment illustrates that the protrusion 16 may only taper along a distal portion 16C provided the outlet orifices 14 have outer openings which are located at least partially in the sloping side wall of the tapering portion.

Figure 3 illustrates a nozzle arrangement with a protrusion 20 similar to the protrusion 12 described above in relation to Figure 1, except that the protrusion 20 in this embodiment is frusto-conical having a flat distal end 20A. As with the embodiment shown in Figure 1, the protrusion 20 has three final outlet orifices 14.

The protrusion 22 in Figure 4 is similar to the protrusion 20 in Figure 3, except that the distal end 22A has an inverted cone shaped indentation. The shape of the distal end 22A of the protrusion in any of the embodiments described can be varied in any manner provided the liquid flowing along the protrusion is able to form a central core jet of liquid from the end.

Figures 5A and 5B show nozzle arrangement with a conical protrusion 26 similar the protrusion 12 in Figures 1A and 1B, except that in this
embodiment there are six final outlet orifices 14 arranged in pairs. The axes 14A of the final outlet orifices 14 are not parallel with the axis longitudinal 26A of the protrusion but arranged at various angles to the axis 26A. Some of the outlet orifices 14 are arranged so that they direct sprays towards each other but all diverge from the longitudinal axis 26A of the protrusion. As noted above, the axes of the outlet orifices should diverge outwardly from the axis 26A of the protrusion by an angle of no more than 10 degrees and more preferably by no more than 5 degrees to ensure that sufficient of the liquid travels along the protrusion to its distal end to form a central core.

The protrusion 28 in Figures 6A and 6B is also conical but has only two final outlet orifices 14 which are arranged on the same plane and with their axes parallel to the longitudinal axis 28A of the protrusion. This configuration is particularly suitable where the nozzle 10 is a split nozzle comprising two halves that join together. In such an arrangement, the protrusion 28 could be formed in two halves, split along its length along the line X. The mating surfaces of each half having grooves which when the two halves are brought together form the outlet orifices 14.

Figures 7A and 7B show a nozzle arrangement 10 having a protrusion 30 with three flat sides in the form of a pyramid. Three final outlet orifices 14 extend through the protrusion 30, with each orifice opening in a respective one of the sides. The axes 14A of the orifices are arranged parallel to the longitudinal axis 30A of the protrusion. The protrusion 30 can have any number of sides with one or more outlet orifices in each side. Whilst it is preferred that the distal end of the protrusion 30A from a fine point, the protrusion could be frusto-pyramidal or the end could be otherwise shaped provided the liquid flowing along the protrusion is able to form a central core. Each side of the pyramid may have an angle of inclination α of 60 degrees. However, the angle of inclination α of the side walls can be anywhere in the range 40 degrees to 80
degrees but is preferably in the range of 50 degrees to 70 degrees and even more preferably in the range of 55 degrees to 65 degrees.

Figure 8 is a cross sectional view through a nozzle arrangement 10' having a conical protrusion 32 similar to the protrusion 12 described above in relation to Figures 1A and 1B at the outlet end. The nozzle arrangement 10' has a body 34 with fluid passage 36 which fluidly connects an inlet 38 of the nozzle with three final outlet orifices 14. The fluid passage 36 includes a first chamber 40 having an outlet orifice 42 leading to a further, shaped expansion chamber 44 adjacent the final outlet orifices 14. A partition means 46 extends across the fluid passage within the shaped expansion chamber to define constricted openings 48 through which the fluid passes from the inlet side of the chamber to the outlet side. The final outlet orifices 14 extend from an end wall of the final shaped chamber 44 through the protrusion 32 where the open partway along the tapering side surface of the protrusion.

Figures 9 and 10 show nozzle arrangements 10’’ and 10’’’ which are similar to that shown in Figure 8 but which have differently configured fluid passages 36’’ and 36’’’ respectively.

In the various embodiments of the invention, the final outlet orifices 14 can be of any shape including straight, tapered, stepped or angled holes. The orifices will usually all open out on a common plane of the protrusion but at least some could be arranged to open on different planes of the protrusion, e.g. at different distances from the distal end of the protrusion.

Whilst all the embodiments described above have final outlet orifices 14 that open partway along the length of the tapering part of the protrusion, many of the advantages of the invention can be obtained if the final outlet orifices 14 are positioned around the base of the protrusion, provided that at least part of an outer opening of each orifice is located in a sloping side wall region of the protrusion, so that at least part of the liquid leaving each orifice flows along the
length of the protrusion to its distal end to form a central core jet as described above. The shape of the final outlet orifices may take any form and they could be provided as two or more slits that extend around all or part of the base of the protrusion.

The fluid passageway in the nozzle arrangement 10 upstream of the protrusion and the final outlet orifice(s) 14 may be a simple channel or it may comprise multiple channels, including any of the arrangements disclosed in WO 2005/005053 A1, and/or one or more spray controlling features, such as any of those disclosed in WO01/89958 A1, and/or one or more shaped chambers, such as those disclosed in WO 2005/005055 A1. In particular, an expansion chamber or a swirl chamber may be provided adjacent the inlet ends of the final outlet orifices 14. An expansion chamber is a chamber having an increased cross sectional area compared to the cross sectional area of the fluid passageway immediately upstream of the chamber. The cross sectional area of an expansion chamber will often be significantly larger than the cross sectional area of the passageway along the majority of its length. A swirl chamber is a chamber which is configured to cause the fluid passing through it to spin, usually about the axis of the nozzle. If a swirl chamber is positioned adjacent the inlet ends of the final outlet orifices, the fluid will enter the orifices whilst spinning. The swirl chamber could be located within the protrusion or at the base of the protrusion with the final outlet orifices 14 of the nozzle 10 being the outlet orifices of the swirl chamber. The swirl chamber can be of any type including any of those described in WO2006/059065, the contents of which are hereby incorporated by reference. The fluid passageway in the nozzle could include a combination of any expansion chamber and any swirl chamber upstream of the outlet orifices.

The protrusion(s) will often be largely hollow, as shown in Figures 2A and 2B for example, though they can be solid except for the orifices 14.
Where very fine outlet orifices 14 are required, it may be difficult to manufacture the protrusion and the orifices as a single moulded piece. In this case all or part of the protrusion can be manufactured as separate item to be inserted into an opening in the nozzle arrangement. To form the orifices 14, matching grooves may be formed around the surface of the protrusion insert and around the opening, which grooves co-operate to form the orifices when the protrusion insert is in position. Alternatively, the orifices 14 may be formed entirely by means of grooves formed about the surface of the protrusion insert, with the surface of the opening being smooth. A further option would be to form the outlet orifices 14 by means of grooves in the surface of the opening with the surface of the insert being smooth. This arrangement would tend to cause the spray to diverge away from the protrusion as well as causing some of the liquid to run along the surface of the protrusion to the distal end.

If the outlet orifices 14 are to be positioned about the base of the protrusion, the opening may be a formed in a generally flat surface of the nozzle arrangement. Where the outlet orifices are to open part way along the protrusion, part of the protrusion may be formed as a wall surrounding the opening with the insert sitting inside the wall to form the distal end part of the protrusion. Figures 11 to 14 illustrate this type of arrangement.

As shown in Figures 11 and 12 an outlet region of a nozzle arrangement has an opening 50 adapted to receive a protrusion insert 52, which is shown in Figures 13 and 14. The opening 50 is circular and has three semi-circular grooves 54 spaced about its surface. A tapered wall 56 surrounds the opening 50 on an outer surface of the nozzle arrangement. The protrusion insert 52 is generally circular in cross section having a first portion 58 with parallel sides and a conical outer or distal end portion 60. Three semi-circular grooves 62 corresponding to the grooves 54 extend from an inner end 64 of the insert to just above the beginning of the conical portion. The insert 52 is positioned in the opening 50 so that the conical end portion of the insert 52 aligns with the
tapered wall 56 to form a substantially continuous conical protrusion. The semi-circular grooves 62 on the insert align with the semi-circular grooves 54 in the opening to form the final outlet orifices 14.

Where all or part of the protrusion is formed as a separate part or insert it may be arranged so that it can be moved relative to the remainder of the nozzle arrangement to allow the outlet orifices to be cleaned or cleared. For example, the protrusion insert may be biased inwardly towards the main body of the nozzle arrangement to enable the outlet orifices to be cleaned or unblocked and be moved outwardly into a dispensing position by the pressure of the fluid when the nozzle is in use. An embodiment of a nozzle arrangement suitable for use in this way is illustrated in Figures 15 to 18.

The arrangement shown in Figures 15 to 18 is similar to that described above in relation to Figures 11 to 14. However, in this embodiment, the opening 70 in the outlet end of the nozzle arrangement narrows slightly from its inner end 72 towards its outer end 74. A first portion 76 of the insert 78 which is received within the opening 70 is correspondingly tapered such that it narrows from an inner base region 80 to the start of the conical outer portion 82. The arrangement is such that the insert 78 can be inserted into the opening 70 through the inner end 72 until the tapered first portion 76 of the insert firmly engages with the tapered walls of the opening 70, at which time further outward movement of the insert 78 is prevented. In this fully extended position, the outer conical portion 82 of the insert will be aligned with the tapered wall 84 surrounding the opening 70 to form a generally continuous conical protrusion and grooves 86 in the outer surface of the insert define outlet orifices opening part way along the length of the conical protrusion. Spring means (not shown) can be provided to bias the insert inwardly from the fully extended position when the nozzle arrangement is not in use, tending to open up the final outlet orifices to allow any foreign matter in them to be dislodged. When the nozzle is in use, the force of the fluid passing through the nozzle will bias the insert 78
outwardly to the fully extended position to reform the outlet orifices and the protrusion. Alternatively, a spring means can be used to bias the insert 78 to the fully extended position and it can be left to a user to push the insert inwardly in order to unblock the outlet orifices. In this embodiment, the final outlet orifices are formed by means of grooves 86 formed around the protrusion insert 78 only, with the walls of the opening 70 being smooth.

It should be appreciated that the description of the operation of the nozzle 10 (including the formation of the central core jet) and the general discussion of the configuration of the protrusion and the outlet orifices provided above in relation to the embodiment shown in Figures 1A to 1C applies equally to the other embodiments described herein.

Nozzle arrangements in accordance with the invention can be adapted for use with liquids of any viscosity. Nozzle arrangements in accordance with the invention can also be adapted for use in a wide range of applications including dispensers such aerosol canisters or manually activated pumps and trigger dispensers and for use in industrial nozzle applications. Accordingly, nozzle arrangements in accordance with the invention can be adapted for use in delivering a wide range of products in spray form including, but not limited to, antiperspirant sprays, de-odorant sprays, perfumes, air fresheners, antiseptics, paints, insecticides, polish, hair care products, pharmaceuticals, water and lubricants, lotions, insecticides, as well as various garden and household sprays and industrial fluids. However, nozzles in accordance with the invention are particularly suitable for use with reduced VOC aerosol canisters, especially for use with products such as air fresheners and insecticides where it is desirable to fill a room with fine droplets which tend to stay in the air longer and thus increase the effectiveness of the product. Nozzles in accordance with the invention are also particular suitable for use with manually actuated pump and trigger dispensers which are configured to dispense a mixture of liquid and air.
Most aerosol canisters have a dip tube with an internal diameter in the region of 3.5 mm in which a volume of liquid is retained between actuations of the dispenser. Where the liquid contains a propellant gas in solution, it is a problem that the gas may separate out from the liquid in the dip tube over time. Even if the canister is shaken prior to use, because the liquid in the dip tube is held in a relatively small volume, it is not always possible to effectively re-mix the gas and liquid. This can cause an aerosol canister fitted with a nozzle in accordance with the invention to produce a jet of liquid rather than an atomised spray for a small period of time, in the region of one second, until the liquid that was held in the dip tube has been dispensed. To reduce this problem, it is advantageous to use a dip tube having a smaller internal volume. Dip tubes having an internal bore of 1mm or less have been found to be effective at reducing any jetting to a very short period of time, less than 0.1 seconds which will not affect an end user. This is particular useful with aerosol canister having a reduced VOC formulation.

Whereas the invention has been described in relation to what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not limited to the disclosed arrangements but rather is intended to cover various modifications and equivalent constructions included within the spirit and scope of the invention. For example, whilst the preferred embodiments show the nozzles with the outlet and protrusions extending vertically, they can be arranged horizontally or in any desired orientation.

Where the terms “comprise”, “comprises”, “comprised” or “comprising” are used in this specification, they are to be interpreted as specifying the presence of the stated features, integers, steps or components referred to, but not to preclude the presence or addition of one or more other feature, integer, step, component or group thereof.
CLAIMS

1. An atomising nozzle for generating a spray of liquid, the nozzle arrangement comprising an outlet having a tapered protrusion and two or more outlet orifices through which a liquid can be ejected, an outer opening of each outlet orifice being located at least partially within a side wall region of the tapered protrusion, characterised in that the tapered protrusion and the orifices are configured so that in use, a portion of the liquid emitted from each outlet orifice atomises to form a spray whilst a further portion of the liquid emitted from each orifice flows along the tapering surface of the protrusion towards a distal end, where the liquid from all the orifices combine to form a core jet of liquid which streams from the distal end of the protrusion for a distance before atomising.

2. An atomising nozzle as claimed in claim 1, in which, the stream of liquid atomises at a distance in the range of 100mm to 150mm from the outlet orifices.

3. An atomising nozzle as claimed in claim 1 or claim 2, in which the whole of the outer opening of each of the outlet orifices is located within a sloping wall region of the tapered protrusion.

4. An atomising nozzle as claimed in any one of claims 1 to 3, in which the axis of each of the outlet orifices is aligned substantially parallel to a longitudinal axis of the protrusion.

5. An atomising nozzle as claimed in any one of claims 1 to 3, in which the axis of each outlet orifice diverges outwardly from a longitudinal axis of the protrusion by no more than 10 degrees.

6. An atomising nozzle as claimed in any one of claims 1 to 3, in which the axis of each outlet orifices diverges outwardly from a longitudinal axis of the protrusion by no more than 5 degrees.
7. An atomising nozzle as claimed in any one of claims 1 to 6, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ in the range 40 to 80 degrees.

8. An atomising nozzle as claimed in any one of claims 1 to 6, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ in the range 50 to 70 degrees.

9. An atomising nozzle as claimed in any one of claims 1 to 6, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ in the range 55 to 65 degrees.

10. An atomising nozzle as claimed in any one of claims 1 to 6, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ of substantially 60 degrees.

11. An atomising nozzle as claimed in any one of claims 1 to 10, in which at least a distal portion of the protrusion is conical.

12. An atomising nozzle as claimed in any one of claims 1 to 11, in which at least a distal portion of the protrusion is frusto-conical.

13. An atomising nozzle as claimed in any one of claims 1 to 11, in which at least a distal portion of the protrusion is pyramidal.

14. An atomising nozzle as claimed in any one of claims 1 to 11, in which at least a distal portion of the protrusion is frusto-pyramidal.

15. An atomising nozzle as claimed in claim 13 or claim 14, in which the protrusion has three or more sides.

16. An atomising nozzle as claimed in claim 15, in which the nozzle has at least one outlet orifice in each side.

17. An atomising nozzle as claimed in any one of claims 1 to 11, in which the protrusion curves towards the distal end.
18. An atomising nozzle as claimed in any one of claims 1 to 17, in which the nozzle has exactly three outlet orifices.

19. An atomising nozzle as claimed in any one of claims 1 to 17, in which the nozzle has exactly four outlet orifices.

20. An atomising nozzle as claimed in any one of claims 1 to 11, in which at least a distal portion of the protrusion is conical, the nozzle having three outlet orifices which open through the tapering side wall region of the conical portion, the outlet orifices having axes that are aligned substantially parallel to the axis of the conical portion and the conical portion having an angle of inclination $\alpha$ in the range of 40 to 80 degrees.

21. An atomising nozzle as claimed in any one of the previous claims, in which the nozzle is configured such that the sprays produced by each final outlet orifice converge about the central core in use.

22. An atomising nozzle as claimed in any one of the preceding claims, in which at least part of the protrusion is formed as an insert which is received in an opening at the outlet end of the nozzle arrangement.

23. An atomising nozzle as claimed in claim 22, in which the, or each, outlet orifice is formed by means of a groove or grooves provided about the surface of the insert and/or the opening.

24. An atomising nozzle as claimed in any one of the preceding claims, in which the tapered protrusion has a length in the range of 0.5mm to 10mm.

25. An atomising nozzle as claimed in any one of the preceding claims, in which the tapered protrusion has a length in the range of 1mm to 3mm.

26. An atomising nozzle as claimed in any one of the preceding claims, in which the nozzle arrangement is moulded from plastics.
27. An atomising nozzle as claimed in any one of the preceding claims, in which the nozzle comprises a swirl chamber immediately upstream of the outlet orifices.

28. An atomising nozzle as claimed in any one of claims 1 to 26, in which the nozzle comprises an expansion chamber immediately upstream of the outlet orifices.

29. An atomising nozzle as claimed in any one of claims 1 to 27, in which the nozzle comprises in an expansion chamber and a swirl chamber in the flow path upstream of the outlet orifices.

30. A nozzle for generating a spray of liquid, the nozzle comprising an outlet portion having a tapered protrusion and two or more outlet orifices through which a liquid can be ejected, an outer opening of each outlet orifice being located at least partially within a side wall region of the tapered protrusion, characterised in that the, or each, side wall region of the tapered protrusion has an angle of inclination $\alpha$ in the range 40 to 80 degrees and in that the axis of each of the outlet orifices diverges outwardly from a longitudinal axis of the protrusion by no more than 10 degrees.

31. A nozzle as claimed in claim 30, in which the axis of each of the outlet orifices diverges outwardly from a longitudinal axis of the protrusion by no more than 5 degrees.

32. A nozzle as claimed in claim 30, in which the axis of each of the outlet orifices is aligned substantially parallel to a longitudinal axis of the protrusion.

33. A nozzle as claimed in any one of claims 30 to 32, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ in the range 50 to 70 degrees.
34. A nozzle as claimed in any one of claims 30 to 32, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ in the range 55 to 65 degrees.

35. A nozzle as claimed in any one of claims 30 to 32, in which the, or each, side wall region of the protrusion has an angle of inclination $\alpha$ of substantially 60 degrees.

36. A nozzle as claimed in any one of claims 30 to 35, in which the protrusion tapers to a point.

37. A nozzle as claimed in any one of claims 30 to 36, in which the protrusion is conical.

38. A nozzle as claimed in any one of claims 30 to 36, in which the protrusion is pyramidal.

39. A nozzle as claimed in any one of claims 30 to 36, in which the protrusion curves toward the distal end.

40. A nozzle arrangement substantially as hereinbefore described, with reference to an as illustrated in the accompanying drawings.

41. A dispenser comprising a nozzle in accordance with any one of the previous claims.

42. A dispenser as claimed in claim 41, in which the dispenser is an aerosol canister.

43. A dispenser as claimed in claim 42, in which aerosol canister comprises a reduced VOC formulation.

44. A dispenser as claimed in claim 42 or 43, in which the aerosol canister has a dip tube having an internal bore with a diameter of 1mm or less.

45. A dispenser as claimed in claim 41, in which the dispenser is a manually actuated pump type dispenser.
46. A dispenser as claimed in claim 45, in which the dispenser is adapted to dispense a mixture of air and liquid.

47. A dispenser as claimed in any one of claims 41 to 46, in which the dispenser is adapted to dispense any one of the group consisting of: air freshener and insecticide.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. B05B1/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search

24 October 2006

Date of mailing of the international search report

31/10/2006

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Brito, Fernando
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