

Title: An apparatus and methods for dispensing and foaming of a product

5 The invention concerns a portable apparatus for dispensing (and foaming) of a product.

An example of a known product dispensing and foaming apparatus is an aerosol can, see e.g. WO2008/033005. The known apparatus includes a reservoir containing a propellant and a foodproduct, operable discharge
10 means to discharge the foodproduct, as well as a dispensing head defining a foodproduct receiving space to receive the foodproduct from the discharge means. A distal part of the head includes foodproduct shaping projections, for shaping of the outflowing foamed product.

The known apparatus is convenient, lightweight, compact and
15 designed to be disposed after being used-up. This has major advantages over e.g. commercially available, bulky and expensive cream whipping machines (usually having an electrically driven pump, and requiring regular maintenance and cleansing operations).

Particularly, during operation of the known aerosol container, in
20 case of operating the discharge means, cream is ejected via the dispensing head and undergoes a so called 'overrun' (i.e. volume increase), such that a 'spray cream' which resembles common whipped cream, is obtained.

The foodproduct is safe for consumption. As a non limiting
example, the known aerosol container can be packed with foodproduct and
25 propellant, the initial pressure in the container being for example in the range of 7–18 atmospheres, depending on the amount of packed foodproduct, as will be appreciated by the skilled person. The propellant of the known apparatus can consist of one or more gases acceptable from the viewpoint of food technology, for example a gas which substantially dissolves in the
30 foodproduct, a gas which substantially does not dissolve in the foodproduct and a combination of these gases. Particularly, according to WO'005 the

propellant can comprise CO₂, nitrogen (N₂), laughing gas (N₂O) or a combination of these gases (such as nitrogen and laughing gas). For example, 15-25 w% (weight%) of the propellant can be N₂ and the remainder of the propellant (i.e. 85-75 w%) can be N₂O.

5 In practice, the aerosol container at least comprises N₂O as a propellant since this gas can provide good foodproduct propelling and foodproduct-overrun results, at the afore-mentioned pressures. One problem is that N₂O is a so-called greenhouse gas. There is a general desire to limit or ban the use of green-house gases to protect the earth from global heating.

10 The present invention aims to solve or alleviate this problem. In particular, the invention aims to provide an apparatus according to the preamble that can provide good foaming results in an environment-friendly and hygienic manner. Also, the invention aims to provide an apparatus that is user friendly, can be capable of dispensing product in different directions,
15 and that can be manufactured in an economical manner.

 According to an aspect of the invention this can be achieved by the features of claim 1.

 Advantageously, there is provided an apparatus including:

 a product container which contains a product that is to be foamed
20 by and dispensed from the apparatus;

 - a gas container, at least containing a gas, for example a single gas or a gas mixture, wherein the gas substantially does not contain any greenhouse gases such as N₂O;

 -a dispersion device, having a product entrance that is connectable
25 to the product container for receiving product, the dispersion device further being connectable to the gas container for supplying the gas to the product during product discharge;

 -a processing device downstream of the dispersion device for performing a mixing treatment and/or pressure reduction on the product
30 provided with the gas; and

-a product dispensing head, being part of a top section of the apparatus and being arranged downstream of the processing device, the dispensing head defining a product receiving space to receive the product from the processing device, a distal part of the dispensing head, preferably
5 having product shaping projections,

wherein the apparatus is configured to be used at least in a substantially upside-down orientation during product discharge.

It has been found that in this way, good product foaming (and subsequent shaping) can be achieved by a portable product dispensing
10 apparatus. The apparatus can be made relatively compact and lightweight (e.g. having a maximum mass of about 1 kg and a maximum internal volume of about 1 liter), so that it can be used in the same way as e.g. prior art aerosol cans in a substantially upside-down orientation to eject the product in a substantially downward dispensing direction (e.g. towards or
15 onto a product receiver or product receiving surface). The product foaming can be achieved in a hygienic manner as well. It should be noted that such a dispensing direction, achieved by the apparatus during operation, can be vertically downwards or a direction that includes a certain angle with a vertical plane (e.g. an angle in the range of 0-90 degrees). Similarly, a
20 substantially upside-down orientation of the apparatus should be interpreted broadly, as will be appreciated by the skilled person.

A basis idea of the invention is the application of a dispersion device as part of the apparatus, which is found to provide good and stable foodproduct foaming, when the apparatus is held in the substantially
25 upside-down orientation. The dispersion device can be configured in various different ways. For example, the dispersion device can be a gas entrainment and/or filtration device, and/or it can include a porous element or porous mass, or a different dispersion device.

Good results can be achieved in case the dispersion device is a
30 microfiltration or an ultrafiltration device. In an embodiment, the

dispersion device can be provided with a wall with gas transmissive pores having a pore size in the range of 0.1 – 200 microns, in particular a pore size of at least 0.1 micron and less than 5 microns. It has appeared that use of such a dispersion device can provide a highly stable, attractive foam, in particular of constant quality, in a relatively simple and economical manner. With various foamable products, moreover, a particularly high overrun (degree of aeration) has thus been found to be obtained, at any rate, a good overrun that is comparable to or higher than the overrun obtained with methods already known. A minimum overrun can be, for instance, approximately 100%, in particular approximately 150% and more particularly approximately 200% (depending on the product and the use). Moreover, a good end-product stability (i.e. sustaining a shape of the foamed product over time) can be achieved.

The dispersion device can include a gas dispersion wall having different configurations, and, for instance, be a tubular (e.g. microfiltration) wall, which separates a tube inner space from a tube outer space. In another embodiment, the dispersion device is provided with, for instance, a flat gas dispersion wall (e.g., sheet or membrane wall), with the product being passed on one side of the wall along this wall (through a first space as mentioned) and the gas on the other side (to a second space as mentioned), such that the gas is injected into the product via the gas dispersion wall (in particular via pores comprised by this wall).

The product formed by the invention can moreover provide a particularly pleasant taste sensation if the product is intended for consumption. Furthermore, it has been found that the dispersion device can be made relatively compact for good integration in the dispensing apparatus, and can still effect foam formation with high-quality foam.

For example, an integrated microdispersion device can be designed in various manners. In particular, this device can comprise a rigid wall, which separates a product feed-through space (for feeding-through the

product) from a gas supply space. The gas dispersion wall is preferably provided with a large number of flow-through channels (extending, for instance, transversely through this wall, from the gas supply space to the product feed-through space), which channels are at least provided with

5 relatively narrow outflow mouths (the channels can each also be narrow channels, but this is not requisite). In particular, the gas dispersion wall is so rigid that the wall does not deform under the influence of any pressure difference that may prevail during use between the product feed-through space and gas supply space, for instance, a pressure difference lower than 1

10 bar the pressures mentioned in this application are absolute pressures).

According to a further elaboration, the product that is dispensed by the apparatus can be a homogeneously foamed product (which may or may not be a monodisperse product foam).

According to a further elaboration, the apparatus can be designed

15 such that downstream of the dispersion device, the product preferably undergoes a controlled pressure reduction. Here, the pressure of the product can in particular be gradually brought from a first pressure value to a second pressure value, with the first pressure value being higher than the second pressure value (a pressure difference between the first and second

20 pressure can comprise, for instance, more than 1 bar, for example in the range of about 2-10 bar, in particular about 4-5 bar, or another pressure difference. The first pressure may be, for instance, superatmospheric. The second pressure may be, for instance, substantially atmospheric pressure.

The pressure reduction can be effected, for instance, by a product

25 processing device suitable for that purpose (i.e., a pressure reducer, pressure decreasing device). The processing device can be configured for, for instance, applying shear to the flowing product for the purpose of decreasing the pressure.

As a gradual pressure reduction is applied, with shear being applied to the product in a controlled manner, separation of the product can be well prevented or limited.

It has been found that good results are obtained if downstream of the microdispersion device the product undergoes a mixing treatment, in particular for obtaining a homogeneous product foam. It is then especially advantageous when the mixing treatment is performed by a static mixing device. The mixing device can be, for instance, a product processing device as mentioned, and has been found capable of applying a pressure decrease and shear to the product in a particularly simple manner.

According to another aspect of the invention, which can be combined with the above aspects, there is provided a portable apparatus for dispensing of a product:

- a product container which contains a product that is to be foamed by and dispensed from the apparatus;
- a gas container, at least containing a gas, for example a single gas or a gas mixture, wherein the gas substantially does not contain any greenhouse gases such as N_2O ; -
- a dispersion device, having a product entrance that is connectable to the product container for receiving product, the dispersion device further being connectable to the gas container for supplying the gas to the product during product discharge;
- a processing device downstream of the dispersion device for performing a mixing treatment and/or pressure reduction on the product provided with the gas; and
- a product dispensing head, and being arranged downstream of the processing device, the dispensing head defining a product receiving space to receive the product from the processing device, a distal part of the dispensing head preferably having product shaping projections,

wherein the product container is integrated in a housing, the housing having a top that includes a discharge valve for discharging the product, the top of the housing further including a gas inlet for feeding gas into the housing, wherein the apparatus also includes a top section that is
5 fitted to the top of the housing, the top section including a pressurized gas supply means containing pressurized gas, for inducing gas flow and product flow during operation, wherein an outlet of the pressurized gas supply means is connectable to the gas inlet of the housing.

In this way, the above-mentioned advantages can be achieved. The
10 pressurized gas supply means can e.g. be made relatively compact for their integration in the top section of the housing. Also, relatively high initial pressure can be used in these pressurized gas supply means.

For example, the product discharge valve of the housing can include a product discharge channel and a gas discharge channel, the gas
15 discharge channel for example being concentrically arranged with respect to (e.g. around or inside) the product discharge channel, or the channels extending next to each other (e.g. in parallel).

According to yet another aspect of the invention, which can be combined with the above aspects, there is provided a portable apparatus for
20 dispensing of a product, including:

- a product container which contains a product that is to be foamed by and dispensed from the apparatus;
- a gas container, at least containing a gas, for example a single gas or a gas mixture, wherein the gas substantially does not contain any
25 greenhouse gases such as N_2O ;
- at least two dispersion devices, each having a product entrance that is connectable to the product container for receiving product, the at least two dispersion devices further being connectable to the gas container for supplying the gas to the product during product discharge;

-a processing device downstream of the dispersion devices for performing a mixing treatment and/or pressure reduction on the product provided with the gas; and

-a product dispensing head, and being arranged downstream of the
5 processing device, the dispensing head defining a product receiving space to receive the product from the processing device, a distal part of the dispensing head preferably having product shaping projections,

wherein the dispersion devices are arranged for operating at the same time.

10 In this way, the above-mentioned advantages can also be achieved. Also, in this way, relatively compact means can provide relatively foamed product flow/dispensing rates, for example such that good foodproduct shaping can be achieved by downstream foodproduct shaping projections (if any).

15 According to yet another aspect of the invention, which can be combined with the above aspects, there is provided a portable apparatus for dispensing of a product, the apparatus including:

- a product container which contains a product that is to be foamed by and dispensed from the apparatus;

20 - a gas container, at least containing a gas, for example a single gas or a gas mixture, wherein the gas substantially does not contain any greenhouse gases such as N_2O ;

-a dispersion device, having a product entrance that is connectable to the product container for receiving product, the dispersion device further
25 being connectable to the gas container for supplying the gas to the product during product discharge;

-a processing device downstream of the dispersion device for performing a mixing treatment and/or pressure reduction on the product provided with the gas; and

-a product dispensing head, and being arranged downstream of the processing device, the dispensing head defining a product receiving space to receive the product from the processing device, a distal part of the dispensing head preferably having product shaping projections,

5 the apparatus including a pressurized gas supply means containing pressurized gas, for inducing gas flow and/or product flow during operation, wherein an initial pressure in the pressurized gas supply means is higher than 15 bar, in particularly higher than 50 bar, for example higher than 100 bar.

10 In this way, also, the above-mentioned advantages can be achieved. The afore-mentioned pressure, higher than 15 bar, is in particular a pressure measured at a temperature of 20 °C.

For example, the pressurized gas supply means may include a gas cartridge, in particular having a rigid construction, and being configured to
15 withstand an internal gas pressure of at least 50 bar, e.g. at least 100 bar, more particularly at least 200 bar (measured at 20 °C) , and preferably made of steel and preferably having a maximum internal volume of 200 ml, for a maximum example internal volume of 20 ml, in particular 14 ml).

The invention also provides a method for foaming and dispensing a
20 product, the method including using an apparatus according to the invention,

According to an embodiment, the method includes: supplying product to a dispersion device and supplying a first gas to the dispersion device, wherein the first gas preferably does not contain any greenhouse
25 gases such as N₂O, wherein the product follows a first path through the dispersion device and receives the first gas via the dispersion device, wherein the product undergoes a controlled pressure reduction downstream of the dispersion device, wherein the product follows a second path during the controlled pressure reduction that substantially deviates from the first
30 path.

Also, according to an aspect, there is provided a method for foaming and dispensing a product, for example an above-mentioned method, wherein the method includes:

supplying product to a dispersion device and supplying a first gas
5 to the dispersion device, wherein the first gas preferably does not contain any greenhouse gases such as N_2O , wherein the product receives the first gas via the dispersion device, wherein the product undergoes a controlled pressure reduction downstream of the dispersion device,
wherein a second gas is used for inducing both the product flow and
10 the flow of the first gas, the second gas being kept separate from the first gas.

Further advantageous embodiments are described in the dependent claims. Examples of the invention will now be elucidated in more detail with reference to the drawings. Therein shows:

15 Figure 1 schematically a first non-limiting embodiment of the invention;

Figures 2A, 2B schematically a detail of the first embodiment of Fig. 1, according to two alternatives;

20 Figure 3 a partly opened side view of a second embodiment of a product dispensing apparatus;

Figure 4 a similar view as Fig. 3 from another viewing angle, of the second embodiment;

Figure 5 a perspective view of the second embodiment, with a top section of the apparatus being separated;

25 Figures 6A-6B a partly opened detail of the second embodiment of the invention is side view, in two operational states;

Figure 7 a partly opened detail of the second embodiment, in another side view;

30 Figure 8 a partly opened detail at the valve section of the second embodiment;

Figure 9 a perspective view of the valve section of the second embodiment;

Figure 10 an opened side view of the valve section of the second embodiment, when the discharge valve is in an initially closed state;

5 Figure 11 a view similar to Fig. 10, indicating gas and product flows, when the valve has been moved to an open valve state;

Figure 12 a detail, in opened side view, of a pressure reducing section of the second embodiment;

10 Figure 13A and 13B a nozzle section of the second embodiment, in cross-section and side view respectively;

Figures 14A-14C the second embodiment, in three operational states;

Figures 15A-15D a third embodiment of a dispensing and foaming apparatus, in four operational states;

15 Figures 16A-16B opened side views of the third embodiment of Fig. 15, before and after separation of a top section, respectively;

Figure 17A, 17B a perspective bottom and top view, respectively of part of the third embodiment;

20 Figure 18 an opened side view of a top section of the third embodiment,

Figure 19 view similar as Fig. 18, indicating flow during discharge;

Figure 20 schematically a fourth embodiment of a dispensing apparatus, partly opened and in partly disassembled state;

25 Figures 21A, 21B a perspective side view of a fifth embodiment, at Fig. 21B in partly opened view;

Figure 22 a perspective side view of a sixth embodiment;

Figure 23 a perspective side view of a seventh embodiment;

Figure 24 shows a detail of a further embodiment of the a dispersion device, in perspective opened side view;

Figure 25A a perspective side view of an eight embodiment of a dispensing apparatus;

Figure 25B a cross-section of Fig. 25A along a longitudinal center plane of the apparatus;

5 Figure 25C part of a lower section of the eight embodiment, in perspective opened view;

Figure 25D a detail Q of Fig. 25B;

Figure 25E a longitudinal cross-section of the apparatus part shown in 25D, along line XXVE-XXVE;

10 Figure 25F a transversal cross-section of the apparatus part shown in 25D, along line XXVF-XXVF;

Figure 25G a perspective view of a top section of the eight embodiment after partial disassembly;

15 Figure 25H a perspective side view of part of a processing device of the eight embodiment; and

Figure 26 a similar view as Figure 25C, of a further alternative embodiment.

Similar or corresponding features are denoted by similar or corresponding reference signs in this application.

20 Figure 1 schematically shows parts of a portable apparatus 1 for dispensing of a product P (and discharging a foamed product P'). The apparatus 1 includes:

- a product container 5 which contains a product P that is to be foamed by and dispensed from the apparatus;
- 25 - at least one gas container 7, at least containing a gas, for example a single gas or a gas mixture, wherein the gas substantially does not contain any greenhouse gases such as N₂O;
- at least one gas dispersion device 10, having a product entrance that is connectable to the product container 5 for receiving product P, the

dispersion device 10 further being connectable to the gas container 7 for supplying the gas to the product P during product discharge;

-a processing device 12 downstream of the dispersion device 10 for performing a mixing treatment and/or pressure reduction on the product
5 provided with the gas; and

-a product dispensing head 20, being part of a top section 19 of the apparatus 1 and being arranged downstream of the processing device 12, the dispensing head 20 defining a product receiving space 21 (see Fig. 4, 5) to receive the foamed product P' from the processing device 12, a distal part
10 of the dispensing head 20 preferably having product shaping projections 22,

The apparatus 1 is configured to be used at least in a substantially upside-down orientation during product discharge, as is indicated in Fig. 1 (see also Fig. 14C and Fig. 15D regarding the further embodiments). It follows that the apparatus can be advantageously configured to be used by
15 reorientation the apparatus 1 from an initial storage position, for example by rotating the apparatus over an angle of at least 90 degrees (with respect to a virtual horizontal rotation axis), for example to an up-side down orientation or similar downwards arrangement. Also, for example, according to a preferred embodiment, the apparatus does not include a dip-tube for
20 receiving product P from the product container (i.e. no dip-tube has to be present in the product container), or it includes a flexible bag-on-valve type product holder that packs product without gas/air voids.

The apparatus has a portable housing H (not shown in Figure 1, see also the housings H of the second and third embodiments 101, 201, in
25 Figures 3 and 14), provided with a bottom B facing away from the product dispensing head 20, the product dispensing head 20 in particular being mounted or mountable to a top section of the apparatus. It is preferred, (as in the examples shown in Figures 3-23), that the product container is integrated in the housing H.

The housing H of the apparatus is shaped to be lifted single-handed by a user (a user's hand R operating the apparatus is shown in Fig. 1), for example a housing H having an elongated shape and/or having a maximum width of 10 cm at a gripping position. For example, the housing H
5 as such can be configured or shaped to provide ease of lifting and manual reorientation by the user. In the present examples, the housing H has a substantially cylindrical external side for that aim, but the external shape of the housing is not limited there-to.

Further, the apparatus 1 includes an operating means K, for
10 example a handle or knob, that can be manually controlled for starting and subsequently halting product foaming and dispensing. The operating means K can be configured to cooperate with e.g. flow control means 40, 41 (e.g. respective flow valves) for controlling gas flow and product flow.

The apparatus 1 particularly includes a pressurized gas supply
15 container 7 containing pressurized gas, for inducing gas flow and product flow during operation. In one embodiment, an initial pressure in the pressurized gas supply means can be relatively high, namely higher than 15 bar, in particularly higher than 50 bar, for example higher than 100 bar (pressures being measured at 20 °C). By using a pressurized gas container 7
20 having such a high (initial) pressure, relatively long operational discharge period can be achieved using relatively compact means. In an alternative embodiment, the initial pressure in the pressurized gas supply means can be at most 15 bar, for example a pressure in the range of 10-15 bar (e.g. about 12 or 13 bar).

25 In a preferred embodiment, for example, the pressurized gas supply means 7 is a disposable gas cartridge, preferably being configured to withstand an internal gas pressure of at least 50 bar, e.g. at least 100 bar or even at least 200 bar, and preferably made of steel and preferably having a maximum internal volume of 200 ml, for a maximum example internal
30 volume of 20 ml (e.g. 14 ml). Such gas cartridges are known as such, and can

provide a relatively compact, cost-efficient, economical means for providing the apparatus 1 with the gas required for operation.

The dispersion device 10 as such can be configured in various ways. It can be provided e.g. by a porous mass, a sheet or membrane, a filtration
5 tube (or tubular membrane), or differently.

In the present example (see Fig. 1), the dispersion device 10 comprises a chamber and a gas dispersion tube, wherein the tube is preferably placed substantially spaced-apart, e.g. centrally, from an inner side of the chamber. The tube can act as a wall (or 'dispersion element') 15a,
10 separating the chamber into a product feed-through space 15b and a gas supply space 15c (see Fig. 2A, 2B). In Figure 2A, the tube wall 15a encloses the product feed-through space 15b, wherein the gas is fed via the externally arranged gas supply space 15c, for dispersion into the product via the wall 15a. Figure 2B shows an alternative arrangement, wherein the tube wall
15 15a encloses the gas supply space 15c, wherein the product is fed via an externally arranged product feed-through space 15b (to receive the gas). The latter arrangement can provide improved gas pressure control and respective dispersion during operation.

Good results can be achieved in case the dispersion device 10 is a
20 microfiltration- or an ultrafiltration-type dispersion device, for example a dispersion device (e.g. tubular dispersion device) that is provided with a wall 15a (see Fig. 2) with gas transmissive pores having a pore size in the range of 0.1 – 200 microns, for example a range of 0.1 - 100 microns, in particular a pore size of at least 0.1 micron and less than 5 microns. In case of a
25 dispersion device having a tubular wall 15a (see Figures 2A, 3, 4) relatively good results can be achieved utilizing a compact filter (membrane) tube.

For example, a respective (e.g. tubular) wall 15a of the dispersion device 10 can be of relatively small length (measured in longitudinal direction, i.e. in parallel with a general product flow direction through a
30 respective product feed-through space 15b), in particular a length of at most

5 cm, preferably at most 4 or 3 cm, for example a length in the range of about 1 to 2 cm. Alternatively, the wall 15a can have a length larger than 5 cm, for a length in the range of 5 to 40 cm, or a length in the range of 10 to 25 cm. In addition, for example, the wall 15a can have a relatively small
5 inner diameter (being the diameter of the respective space 15b or 15c enclosed thereby), for example an inner diameter of at most 6 mm, preferably at most 5 mm, more particularly at most 3 mm, e.g. at most 2 mm. A wall thickness of the respective wall 15a (i.e. measured laterally from an inner side to an outer side of the filter wall) is also preferably small, and
10 may be at most 3 mm or at most 2 mm, preferably at most 1 mm, for example a wall thickness in the range of about 0.5 to 1 mm. In one non-limiting example, a plastic (in particular polypropylene) filter tube having an inner diameter of 1.8 mm and outer diameter of 2.8 cm, of a length in the range of 1 to 2 cm, and pore size of 0.2 micron, provided good results.

15 It follows that in particular, the dispersion device 10 can comprise a wall 15a, which separates a product feed-through space 15b (for feeding-through the product) from a gas supply space 15c. The wall 15a is preferably provided with a large number of flow-through channels (extending, for instance, transversely through this wall 15a, from the gas supply space 15c
20 to the product feed-through space 15b), which channels are at least provided with relatively narrow outflow mouths (the channels can each also be narrow channels, but this is not requisite). In particular, the wall 15a can be so rigid that the wall 15a does not deform under the influence of any pressure difference that may prevail during use between the product feed-
25 through space 15b and gas supply space 15c, for instance, a pressure difference lower than 1 bar, e.g. about 0.1 bar, or another pressure difference (the pressures mentioned in this application are absolute pressures).

According to a further elaboration, a cumulative pore surface of the
30 pores in a surface of the wall 15a bounding the product feed-through

channel may be, for instance, smaller than a remaining, closed part of that surface. In that wall surface the pores may further, for instance, be so distributed over the surface that circumferential edges of neighboring pores are, for instance, at a mutual distance from each other that is greater than a pore dimension mentioned. A ratio between average pore size and average least neighbor distance (between neighboring pores) may be, for instance, in the range of about 1:1-1:50, in particular 1:2-1:20, or another ratio.

Alternatively, a cumulative pore surface of the pores in a surface of the wall 15a bounding the product feed-through channel may be, for instance, greater than a remaining, closed part of that surface. In that wall surface the pores may further, for instance, be so distributed over the surface that circumferential edges of neighboring pores are, for instance, at a mutual distance from each other that is smaller than a pore dimension mentioned. A ratio between average pore size and average least neighbor distance (between neighboring pores) may be, for instance, in the range of about 10:1-1:1, in particular 5:1-1:1, or another ratio.

In Figures 2A, 2B, arrows f_g indicate respective gas flow and arrow f_p indicates respective product flow. As follows from Fig. 2A, 2B during discharge, the product P can flow, for instance, along the gas dispersion wall of the dispersion device, while the gas is supplied from a gas supply space to the pores, to be supplied via the pores to the product. More particularly, a pressure prevailing in the gas supply space can, for instance, be higher than a pressure of the product flowing along the gas dispersion wall. In the arrangement according to Fig. 2A, in case of application of a tubular dispersion element 15a, gas is injected substantially radially inwards into the product, whereas the alternative embodiment of Fig 2A shows a substantially radially outwards injection of gas into the product. The skilled person will appreciate that other gas dispersion/injection directions are also feasible.

A dispersion device/element (e.g. wall 15a) can be configured in various ways as will be appreciated by the skilled person. In a preferred embodiment, the dispersion element 15a can be made from a plastic or a plastic compound, for example (but not limited to) polyethylene (PE), high density polyethylene (HDPE), polytetrafluorethene (PTFE), polypropylene (PP), Polyethersulphone (PE) or another plastic or thermoplastic. Alternatively, the dispersion element 15a can be made from a ceramic material, e.g. a ceramic containing Alumina or aluminum oxide (Al_2O_3). According to a further elaboration of the invention, the gas can be brought via the dispersion device into the product under the influence of an (absolute) pressure of more than 2 bar, for instance, a pressure in the range of more than 3 bar, in particular a pressure in the range of about 3 – 10 bar. A preferred pressure range, of gas pressure in the gas supply space 15c, has found to be 4-6 bar.

Optionally, the apparatus includes a plurality of dispersion devices 10(1), 10(2), arranged in parallel in this case, and being configured to operate at the same time. An example of such an embodiment is shown in Figure 24. In this case, each of the dispersion devices 10(1), 10(2) can e.g. include an afore-mentioned microfiltration- or an ultrafiltration-type dispersion device, or different type of dispersion device, e.g. arranged to simultaneously receive product and inject gas into the product, and to simultaneously discharge the resulting product P' towards the discharge nozzle 20. The dispersion devices 10(1), 10(2) can be oriented in substantially the same direction, extending next to each other or near one another, leading to a relatively compact configuration.

The processing device 12 can be configured in various ways. For example, the processing device 12 can be a static mixer. In a preferred embodiment, the processing device 12 can comprise at least one elongated channel (path), for example extending along a spiral and/or helix trajectory. For example, the expansion path or tube can be longer than 1 cm, for

example longer than 10 cm, in particular at least being 15 cm in length, for providing a good controlled pressure reduction downstream of the dispersion device 10. An example of a relatively compact processing device 12, providing a relatively long helical product processing path, is also shown in
5 the embodiments of Figures 3-18 (see below); the helical and/or spiral path can include e.g. numerous subsequent loops (e.g. at least 2 loops) providing a desired long processing path length.

The apparatus can further comprise a pressure regulation means 30, 31, configured to regulate the pressure and/or ratio of product and/or gas
10 fed to the dispersion device 10. In the example of Fig. 1, the pressure regulation means include a first pressure reducer 30, arranged in a gas flow path between the gas container 7 and the dispersion device 10. The first pressure reducer 30 is configured to reduce an afore-mentioned relatively high pressure of gas, received from the gas container 7, to a first
15 predetermined lower pressure (i.e. lower than said relatively high pressure) for injection of the gas into the product via the dispersion device 10.

Also, in the example of Fig. 1, the pressure regulation means include a second pressure reducer 31, arranged in a gas flow path between the gas container 7 and the product container. The second pressure reducer
20 31 is configured to reduce the relatively high pressure of gas, received from the gas container 7, to a second predetermined lower pressure (i.e. lower than said relatively high pressure) for propelling product P out of the product container to the dispersion device 10, and such that the product can pass the dispersion device 10, receiving gas from the dispersion device, to be
25 discharged via the discharge nozzle 20 as a foamed product P'.

In a further, preferred, embodiment, the apparatus includes control means 40, 41 for controlling gas flow and product flow, preferably such that a supply of gas from the gas container 7 to the dispersion device 10 is started before supply of product thereto, in particular upon actuation of an
30 operation means K of the apparatus. For example, a said operating means K

can be arranged to actuate a gas flow control means 40 before actuating a product flow control means 41 during manual discharge activation of the apparatus via the operating means K. Also, or in addition, it is preferred that the control means 40, 41 can be configured such that product enters the dispersion device 10 just after the gas enters that device, e.g. to prevent that product is forced into the dispersion wall 15a (towards the gas supply space 15c) before that wall receives the gas from the gas supply space 15c.

In the embodiment of Figure 1, the gas container provides the pressurized gas supply means 7. Alternatively, see e.g. Figures 3-11, the pressurized gas supply means 187 can be separate from the gas container.

Referring to Fig. 1, the apparatus can contains a single gas container 7, containing the gas, for example a single gas or a gas mixture, that substantially does not contain any greenhouse gases such as N_2O . For example, the respective gas can be nitrogen, argon, or air, or a mixture thereof. In a preferred embodiment, the apparatus can contain a plurality of such gas containers 7, for example a plurality of relatively compact gas containers, mutually providing relatively long operating periods.

As will be explained in further detail below, an outlet of the pressurized gas supply means 7 may be initially is sealed by a closed sealing structure. Then, preferably, the apparatus 1 may include a mechanism (e.g. a seal piercing structure) for opening the sealing structure prior to an initial use of the gas supply means 7. Thus, the apparatus 1 can be stored and transported safely before initial use, without downward sections of the integrated gas supply system being pressurized yet

The product P can be a foodproduct, for example containing milk or dairy cream, or a different type of product that is to be foamed. In particular, the product P is a foamable liquid or liquid-like substance (in particular at operating temperature, i.e. during normal use). As is indicated in Figure 1, such a product P will be located at least at a vertically lower level within the respective container 5, under the force of gravity. In this

example, the arrangement of the product container 5 is such that a respective product exit 5a is located at a substantially lower level of the product container 5 when the apparatus 1 (including that container 5) 1 held in the substantially upside-down discharge position. This can ensure
5 that product P is at least present at the product exit 5a when the apparatus 1 is being operated (via a respective operating means K) to discharge the product P. In another embodiment, the product can be held within a flexible Bag-on-Valve (BOV) type container, wherein the product can be forced towards the outlet ('valve') of the container irrespective of the orientation of
10 the container.

In the example of Fig. 1, the content of the product container 5 is configured to be directly pressurized by the gas (from the gas container 7). To that aim, the product container 5 can include a gas inlet 5b for receiving the gas during operation. In a further, preferred embodiment, the product
15 container is a flexible bag, for example a bag to be compressed by external gas pressure during operation. An example of such a configuration is shown in Figures 3-11 (see below).

Alternatively, see figure 22, the apparatus 1 can be configured to cooperate with an external compressor and/or high pressure external gas
20 reservoir, for charging or recharging the gas container. Moreover, in yet another embodiment, see figure 23, the apparatus 1 can includes an internal compressor, for charging or recharging the gas container.

Operation of the apparatus 1 can include a method for foaming and dispensing the product P. Before an initial use, an optional seal of the gas
25 container 7 may be removed or broken by the user. Next, the user can reposition the apparatus 1 (e.g. from an initial idle or storage position) to a substantially downwards (upside-down) orientation and e.g. aim the apparatus discharge nozzle 20 to a product receiving area. Next, the user can initiate product foaming and discharge by actuation of the operating
30 means K, e.g. by pressing or moving a respective actuator element, handle

or knob (if any) from a idle position to an active position. As a result of the actuation of the operating means K, the gas flow control means 30, 31 open respective flow paths. Consequently, gas is released from the gas container 7 into the product container 5, and propels product P via the container exit 5a and a respective product supply path towards and through the dispersion device 10. Gas is also released from the gas container 7 directly towards the dispersion device 10 (via a respective gas supply path), to be injected via that device 10 to foam the product. As is mentioned before, preferably, a gas flow into the dispersion device 10 is started just before the product flow into the dispersion device starts (e.g. as provided by the flow control means 30, 41). In this way, e.g., clogging of the dispersion device and/or discharge can be prevented and a regular product discharge can be achieved. Preferably, the resulting product is processed in/by the downstream processing device 12, performing a mixing treatment and/or pressure reduction on the product. The processed foamed product P' is then discharged via the nozzle 20, and can e.g. be shaped by respective nozzle projections (e.g. teeth) 22 if present.

After a desired amount of foamed product P' has been discharged, the user can release the operating means K, which can then return to an initial idle state, so that the gas flow control means 30, 31 close respective flow paths.

In this example, the foamed product P' is discharged vertically downwards or in a direction that includes a certain angle with a vertical plane (e.g. an angle in the range of 0-90 degrees, more particular an angle in the range of about 0-45 degrees with a vertical plane). Thus, operation of the apparatus is extra user friendly .

In this case, the same gas is used for inducing the product flow and for foaming of the product, by injecting that gas into the product.

Alternatively, as in the second embodiment, a second gas can be used for inducing both the product flow and the flow of the first gas, the

second gas being kept separate from the first gas. For example, the second gas can remain in the apparatus during and after use of the apparatus.

A major advantage of the present invention over such prior art aerosol containers is that the present apparatus 1 substantially does not
5 discharge greenhouse gases during operation and can still provide good foaming results, product shaping results (if desired) at a relatively high level of hygiene.

Figures 3-14 show a second non-limiting embodiment of the invention. The second embodiment differs from the first embodiment in that
10 the apparatus 101 includes two different gas containers 107, 187. One of the gas containers 107 contains the gas that is to be injected into the product P. The other gas container 187 includes a pressurized gas, for inducing the foaming process.

In particular, in the second embodiment, the product container 105
15 integrated in the housing H. Part of the product container 105 is shown in Figures 8, 10, 11.

In particular, the product container 105 is a flexible bag, configured to be compressed by external gas pressure during operation for product discharge.

20 Also, in the second embodiment, the first gas container 107 that contains non-greenhouse gas, is integrated in the housing H. Part of the respective gas container 107 is also shown in Figures 8, 10, 11. This gas container 107 can for example be a flexible bag as well, configured to be compressed by external gas pressure during operation for gas ejection.

25 It should be observed that a flexible product container 105 may be entirely or partly flexible. For example, such a product container may include at least a flexible wall section that can be moved inwardly under external pressurization, allowing discharge of the content of the container.

Similarly, it should be observed that a flexible gas container 107
30 may be entirely or partly flexible. For example, such a gas container may

include at least a flexible wall section that can be moved inwardly under external pressurization, allowing discharge of the gaseous content of that container.

Moreover, in the present example, the flexible product container
5 105 extends within the flexible gas container 107. Thus, the embodiment can be called a 'bag-in-bag' type apparatus. Alternatively, two bag-type containers (one for product and one for gas) can be located next to each other within the housing H of the apparatus.

The housing H further includes a pressurization (i.e. compression)
10 chamber 145 that encloses (surrounds) both the product container 105 and the gas container 107. By pressurizing the pressurization chamber 145, in particular, by feeding a pressurized second gas (emanating from the second, pressurized, gas container 187) into that chamber, both the product
15 container 105 and the gas container 107 can be pressed inwardly for product and gas discharge. A gas that is fed into the pressurization chamber can remain in that chamber, i.e., it does not mix with the product and with the content of the flexible gas container 107. Thus, the pressurizing gas may substantially be e.g. a greenhouse gas (for example N_2O), wherein the
20 apparatus can ensure that that gas does enter an environment during product discharge.

Besides, in this example, the flexible product container 105 extends substantially within the flexible gas container 107, wherein gas (to be ejected) can be held in a space between the walls of the two containers 105, 107. Alternatively, for example, a flexible gas container may extend
25 substantially within a flexible gas container, wherein product to be expelled is located between the two containers. Also, in another embodiment, the flexible product container 105 and flexible gas container 107 may both be located next to each other, separately, within the pressurization chamber 145 of the housing H

Further, the housing H (and e.g. respective product container and other parts of the apparatus) may have a disposable construction.

In this example, the housing H has a construction similar to a common aerosol container, having a substantially cylinder shaped wall with
5 a top section T having a central top rim 161, centrally of which there is a product discharge valve 171. The discharge valve is movable inwardly (slightly into the housing H) against spring force (of a spring 174, see Fig. 10), from a closed valve state to an open valve state, allowing discharge of product from the valve. An upstream section of the discharge valve 171 is in
10 fluid communication with the integrated product container 105, when the valve has been moved to its open valve state (as in Figure 11).

Further, the present apparatus according to the second example has a top section 119 that has been connected to the rim 161 of the top of the housing H, for example via a clamping or clicking connection. In a further
15 embodiment, the top section 19 of the apparatus may be removably connected to the housing H, for example allowing separate disposal after use.

In this embodiment, the top section 119 of the apparatus includes a downwardly expending skirt part 119a, configured to cover and smoothly
20 join up with an external side of the housing.

In this case, the top section 119 (also) includes a substantially cylindrical cap section that includes various product discharge operating elements, as will be explained in the following.

In the second (and third) embodiment, in particular, the top section
25 119 of the apparatus includes the dispersion device 110 and a respective downstream processing device 112, as well as the dispensing head 20. Also, the top section 119 may include a pressurized gas supply means 187, i.e. the afore-mentioned second gas container 119 (see e.g. Figure 5). Moreover, gas pressure control means can be located within that top section 119, whereas

the top section 119 can further be provided with gas flow control means 130, a seal opening mechanism 190, and a manual operating means K.'

In this way, a relatively large volume can be provided within the housing for containing product. Also, this embodiment provides ease of use, good disposal properties (potentially even providing an option of reuse of one or more components after disassembly). Also, in this way, relatively small product flow paths can be achieved, thereby providing proper functioning low chances of contamination.

In particular, as follows from the drawings (Fig. 3-5), the top section 119 includes a second gas container 187, in the form of a pressurized gas cylinder. This pressurized gas container can be a rigid (e.g. disposable) gas cartridge, being configured to withstand an internal gas pressure of at least 50 bar, e.g. at least 100 bar or even at least 200 bar, and preferably made of steel and preferably having a maximum internal volume of 200 ml, for a maximum example internal volume of 20 ml (e.g. 14 ml).

The present gas cylinder 187 extends substantially in parallel with a central axis of the housing, allowing a compact integration thereof. Referring to Figures 6A, 6B, 7, an outlet of the pressurized gas supply means 187 is preferably sealed by a closed sealing structure 143 before initial use. The sealing structure 143 can be configured in various ways, and can be e.g. a piercable element or seal. The apparatus (in particular its top section 119) also includes a manually controllable opening mechanism 190 for opening the sealing structure 143 prior to an initial use of the gas supply means 187. The present opening mechanism includes a piercing element 191, movable from an idle state (shown in Figure 6A) wherein it does not penetrate the seal 143 to a piercing state (shown in Figure 6B) wherein it has opened the seal 143 and receives gas from the content of the second gas container 187. The piercing element 191 may e.g. include an integrated gas feed channel 191a (see Fig. 7) for passing the gas to downstream gas channel of the apparatus.

Furthermore, the manually controllable opening mechanism 190 may include e.g. a pivotable lever 193 that can mechanically cooperate with the piercing element 191 to push the element 191 towards the gas container 187 (for piercing the seal). Figures 21A, 21B show an alternative
5 embodiment, wherein the manually controllable opening mechanism 490 includes a ring that is mounted at an external side of the housing H (concentric there-with)..

In this example, the apparatus is configured to hold the second gas container gas container 187 firmly in place, in particular with its gas outlet
10 rim onto a gas seal (e.g. a resilient sealing member) 188 to prevent unwanted escape of gas into the interior of the apparatus top section 119 after the seal 188 has been pierced. For locking the pressurized gas cylinder in place, e.g. a top of the cylinder (that includes the gas outlet) may e.g. be provided with screw thread, for turning and locking the cylinder in receiving
15 screw-thread of a locking member 144 of the apparatus. The respective screw threads are not shown in the present drawings. In the present example, the locking member 144 is a locking sleeve that is arranged for receiving a neck portion of the gas cylinder 187.

Alternatively, a bayonet-coupling between the pressurized gas
20 cylinder 187 and the locking member 144 may be applied, or a different type of fixation (e.g. via a glued connection). For recycling it is preferred that the second container 187 can be releasably locked into its operation position, allowing removal of the container 187 (e.g. for reuse) at a recycling center after disposal of the apparatus.

25 Downstream of the second gas container 187, the top section of the apparatus includes one or more gas pressure regulators 130 for regulating pressure of gas, received from that container 187, to a certain (predetermined) operating pressure. For example, an initial gas pressure in the second gas container can be significantly higher than 15 bar (as
30 mentioned before), whereas a predetermined operating pressure can be at

most 15 bar (at 20 °C). The gas pressure regulator, or 'pressure reducer', can be configured in several means, including a suitable valve means (as in the drawings), as will be clear to the skilled person.

Downstream of the gas pressure regulator(s) 130, the top section
5 119 of the apparatus includes a gas feed channel 169 that is connected to a gas inlet 170 of the housing top T after assembly, for feeding pressure controlled gas into the housing H, i.e. into the pressurization chamber 145. In particular, the gas pressure regulator 130 can automatically control pressure inside the pressurization chamber 145, after being pressurized by
10 the gas cylinder 187..

Also, in the second embodiment, the product discharge valve 171 of the housing includes both the product discharge channel 172 and a gas discharge channel 173 (see Figures 8-11). The gas discharge channel 173 is for example concentrically arranged with respect to the product discharge
15 channel 172, and/or extends in parallel there-with. The gas inlet 170 for receiving gas is located near the discharge valve 171, and extends substantially in parallel therewith.

The present product discharge valve 171 is configured such that it provides both a closable product passage and a closable gas passage, from
20 the product container 105 and first gas container 107 respectively, towards the top section of the apparatus.

An upstream section of the integrated gas discharge channel 173 (see Fig. 11) is in fluid communication with the integrated gas container 107, when the valve has been axially moved to its open valve state. The fluid
25 communication between the upstream section of the of the gas discharge channel 173 and the first gas container 107 is closed when the valve 171 has moved (by spring force of the valve spring 174) to an initial, idle state (as in Fig. 10).

Further, in this embodiment, the arrangement of the gas discharge
30 channel 173 and the product discharge channel 172 is such, that they serve

as a flow timing control means, starting a supply of gas from the gas container 107 into the dispersion device 10 just before supply of product in the dispersion device 10. In particular, the discharge valve 171 is configured to have an intermediate valve position, between its idle state and its opened valve state (shown in Figures 10-11). In this intermediate valve state, the integrated gas discharge channel 173 has been brought in fluid communication with the integrated gas container 107, but the integrated product discharge channel 172 is still blocked from a respective product flow communication.

Upstream of the valve, within the top section 119 of the apparatus, there can be provided a product receiving section 151 (see Fig. 12), configured to receive and gas and product separately from the respective gas and product outlets of the valve 171. Also, the product receiving section 151 is configured to separately feed product and gas to the downstream dispersion device 110 (see Fig. 4, 13 as well). To that aim, the product receiving section 151 can include a product feed line 152 and a gas feed line 153. As follows from the drawing, in this embodiment, these feed lines 152, 153 extend substantially in parallel with each other, and substantially in parallel with a central axis of the housing H. One or more, for example each, of these feed lines 152, 153 can include further flow controlling means 152a, 153a, for example, flow rate control valves or pressure reduction means, as in the present example (see Fig. 12). The present dispersion device 110, configured to receive the product and gas from the receiving section 151, is arranged substantially perpendicularly with respect to a central axis of the housing, i.e. substantially normally with respect to the feed lines 152, 153, allowing a compact arrangement. During operation, the dispersion device 110 received gas and product, and injects the gas into the product, similar to the process described above with concerning the first embodiment (Figures 1-2).

The dispersion device 110 has a product exit for passing foamed or foaming product into a downstream helical path of the processing device 112 (see Fig. 13A, 13B). In this example, a virtual center of the product processing path that is provided by the processing device 112 is

5 substantially in parallel with a center axis of the housing H. In this example, the path is not only a helical (or spiral) path, it is also a path that has a gradually increasing cross-section, allowing better control of product processing, e.g. pressure reduction. This can be achieved in various ways. In this example, an external diameter of the helical path gradually increases

10 from a first diameter D1 to a second diameter D2 (see Fig. 13A). An inner diameter of the helical path remains substantially constant; the same holds for a local width of the path (seen in cross-section, measured in parallel with the path's central axis of rotation). An alternative configuration of a product processing path e.g. does not have a gradually increasing cross-section, see

15 for example the embodiment of Figure 25.

Upstream the helical path ends into a downstream section of the dispensing head 20. The dispensing head 20 as such can be configured in various ways, as will be appreciated by the skilled person. For example, the dispensing head 20 and the processing device 112 can be made in one piece

20 with one another, for example from plastic. Also, in a preferred embodiment, the dispensing head 20 and a respective processing device 112 can be releasably connected to the apparatus, for removal and separate cleansing thereof. Figures 25E-25F show an alternative embodiment, wherein a processing device 812 extends along an inner side of an external cap of the

25 respective apparatus.

Finally, the apparatus includes a manual operating means K', for example a lever or handle, that is mechanically coupled to the discharge valve 171 for controlling (i.e. opening) that valve. In a non-limiting example, at least the product receiving section 151 can be mechanically linked to the

30 operating means K', to be pressed axially downwardly thereby for actuation

of the valve. The operating means K' can include spring-means themselves, for counteracting manual operation. Also, or in addition, a valve spring 174 can be configured to allow restoring positions of both the valve and operating means K', after manual release of the operating means.

5 Also, other components of the apparatus, e.g. the respective feed lines 152, 153, dispersion device 110, processing device 112 and dispensing head 20 can be linked to the operating means K', and can be movably or slidably arranged in the top section 110 of the apparatus for valve actuation. Alternatively, one or more components can allow movement via a flexible
10 construction, for example, the intermediate gas and product feed lines 152, 153 can include flexible feed sections, for providing freedom of movement of an upstream section of the product receiving section 151 with respect to the downstream dispersion device 110.

 Use of the second embodiment can encompass (see Figures 14A, 14B, 14C) a first step of removing or piercing an initial seal 143 of the
15 pressurized gas container 187. As a result, gas is released from the container 187 and pressurizes the pressurization chamber 145 of the housing H, to a predetermined, controlled pressure. Also, as a result, both the product container 105 and first gas container 107 are pressurized.

20 Also, before initial use, an optional dispensing head cap 199, shielding the head 20 from an environment for storage etc., can be removed.

 Next, the apparatus can be subsequently reoriented, for discharging foamed product P' in a substantially downwards direction, i.e. with a bottom B of the apparatus facing in a substantially upwards
25 direction.

 In order to start the discharge, the operating means K' can be manually actuated, e.g. pressed or shifted, thereby moving the valve 171 from an closed valve state via the intermediate valve state to the open valve state. As a result, the pressurized product container 105 and pressurized
30 first gas container 107 discharge product P and gas via the valve and

respective feed channels to the dispersion device 110, as is described above. After a proper foaming and product processing, by the dispersion device 110 and processing means 112, the foamed product P' leaves the dispensing head 20, optionally being shaped with e.g. a desired relief or the like

5 During discharge, the product P follows a first path through the dispersion device 110, namely a substantially straight path, and receives the first gas via the dispersion device. The product undergoes the controlled pressure reduction downstream of the dispersion device 110, and in this case follows a second path during that controlled pressure reduction that
10 substantially deviates from the first path (the second path being a helical path, in this example).

 Figures 16-19 show a third embodiment, which differs from the second embodiment in that a single pressurized gas container 207 is included in the apparatus. Thus, the third embodiment follows the
15 configuration that has been schematically shown in Fig. 1 regarding the first embodiment.

 As follows from Figures 15A-15D, the third embodiment also includes a substantially cylindrical housing H', which can function as a durable holder (or primary packaging) for the other components of the
20 apparatus 201. The apparatus also includes a (secondary) refill-unit SU, for example of a disposable configuration, that is insertable into the housing H', wherein the refill-unit includes product, gas, foaming means as well as the dispensing head 20 (as will be explained below). In this example, a removable cap Y is provided, that can be connected to a top of the housing H'
25 via e.g. a screw-thread connection TD (as in this example) or bayonet coupling. As follows from Figures 15A-15C, assembly of the apparatus can include the steps of inserting the refill-unit SU into the housing H', and subsequently closing the housing by installing the cap Y thereon. In this case, the cap Y has a central opening, allowing passage of the dispensing
30 head 20 of the refill-unit SU after assembly. The cap Y can also include a

knob K" or similar actuation member, arranged for cooperation with valve activation means after assembly. Also, the cap Y can be provided with other means for operation of the apparatus, e.g. capsule seal piercing means and gas pressure reduction means, and a pressure chamber, as follows from
5 Figures 17-18.

Figure 16-19 show in more detail that the refill-unit SU may include an at least partly flexible product container 205 for holding the product P. Also, in this example, the refill-unit SU includes a number of gas containers 207, in particular a plurality (e.g. two or three as in this
10 example) of pressurized gas cylinders. As in the above embodiments, each pressurized gas container can be a rigid (e.g. disposable) gas cartridge, being configured to withstand an internal gas pressure of at least 50 bar, e.g. at least 100 bar or even at least 200 bar, and preferably made of steel and preferably having a maximum internal volume of 200 ml, for a maximum
15 example internal volume of 20 ml (e.g. 14 ml). Moreover, in the present third example, each of these gas cylinders is filled with a non-greenhouse gas, for example air or N₂.

As in the above embodiments it is preferred that the gas containers 207 are sealed before initial use. In the present example, the cap Y of the
20 apparatus includes i.e. provides an opening mechanisms 280 for opening the sealing structures 243 of the gas containers, during assembly of the cap Y onto the housing H' (see Fig. 18). Similar to the second embodiment, the opening mechanism can include a number of elements 291, that can move into respective piercing states (one shown in Figure 19). In the present
25 example, however, the piercing states are automatically reached during the mounting of the cap Y. The piercing elements 291 can receive gas from the content of the respective gas container 207, and can include integrated gas feed channels for passing the gas to a downstream pressure chamber 245 that is also integrated in the cap Y in this example (see Figure 17B).

In this example, a first pressure regulator 230a is provided directly downstream each of the gas containers 207, for reducing or regulating pressure of gas that is fed into the pressure chamber 245. Also, a second pressure regulator 230b is provided, at a gas exit of the pressure chamber
5 245, for controlling pressure of gas that is fed from that chamber 245 to a downwards gas receiving inlet 270 of the refill-unit SU (see Fig. 16B) .

In this example, the pressure chamber 245 and respective pressure regulators 230a, 230b, as well as the piercing elements 291 can be part of a cap insert unit that is rotational held within the surrounding cap Y. Thus,
10 these elements can be positioned onto the refill unit SU during assembly, with e.g. the second pressure regulator 230b interconnecting with the gas receiving inlet 270 of the refill-unit SU, and the piercing elements 291 pointing towards gas cylinders to be opened. The respective positions can be upheld during a screwing movement M of the cap Y onto the holder H',
15 wherein the axial movement of the cap Y presses the piercing elements 291 through the gas container seals (see Fig. 18).

The refill unit SU is configured to receive pressurized gas from the pressure chamber 245, via the respective gas inlet 270 after assembly. The gas pressurizes a second pressure chamber 246 to a predetermined
20 pressure, set by the afore-mentioned regulator. This also leads to pressurizing the product container 205, which is located in the second pressure chamber 246 as is shown in the drawing.

The discharge valve 271 of the third embodiment is of similar construction as the discharge valve of the second embodiment, providing
25 separate product and gas flow paths towards the downstream dispersion device 210. Similarly, the respective dispersion device 210 has a similar configuration as the above-described dispersion devices 10, 110. Besides, the processing device 212 of the third embodiment can have a similar configuration as the above-described processing devices 12, 112 of the other
30 embodiments.

Also, the third embodiment can include a movable product receiving section 251, linked to the operating means K", the product receiving section being configured to be pressed axially downwardly by those operating means K" for actuation of the discharge valve. For example, the
5 dispersion device 210, processing device 212 and dispensing head 20 can be components of that a product receiving section 251.

In the third embodiment, the downstream dispersion device 210 is oriented substantially in parallel with a central axis of the apparatus, and is in particular located in line with the discharge valve 271 (see Fig. 19). Also,
10 in the depicted relatively compact configuration, the dispersion device 210 reaches into the respective processing device 212. In this example the (elongated) dispersion device 210 is located for more than 50% within the respective processing device 212, and e.g. extends along a center line of that device 212.

15 As follows from Figure 19, during operation (when the apparatus 201 is held in a position as shown e.g. in Fig. 15D), the operating means K" can be manually actuated, which leads to the opening of the discharge valve 271 and subsequent release of gas and product towards the dispersion device 210, and finally to the dispensing of the foamed product P'.

20 Various alternative configurations are possible, using one or more of the above-described innovative concepts.

For example, as is shown in Figure 20, the apparatus 301 can include a housing H, for example a durable can, configured to receive a removable (e.g. disposable) refill-unit SU' that includes an afore-mentioned
25 dispersion device 310 and processing device 312, and a distal (downstream) dispensing head 20, a respective product discharge valve and manual operating means. Also, the present refill-unit SU' can include an at least partly flexible product holder 305. The refill unit SU' can be mounted onto a top rim or top section of the housing, e.g. a via screw thread connection or a
30 clickable construction.

As follows from Fig. 20, the housing (in this case a bottom section thereof) includes an integrated, relatively small pressurized gas container 307, to be filled with pressurized non-greenhouse gas. The integrated gas container 307 includes a gas outlet having a pressure reducer 330, for feeding gas at a controlled, reduced pressure into a pressure chamber defined within the housing after assembly, for externally pressurizing the product container 305. The housing H includes a gas inlet return valve 307x for filling and pressuring the integrated gas container 307 before initial use. Filling and refilling, with respective assembly and potential disassembly, can be achieved e.g. in a production plant. A refilling can also e.g. include replacement of a used-up product container 305 by a freshly filled product container. Thus, the apparatus can provide good recyclability.

Figures 21A, 21B show one alternative example of a manually controllable seal opening mechanism 490. In this case, the mechanism 490 includes an activation ring that is mounted at an external side of the housing H (concentric there-with), wherein the ring can be manually rotated to push a respective piercing element (e.g. being movable with respect to a gas container locking member 444) to a respective pressurized gas container 487 of the apparatus. An external side of the ring 490 can be provided with grip enhancing means, for example a certain rough structure and/or a grip enhancing material. A mechanical coupling mechanism for transmission of ring rotation to piercing element movement is not shown in the drawing, the skilled person will appreciate that such a mechanism can be achieved in various different ways. For example, the activation ring 490 can be mounted using screw thread, such that rotation of the ring leads to axial displacement of the ring. This axial displacement can be mechanically transmitted to the piercing element via a suitable bridging part (not shown).

Figure 22 shows another alternative example of embodiments 501 of the apparatus, that differs from the example shown in Figure 20 in that the apparatus includes an integrated air compressor AC. The compressor

can be e.g. recharged using an external charger. Also, the compressor can be configured to automatically pressurize an air pressurization chamber in the holder H, or be configured differently. In this example, the compressor section is removably connected to the holder H, e.g. via a screw-thread
5 connection, allowing access to the air pressurization chamber (and e.g. a flexible product container present in that chamber).

Figure 23 shows yet another example 601, which differs from the embodiment shown in Figures 20 and 23 in that the apparatus includes an air charging station AC', having an air compressor, for feeding air into an
10 integrated gas container of the holder (via a respective gas inlet 607x). The air compressor AC' and a bottom of the holder H preferably include locking means (e.g. a bayonet coupling or the-like) for mutually locking the two units during the charging of the integrated gas container. During operation, apparatus 601 can cooperate with the external compressor AC', for
15 charging or recharging the respective gas container.

Referring to figure 24, a further embodiment of the apparatus (only the dispersion device part 710 being shown) can include at least two dispersion devices 10, each having a product entrance that is connectable to the product container 5 for receiving product P. In this case, the at least two
20 dispersion devices 10 are further connectable to the gas container 7 for supplying the gas to the product P during product discharge. A similar configuration is implemented in the eight embodiment.

Figures 25A-25H show an eight embodiment 801 of a portable apparatus for dispensing (and foaming) of a product. The eight embodiment
25 can provide a combination of some of the above-described embodiments. The eight embodiment can operate at a relatively low initial pressure of a respective integrated gas primary gas container 807a. Also, it preferably includes a stationary processing device 812 a having relatively large diameter, the processing device 812 preferably extending along an inner
30 side of a removable cap. Another aspect of the eight embodiment provides an

axially movable dispersion device 810 (extending between a manual operating means K''' and a discharge nozzle of the housing), the dispersion device 810 in particular being part of a slidable product receiving section 851 mechanically linking the valve 871 to the operating means K'''. The skilled person will appreciate that various aspects of the eight embodiment are not intrinsically linked to each other.

In particular, as follows from the drawing, a first section H1 of the housing H of the eight embodiment functions as a pressure chamber and includes a flexible product container 805 (see Fig. 25C). The product container contains the product that is to be foamed by and dispensed from the apparatus, similar to the embodiment shown in Figure 20. Besides, the first section H1 of the housing H provides a secondary gas container 807b, for containing gas that is to be dispensed into the product. In particular, the secondary gas container 807b is the space that is available in the housing's first section H1, external to the flexible product container 805.

Also, the housing H of the eight embodiment 801 includes a second section H2, providing a relatively large integrated gas container 807a, to be filled with gas. This integrated gas container 807a acts as a primary gas container and includes a gas outlet having a pressure reducer 830 (see Fig. 25C), for feeding gas at a controlled, reduced pressure into the secondary gas container 807b, i.e. into the first section H1 of the housing (for pressurizing the secondary gas container 807b to a working/operating pressure).

As follows from Figures 25B, 25C the interior volume of the second section H2 of the housing (i.e. of the primary gas container 807a) can take-up at least 20% of the total interior volume of the housing H, for example at least 30%. Similarly, the interior volume of the first section H1 of the housing (or of the flexible product container 805 when filled to a maximum before initial use) can take-up at least 30% of the total interior volume of the housing. In a further embodiment, a ratio of the interior volume of the first

housing section H1 and the interior volume of the second housing section H2 (H1:H2) can be in the range of 1:3-3:1, more particularly the range of 1:2-2:1. In this example, it is preferred that the interior volume H1 for receiving the flexible product holder 805 is slightly larger than the interior volume of
5 the respective primary gas container 807a. According to a non-limiting aspect, and e.g. depending on an overall interior volume of the housing, the volume of the primary gas container 807a can be in the range of about 300-500 ml. The volume of a respective flexible product container 805 (in initially filled condition) can be e.g. in the range of about 400-600 ml.

10 By implementing a relatively large integrated primary gas container 807a, the gas container can be pressurized with sufficient gas to an initial pressure of at most 15 bar (and preferably at least 10 bar), for providing proper apparatus functioning during a long operating time. The pressure reducer 830 of the eight embodiment is configured to reduce the
15 pressure of the gas from the second section H2, received from the primary gas container 807a, to a second predetermined lower pressure, for propelling product P out of the flexible product container 805 to the downstream dispersion device 810, and such that the product can pass the dispersion device 810, receiving gas from the dispersion device, to be discharged via the
20 discharge nozzle 20 as a foamed product P'.

The eight embodiment 801 includes a gas inlet return valve 807x for filling and pressuring the primary gas container 807a before initial use. In this case, both gas container 807a, 807b are preferably filled with air or nitrogen (N₂), wherein CO₂ and/or argon (or a mixture of the afore-
25 mentioned gases) can be alternative options.

Referring to Fig. 25D (with does not depict the product container 805), the eight embodiment 801 has a discharge valve configuration of the dual-type, similar to the valve used in the embodiment shown in Figures 8-11. The product discharge valve 871 of the housing H includes both the
30 product discharge channel 872 and a gas discharge channel 873 (see Figure

25E). In the eight embodiment, the gas discharge channel 873 is for example concentrically arranged with respect to the product discharge channel 872, and/or extends in parallel there-with. During valve actuation, the gas discharge channel 873 feeds gas from the secondary gas container 807b
5 towards a downstream dispersion means 810.

Following from Figures 25D, 25E, 25F, the present embodiment has at least two dispersion devices 810 (two in this example), each having a gas discharge channel 815c and respective product feed channel 815b, the dispersion devices 810 extending in parallel and being configured for
10 simultaneous operation. The dispersion devices 810 and a respective downstream processing device 812 and discharge nozzle 20 as well as an operating means K''' are part of a top section 819 of the apparatus 801.

The eight embodiment does not require gas additional dedicated pressure regulator means, downstream of the gas discharge channel 873 of
15 the valve 871. In this case, the gas (received from the secondary gas container 807b) is fed directly from that gas discharge channel 873, via a respective gas feed line 853, to the gas channels 815c of the gas dispersion devices 810. Similarly, a product feed line 852 is present in the top section 819 for feeding product from the product discharge valve 871 to the
20 dispersion devices 810.

According to an aspect, the processing device 812 of the eight embodiment includes a plurality of loops providing a pressure reduction path for controlled pressure reduction of product, downstream of the dispersion devices 810. In this example, subsequent loops include circle
25 sections 812a and intermediate loop bridging sections 812b (see Fig. 25H) for axially interconnecting the circle sections 812a. In this embodiment, a plurality of downstream circle sections 812a and respective bridging sections 812b have substantially constant path widths (viewed in both axial and radial directions). An upstream (final) circle section 812c, which

terminates into a nozzle feed channel 865, has an enlarged path width with respect to the widths of the upstream circle section 812c (see Fig. 25E).

According to an aspect, the eight embodiment preferably includes a movable product receiving section 851, linked to the operating means K"

5 after assembly. The product receiving section 851 is configured to be pressed axially downwardly by those operating means K" for actuation of the discharge valve (the downward movement e.g. being counteracted by a spring means 874 of the discharge valve). In this case, the dispersion devices 210 are components the product receiving section 851.

10 In this case, the apparatus includes a stationary guiding unit 849, mounted onto the container H". For example, the guiding unit 849 can be fixed or integrally include a coupling member 849a that is coupled or fixed to a top of the housing H". In the present embodiment (see Fig. 25D), the coupling member 849a of the guiding unit 849 is connected to a top of the
15 housing via screw thread connection.

In this non-limiting example, the processing device 812 is part of the stationary guiding unit 849.

The guiding unit 849 slidably holds the product receiving section 851. In particular, the guiding unit 849 includes a guiding space 849a for
20 receiving the product receiving section 851. In this example, the apparatus includes a number of parallel guiding elements 849b, e.g. elongated guide bars, located along a longitudinal central plane and extending in axial direction (i.e. in parallel with the product valve 871), for axially positioning and guiding the product receiving section 851 with respect to the guiding
25 unit 849.

According to an aspect, a (joint) product outlet 813 of the dispersion devices 210 extends in parallel with respect to the valve 871 of the housing and is in fluid-tight engagement with an upstream product entry chamber 812d of the processing device 812. In the example, to that aim, a first
30 sealing means m1, e.g. a resilient O-ring, is located between an external side

of the product outlet 813 and an inner side of the product entry chamber 812d. The arrangement is such that the product outlet 813 of the dispersion devices 210 is allowed to axially move with respect to the product entry chamber 812d of the processing device 812 during valve actuation.

5 In this example, the top section 819 of the apparatus 801 has a cap Y', similar to the embodiment shown in Figures 15A-15D. The present cap Y' defines (encloses) an outer side of a substantial part of the product flow paths of the processing device 812, a remaining part of the processing device being substantially provided by a respective groove structure in an opposite
10 external side of the guiding unit 849 of the top section of the apparatus.

 As follows from Fig. 25G, preferably, the cap Y' is removably connected to the guiding unit 849 of the top section of the apparatus, e.g. via a screw-thread connection or bayonet coupling, or a dedicated locking ring LR as in this example. The optional locking ring LR may include
15 engagement members (e.g. locking cams, not shown) for engaging associated locking members (e.g. locking notches) of the guiding unit 849. The ring can be turned between a locking state to lock the cap Y' to the guiding unit 4429 (as in Figures 25A-25F) and a releasing state allowing removal of the cap Y' (as in Fig. 25G, 25H). The assembly further includes second sealing mean
20 m2, e.g. two O-rings, for providing fluid-tight seals between the inner side of the cap Y' and the outer side of the guiding unit 849 at axial locations above and below the product path provided by the processing device 812 (see Fig. 25D, 25G, 25H).

 Figure 25G also shows that the dispensing head 20 can be
25 removably connected to the guiding unit 849, in particular to a respective nozzle feed channel 865 of the processing device 812.

 The eight embodiment 801 can be operated at relatively low pressures in the primary gas container (e.g. lower than or at most 15 bar). Also, after use, the top section of the eight embodiment can be at least
30 partially dismantled by removing the cap Y', allowing access to the product

path along the processing device 812 for cleansing (e.g. rinsing) purposes, and allowing rinsing of the dispensing head 20. Herein, it is preferred that the product receiving section 851 can be removed from the guiding unit 849 after the cap Y' has been taken-off, for example to be temporarily
5 disassembled (e.g. by taking out the processing devices 810) and rinsed as well. Also, the guiding structure of the eighth embodiment, including the guiding unit 849 and product receiving section 851, allows for a stable and reliable operation of the apparatus.

Figure 26 schematically shows part of a ninth embodiment, which
10 differs from the above embodiments (such as the eighth embodiment) in that the housing H''' includes a primary integrated gas container 907a, to be filled with gas, wherein a volume of the primary integrated gas container 907a increases during the filling thereof.

In the ninth embodiment, the housing H''' includes a substantially
15 cylindrical bottom section and a second section having a reduced width. Figure 26 shows the example before the filling of the primary gas container 907a.

The primary gas container 907a includes a gas outlet having a pressure reducer 930, for feeding gas at a controlled, reduced pressure into a
20 secondary gas container 907b, i.e. into a first section of the housing (for pressurizing the secondary gas container 907b). In particular, the secondary gas container 907b is the space that is available in the housing's first section, next to the flexible product container 805 (located in the housing's first section as well). In this case, however, the primary and secondary gas
25 containers 907a, 907b are separated by a wall 930a that includes the pressure reducer 930, which wall 930a is initially movable in axial direction. The present movable wall 930a acts as a piston, moving from an initial position upwardly (as indicated by arrows) along the cylindrical section of the housing during the filling of the primary gas container 907a (the filling
30 being achieved via a respective inlet return-valve in the bottom of the

housing), towards a blocked end location wherein the wall 930a engages and seals to the section of the housing having a reduced radial width (e.g. a inwardly tapered section of the housing).

After the movable partition wall of the pressure reducer 930 has
5 moved to a final (blocked) position, the interior volume of the resulting second section of the housing (i.e. of the primary gas container 807a) can take-up at least 20% of the total interior volume of the housing H, for example at least 30%. Similarly, the interior volume of the resulting first
10 section of the housing (or of the flexible product container when filled to a maximum before initial use) can take-up at least 30% of the total interior volume of the housing. As in the eight embodiment, e.g., the volume of the primary gas container 907a can be in the range of about 300-500 ml. The volume of a respective flexible product container can be in the range of 400-600 ml.

15 In this way, the housing can be manufactured from relatively little components and still provide a good separation between two internal gas compartments (allowing proper pressure control therein).

While specific embodiments have been described above, it will be appreciated that the invention may be practiced otherwise than as
20 described. The descriptions above are intended to be illustrative, not limiting. Thus, it will be apparent to one skilled in the art that modifications may be made to the invention as described in the foregoing without departing from the scope of the claims set out below.

For example, an afore-mentioned processing device 12 can be
25 arranged downstream of the dispersion devices 10 for performing a mixing treatment and/or pressure reduction on the product provided with the gas. A respective product dispensing head 20 can be arranged downstream of the processing device 12, the dispensing head 20 defining a said product receiving space 21 to receive the product P from the processing device 12. As

follows from the drawing, the at least two dispersion devices are arranged for operating at the same time.