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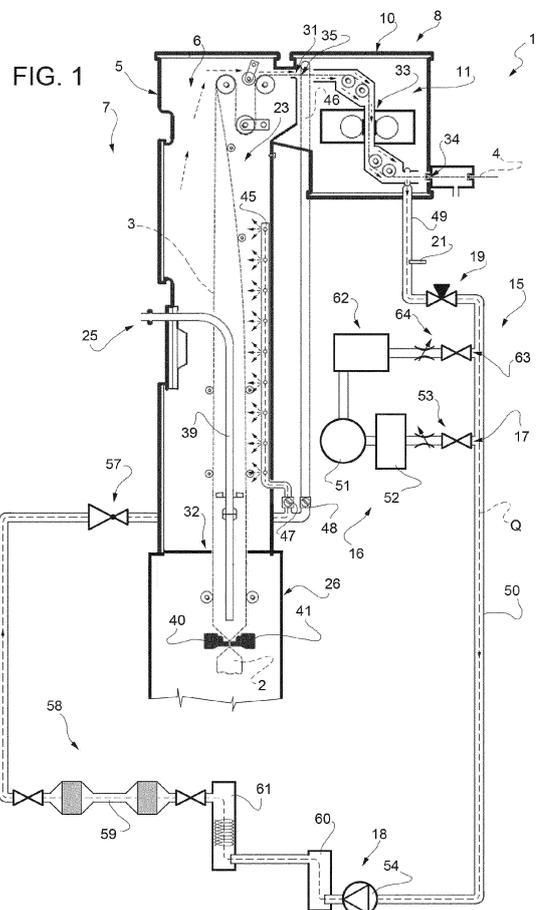
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(54) **PACKAGING MACHINE AND METHOD FOR PRODUCING SEALED PACKAGES**

(57) There is described a packaging machine (1) for producing sealed packages (2) of a pourable product from a web (4) of packaging material, the packaging machine (1) comprises an isolation chamber (5) having an inner environment (6) and within which, in use, the web (4) of packaging material is formed into a tube (3), a conduct assembly (15) being in fluid connection with the inner environment (6); the conduct assembly (15) defining and/or forming together with the inner environment (6) at least a portion of a flow circuit of the packaging machine (1), a nitrogen distribution unit (16) configured to inject and/or direct nitrogen into the flow circuit and a flow controlling device (18) configured to create a flow of gas along a flow path (Q) within the flow circuit from the inner environment (6) through at least a portion of the conduct assembly (15) back into the inner environment (6).



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Description

TECHNICAL FIELD

[0001] The present invention relates to a packaging machine for producing sealed packages of a pourable product, in particular a pourable food product.

[0002] The present invention also relates to a method for producing sealed packages of a pourable product, in particular a pourable food product.

BACKGROUND ART

[0003] As is known, many liquid or pourable food products, such as fruit juice, UHT (ultra-high-temperature treated) milk, wine, tomato sauce, etc., are sold in packages made of sterilized packaging material.

[0004] A typical example is the parallelepiped-shaped package for liquid or pourable food products known as Tetra Brik Aseptic (registered trademark), which is made by sealing and folding laminated strip packaging material. The packaging material has a multilayer structure comprising a base layer, e.g. of paper, covered on both sides with layers of heat-seal plastic material, e.g. polyethylene. In the case of aseptic packages for long-storage products, such as UHT milk, the packaging material also comprises a layer of oxygen-barrier material (an oxygen-barrier layer), e.g. an aluminum foil, which is superimposed on a layer of heat-seal plastic material, and is in turn covered with another layer of heat-seal plastic material forming the inner face of the package eventually contacting the food product.

[0005] Packages of this sort are normally produced on fully automatic packaging machines, which advance a web of packaging material from a magazine unit through a sterilization apparatus for sterilizing the web of packaging material and to an isolation chamber (a closed and sterile environment) in which the sterilized web of packaging material is maintained and advanced. During advancement of the web of packaging material through the isolation chamber, the web of packaging material is folded and sealed longitudinally to form a tube having a longitudinal seam portion, which is further fed along a vertical advancing direction.

[0006] In order to complete the forming operations, the tube is filled with a sterilized or sterile-processed pourable product, in particular a pourable food product, and is transversally sealed and subsequently cut along equally spaced transversal cross sections within a package forming unit of the packaging machine during advancement along the vertical advancing direction.

[0007] Pillow packages are so obtained within the packaging machine, each pillow package having a longitudinal sealing band, a top transversal sealing band and a bottom transversal sealing band.

[0008] In the recent years, sterilization apparatuses have become available, which are configured to sterilize the web of packaging material by means of the applica-

tion of physical irradiation, in particular electromagnetic irradiation, even more particular electron beam irradiation.

[0009] A typical sterilization apparatus of this kind comprises an irradiation device typically having a pair of electron beam emitters spaced apart from one another.

[0010] A drawback of such sterilization apparatuses is seen in that reaction products may form, which require to be removed and decomposed in a controlled manner, thus increasing the complexity of the design of such packaging machines.

[0011] Even though this kind of packaging machine provides for good results, a desire is felt to simplify the design of these packaging machines.

DISCLOSURE OF INVENTION

[0012] It is therefore an object of the present invention to provide a packaging machine to overcome, in a straightforward and low-cost manner, at least one of the aforementioned drawbacks.

[0013] It is a further object of the present invention to provide a method for producing sealed packages to overcome, in a straightforward and low-cost manner, at least one of the aforementioned drawbacks.

[0014] According to the present invention, there is provided a packaging machine and a method according to the respective independent claims.

[0015] Preferred embodiments of the packaging machine and the method are claimed in the respective dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawing, in which:
Figure 1 is a schematic view of a packaging machine according to the present invention, with parts removed for clarity.

BEST MODES FOR CARRYING OUT THE INVENTION

[0017] Number 1 indicates as a whole a packaging machine for producing sealed packages 2 (only partially shown to the extent necessary for the understanding of the present invention) of a pourable product, in particular a pourable food product, even more particular a sterilized or sterile-processed pourable food product, such as pasteurized milk, fruit juice, wine, tomato sauce, etc., from a tube 3 of a web 4 of packaging material. In particular, in use, tube 3 extends along a longitudinal axis, in particular having a vertical orientation.

[0018] Web 4 of packaging material has a multilayer structure (not shown), and comprises at least a layer of fibrous material, such as e.g. a paper or cardboard layer, and at least two layers of heat-seal plastic material, e.g. polyethylene, interposing the layer of fibrous material in

between one another. One of these two layers of heat-seal plastic material defines the inner face of package 2 eventually contacting the pourable product.

[0019] Preferably but not necessarily, web 4 also comprises a layer of gas- and light-barrier material, e.g. aluminum foil or ethylene vinyl alcohol (EVOH) film, in particular being arranged between one of the layers of the heat-seal plastic material and the layer of fibrous material. Preferentially but not necessarily, web 4 also comprises a further layer of heat-seal plastic material being interposed between the layer of gas- and light-barrier material and the layer of fibrous material.

[0020] A typical package 2 obtained by packaging machine 1 comprises a longitudinal seam portion and a pair of transversal sealing bands, in particular a transversal top sealing band and a transversal bottom sealing band.

[0021] With particular reference to Figure 1, packaging machine 1 is configured to advance web 4 along a web advancement path, to sterilize web 4 during advancement along the web advancement path, to form tube 3 from web 4, to fill tube 3 with the pourable product and to form single packages 2 from the filled tube 3.

[0022] With particular reference to Figure 1, packaging machine 1 comprises at least:

- an isolation chamber 5 having an inner environment 6 (in particular, containing a sterile gas) and separating inner environment 6 from an outer environment 7 and within which, in use, web 4 is formed into tube 3;
- a sterilization apparatus 8 for sterilizing at least a first face, in particular also a second face, of web 4 at a sterilization station and comprising a sterilization chamber 10 having an inner space 11 being in fluid connection with inner environment 6; in particular, web 4 (i.e. at least the first face, in particular also the second face) is, in use, sterilized within sterilization chamber 10 and/or inner space 11;
- a conduct assembly 15 being in fluid connection with inner environment 6, and in particular also with inner space 11, and defining and/or forming together with at least inner environment 6, in particular also with inner space 11, a flow circuit of packaging machine 1;
- a nitrogen distribution unit 16 configured to inject and/or direct nitrogen into the flow circuit, in particular conduct assembly 15, at an injection station 17; and
- a flow controlling device 18 configured to create a flow of gas along a flow path Q and within the flow circuit from inner environment 6 through at least a portion of conduct assembly 15 back into inner environment 6, in particular from inner environment 6 into inner space 11 and from inner space 11 through at least a portion of conduct assembly 15 into inner environment 6.

[0023] According to a preferred non-limiting embodiment, packaging machine 1 also comprises, a control

valve 19, in particular a three-way valve, connected to, in particular being integrated into, conduct assembly 15, and configured to control an evacuation and/or releasing of a portion of the gas flowing, in use, along flow path Q from the flow circuit.

[0024] According to a preferred non-limiting embodiment, packaging machine 1 also comprises a control device (not shown) configured to at least partially control operation of packaging machine 1.

[0025] According to a preferred non-limiting embodiment, packaging machine 1 also comprises a gas sensor 21, configured to determine and/or measure a nitrogen content and/or an oxygen content within the gas flowing along flow path Q and/or within the flow circuit.

[0026] According to a preferred non-limiting embodiment, the flow circuit is a closed flow circuit. In particular, the closed flow circuit is configured and/or constructed such that uncontrolled losses of the gas flowing along the flow path Q and/or within the flow circuit are limited.

[0027] According to a non-limiting embodiment, it may be possible to extract gas from the (closed) flow circuit in a controlled manner.

[0028] According to a preferred non-limiting embodiment, packaging machine 1 also comprises:

- a tube forming device (not specifically shown) extending along a longitudinal axis, in particular having a vertical orientation, and being arranged, in particular at a tube forming station 23 and, at least partially, preferably fully, within isolation chamber 5, in particular inner environment 6, and being adapted to form tube 3 from the, in use, advancing (and sterilized) web 4; and/or
- a sealing device (not shown) at least partially arranged within isolation chamber 5 and being adapted to longitudinally seal tube 3 formed by the tube forming device so as to form a longitudinal sealed seam portion of tube 3; and/or
- a filling device 25 for filling tube 3 with the pourable product, in particular the pourable food product; and/or
- a package forming unit 26 adapted to at least form and transversally seal tube 3, in particular the, in use, advancing tube 3, for forming packages 2; and/or
- a conveying device configured to advance web 4 along the web advancement path to tube forming station 23 and to advance tube 3 along a tube advancement path towards and at least partially through package forming unit 26.

[0029] In particular, package forming unit 26 is arranged downstream of isolation chamber 5 and the tube forming device along the tube advancement path.

[0030] According to a preferred non-limiting embodiment, the conveying device is adapted to advance tube 3 and any intermediate of tube 3 in a manner known as such along the tube advancement path, in particular from tube forming station 23 towards and at least partially

through package forming unit 26. In particular, with intermediates of tube 3 any configuration of web 4 is meant prior to obtaining the tube structure and after folding of web 4 by the tube forming device has started. In other words, the intermediates of tube 3 are a result of the gradual folding of web 4 so as to obtain tube 3, in particular by overlapping opposite lateral edges of web 4 with one another.

[0031] With particular reference to Figure 1, isolation chamber 5 comprises an inlet opening 31 configured to allow, in use, (the sterilized) web 4 to enter into isolation chamber 5, in particular inner environment 6, and an outlet opening 32 configured to allow, in use, the outlet of tube 3 from isolation chamber 5, in particular inner environment 6.

[0032] With particular reference to Figure 1, sterilization apparatus 8 further comprises:

- an irradiation device 33 arranged in the area of, in particular at, the sterilization station and within sterilization chamber 10, even more particular within inner space 11, and being configured to sterilize at least the first face, preferentially also the second face, of web 4 by directing a sterilizing irradiation, in particular electromagnetic irradiation, even more particular electron beam irradiation, onto at least the first face, preferentially also onto the second face, while, in use, web 4 advances along a sterilization portion of the web advancement path.

[0033] According to a preferred non-limiting embodiment, sterilization chamber 10 is arranged upstream of isolation chamber 5 along the web advancement path. In particular, in use, web 4 advances from inner space 11 into inner environment 6 (i.e. inner environment 6 receives web 4 after its sterilization).

[0034] According to a preferred non-limiting embodiment, sterilization chamber 10 comprises an inlet passage 34 and an outlet passage 35 configured to allow respectively the entrance and the exit of web 4 into and from sterilization chamber 10, in particular inner space 11.

[0035] According to a preferred non-limiting embodiment, isolation chamber 5 and sterilization chamber 10 are connected to one another, in particular such that inlet opening 31 and outlet passage 35 are adjacent to one another. In other words, in use, (the sterilized) web 4 exits from sterilization chamber 10 and enters directly into isolation chamber 5.

[0036] With particular reference to Figure 1, the tube forming device comprises at least a first forming ring assembly and a second forming ring assembly, in particular arranged within isolation chamber 5, even more particular within inner environment 6, and being adapted to gradually fold in cooperation with one another web 4 into tube 3, in particular by overlapping the edges of web 4 with one another for forming the longitudinal seam portion.

[0037] Even more particular, the first forming ring as-

sembly and the second forming ring assembly are spaced apart from and parallel to one another.

[0038] Furthermore, the first forming ring assembly and the second forming ring assembly are arranged coaxial to one another and define the longitudinal axis of the tube forming device.

[0039] According to a preferred non-limiting embodiment, the sealing device comprises a sealing head arranged within isolation chamber 5, in particular inner environment 6, and being adapted to (configured to) transfer thermal energy to tube 3, in particular to the seam portion for longitudinally sealing tube 3, in particular the seam portion. The sealing head can be of any type. In particular, the sealing head can be of the kind operating by means of induction heating and/or by a stream of a heated gas and/or by means of ultrasound and/or by laser heating and/or by any other means.

[0040] Preferentially but not necessarily, the sealing device also comprises a pressing assembly adapted to exert a mechanical force on tube 3, in particular onto the seam portion, so as to ensure the longitudinal sealing of tube 3 along the seam portion. In particular, the pressing assembly comprises at least an interaction element (not shown) and a counter-interaction element (not shown) adapted to exert the mechanical force onto the seam portion from opposite sides thereof.

[0041] Preferentially but not necessarily, the sealing head is arranged between the first forming ring assembly and the second forming ring assembly.

[0042] With particular reference to Figure 1, filling device 25 comprises a filling pipe 39 being in fluid connection with a pourable product supply (not shown) and being adapted to (configured to) direct, in use, the pourable product into tube 3.

[0043] Preferentially but not necessarily, filling pipe 39 is, in use, at least partially placed within tube 3 for feeding the pourable product into tube 3.

[0044] According to a preferred non-limiting embodiment as shown in Figure 1, package forming unit 26 comprises a plurality of pairs of at least one respective operative assembly 40 and at least one counter-operative assembly 41 (only partially shown to the extent necessary for the understanding of the present invention); and

- in particular, a conveying device (not shown and known as such) adapted to advance the respective operative assemblies 40 and the respective counter-operative assemblies 41 of the pairs along respective conveying paths.

[0045] In more detail, each operative assembly 40 is configured to cooperate, in use, with the respective counter-operative assembly 41 of the respective pair for forming a respective package 2 from tube 3. In particular, each operative assembly 40 and the respective counter-operative assembly 41 are configured to form, to transversally seal and, preferably but not necessarily also to transversally cut, tube 3 for forming packages 2.

[0046] With particular reference to Figures 1 and 2, conduct assembly 15 comprises at least one main injection portion 45 configured to introduce and/or inject gas flowing, in use, within the flow circuit, in particular conduct assembly 15, into isolation chamber 5, in particular inner environment 6.

[0047] According to the non-limiting embodiment shown, injection portion 45 extends within inner environment 6.

[0048] Alternatively, injection portion 45 could be connected to isolation chamber 5 without extending within inner environment 6.

[0049] According to a non-limiting embodiment, conduct assembly 15 also comprises at least an auxiliary injection portion 46 configured to introduce and/or inject gas flowing, in use, within the flow circuit, in particular conduct assembly 15, into an interface area between isolation chamber 5 and sterilization chamber 10.

[0050] According to a non-limiting embodiment, conduct assembly 15 also comprises at least a first valve 47 configured to selectively control the outflow of gas through main injection portion 45, and in particular also at least a second valve 48 configured to control the outflow of gas through auxiliary injection portion 46.

[0051] According to a preferred non-limiting embodiment, conduct assembly 15 comprises an inlet portion 49 configured to receive gas flowing, in use, from inner space 11 into conduct assembly 15. In particular, inlet portion 49 is connected to sterilization chamber 10.

[0052] According to a preferred non-limiting embodiment, conduct assembly 15 also comprises a main conduct portion 50 connected to inlet portion 49 and main injection portion 45 and/or auxiliary injection portion 46. In particular, main conduct portion 50 fluidically connects main injection portion 45 and/or auxiliary injection portion 46 with inlet portion 49.

[0053] With particular reference to Figure 1, nitrogen distribution unit 16 comprises at least a nitrogen generator 51 configured to generate nitrogen, in particular from air. Preferentially but not necessarily, nitrogen distribution unit 16 also comprises a nitrogen storage tank 52 configured to store and/or buffer nitrogen generated by nitrogen generator 51.

[0054] According to a preferred non-limiting embodiment, nitrogen distribution unit 16 also comprises a flow control assembly 53 configured to control the injection and/or inlet of the nitrogen into the flow circuit, in particular into conduct assembly 15. Preferentially but not necessarily, flow control assembly 53 is also configured to control the flow rate of the nitrogen being, in use, introduced and/or injected by nitrogen distribution unit 16, in particular so that the flow rate ranges between 1 to 20 m³/h, even more particular between 3 to 10 m³/h.

[0055] According to a preferred non-limiting embodiment, nitrogen distribution unit 16 is operationally connected to the control device.

[0056] With particular reference to Figure 1, flow controlling device 18 comprises a rotary machine 54, in par-

particular a compressor, even more particular a dry-type compressor, being arranged within conduct assembly 15, in particular main conduct portion 50, and being configured to generate the flow of gas along flow path Q. In particular, rotary machine 54 exerts a suction force within inner space 11 so as to extract gas from inner space 11 and to direct gas, in particular through main injection portion 45, into inner environment 6.

[0057] According to a preferred non-limiting embodiment, rotary machine 54 is also configured to direct the nitrogen injected and/or introduced by nitrogen distribution unit 16 into at least isolation chamber 5, in particular inner environment 6.

[0058] Preferentially but not necessarily, rotary machine 54 is positioned downstream of injection station 17 along flow path Q.

[0059] According to a preferred non-limiting embodiment, flow controlling device 18 is operationally connected to the control device.

[0060] According to a preferred non-limiting embodiment, control valve 19 is operationally connected to the control device.

[0061] According to a preferred non-limiting embodiment, control valve 19 is controllable, in particular by the control device, so as to at least selectively open and close for respectively allowing or impeding the evacuation and/or release of gas from the flow circuit (and through control valve 19).

[0062] Preferentially but not necessarily, control valve 19 is of the three-way type and is integrated into conduct assembly 15, in particular main conduct portion 50.

[0063] Preferentially but not necessarily, control valve 19 is configured to allow a fluid connection between inlet portion 49 and at least main injection portion 45, in particular also auxiliary injection portion 46, when being opened and when being closed.

[0064] According to a preferred non-limiting embodiment, packaging machine 1 also comprises a pressure control assembly 57 configured to control the pressure within at least isolation chamber 5, and in particular also within sterilization chamber 10, in particular such that the pressure is above the ambient pressure, even more particular controlling an overpressure of 20 Pa or more.

[0065] Preferentially but not necessarily, pressure control assembly 57 is configured to control the pressure and/or the flow rate of the gas to be introduced into inner environment 6 and/or inner space 11.

[0066] According to a preferred non-limiting embodiment, at least a portion of pressure control assembly 57 is arranged downstream of rotary machine 54 and upstream of isolation chamber 5 along flow path Q.

[0067] According to a preferred non-limiting embodiment, packaging machine 1 also comprises a gas sterilization assembly 58 configured to sterilize and/or purify the gas to be introduced and/or inserted into inner environment 6. In particular, gas sterilization assembly 58 is integrated into conduct assembly 15 and arranged upstream of isolation chamber 5 and/or inner environment

6 along flow path Q. Preferentially but not necessarily, gas sterilization assembly 58 is arranged downstream of rotary machine 54 along flow path Q.

[0068] According to a preferred non-limiting embodiment, gas sterilization assembly 58 comprises at least a main sterilization portion 59 (comprising a plurality of gas filters) and, preferentially but not necessarily a pre-sterilization portion 60 arranged upstream of main sterilization portion 59 along flow path Q.

[0069] According to a preferred non-limiting embodiment, packaging machine 1 also comprises a heating unit 61 configured to heat the gas flowing along flow path Q. In particular, heating unit 61 is arranged downstream from rotary machine 54 and upstream of isolation chamber 5, along flow path Q.

[0070] Preferentially but not necessarily, heating unit 61 is arranged upstream of main sterilization portion 59 along flow path Q; and in particular downstream from pre-sterilization portion 60 along flow path Q.

[0071] According to a preferred non-limiting embodiment, packaging machine 1 also comprises an air distribution unit 62 configured to at least distribute air to nitrogen distribution unit 16, in particular nitrogen generator 51.

[0072] Preferentially but not necessarily, air distribution unit 62 comprises at least an air compressor and an air filter assembly.

[0073] Preferentially but not necessarily, air distribution unit 62 is also configured to selectively introduce and/or inject air into the flow circuit, in particular into conduct assembly 15 at an air inlet station 63, in particular downstream of control valve 19 along flow path Q.

[0074] Preferably but not necessarily, air distribution unit 62 also comprises an air flow control assembly 64 configured to control the injection and/or inlet of the air into the flow circuit, in particular into conduct assembly 15.

[0075] According to a preferred non-limiting embodiment, air distribution unit 62 is operationally connected to the control device.

[0076] According to a preferred non-limiting embodiment, the control device is configured to control packaging machine 1 at least into:

- an operative configuration in which packaging machine 1 produces, in use, packages 2; and
- a set-up configuration in which packaging machine 1 is prepared so as to obtain the desired and/or required conditions within at least inner environment 6 and inner space 11.

[0077] Preferentially but not necessarily, the control device is also configured to control packaging machine 1 into a venting configuration during which packaging machine 1 is vented, in particular such that inner environment 6 and/or inner space 11 is/are filled with air.

[0078] According to a preferred non-limiting embodiment, in use, packaging machine 1 is controlled into the

set-up configuration for controlling and/or determining a defined gas atmosphere within inner environment 6 and/or inner space 11.

[0079] According to a preferred non-limiting embodiment, the control device is configured to control packaging machine 1 into the set-up configuration so as to control and/or determine the gas atmosphere within inner environment 6 and/or inner space 11 and/or the gas flowing along flow path Q. In particular, the control device controls packaging machine 1 in the set-up configuration for obtaining a nitrogen content of the gas within inner environment 6 and/or inner space 11 and/or the gas flowing along flow path Q being at least 90 volume%, in particular being at least 95 volume%, even more particular substantially equaling 99 volume%.

[0080] According to a preferred non-limiting embodiment, the control device is configured to control, in particular when packaging machine 1 is, in use, controlled into the set-up configuration, control valve 19 so as to selectively open and close control valve 19 for respectively allowing or impeding the evacuation and/or release of gas from the flow circuit (and through control valve 19) as a function of the nitrogen and/or oxygen content within the flow of gas, in use, along flow path Q and as determined and/or measured by gas sensor 21. In particular, the control device is configured to close control valve 19 if the flow of gas within flow circuit and/or the gas being within inner environment 6 and/or within inner space 11 corresponds to a pre-determined and/or desired and/or required condition, in particular having the desired nitrogen content. In this way, it is guaranteed that the formation of package 2 and/or the sterilization of web 4 can be performed within a substantially nitrogen atmosphere.

[0081] In use, packaging machine 1 forms packages 2 filled with the pourable product.

[0082] According to a preferred non-limiting embodiment, packaging machine 1 forms packages 2 while being controlled, in particular by the control device, into the operative configuration.

[0083] According to a preferred non-limiting embodiment, packaging machine 1 is, in particular prior to being controlled into the operative configuration, controlled into the set-up configuration, so as to control the gas atmosphere within inner environment 6 and/or inner space 11 and/or of the gas flowing along flow path Q.

[0084] According to a preferred non-limiting embodiment, packaging machine 1 is, in particular after having been controlled in the operative configuration, controlled in the vent configuration, so as to allow a venting of at least inner environment 6 and/or inner space 11 and/or conduct assembly 15, in particular so as to exchange the gas present with air.

[0085] Advantageously, a method for forming packages 2 comprises at least the steps of:

- controlling the flow of gas along flow path Q within the flow circuit; and
- controlling the gas content of the gas flowing within

the flow circuit and/or of the gas present within inner environment 6 and/or the gas present within inner space 11 by introducing nitrogen into the flow circuit at injection station 17.

[0086] According to a preferred non-limiting embodiment, the step of controlling the gas content is executed with packaging machine 1 being controlled in the operative configuration or the set-up configuration.

[0087] Preferentially but not necessarily, during the step of controlling the gas content, nitrogen distribution unit 16 directs the nitrogen into the flow circuit. In particular, flow control assembly 53 controls and/or determines the flow of nitrogen into the flow circuit, even more particular so that the flow rate ranges between 1 to 20 m³/h, most preferably between 3 to 10 m³/h.

[0088] Preferentially but not necessarily, during the step of controlling the gas content, the volume ratio of the nitrogen within inner environment 6 and/or inner space 11 is controlled to be at least 90 volume%, in particular being at least 95 volume%, even more particular substantially equaling 99 volume%.

[0089] Preferentially but not necessarily, during the step of controlling the gas content, in particular, with packaging machine 1 being controlled in the operative configuration, the flow of the nitrogen is controlled such that the volume of the introduced nitrogen compensates for any gas, in particular any nitrogen, being lost from the flow circuit.

[0090] According to a preferred non-limiting embodiment, during the step of controlling the flow of gas, gas flows from inner environment 6 through at least a portion of conduct assembly 15 back into inner environment 6. Preferentially but not necessary, the gas flows from inner environment 6 to inner space 11 and from inner space 11 into inner environment 6 through at least a portion of conduct assembly 15.

[0091] According to a preferred non-limiting embodiment, rotary machine 54 creates a suction force on the gas present within inner space 11 and directs the gas through main injection portion 45 into inner environment 6.

[0092] Preferentially but not necessarily, during the step of controlling the flow of gas, the gas flows through at least gas sterilization assembly 58, in particular main sterilization portion 59 and/or pre-sterilization portion 60, and/or heating unit 61.

[0093] According to a preferred non-limiting embodiment, the method also comprises the step of producing nitrogen, during which nitrogen generator 51 produces nitrogen, in particular by extracting nitrogen from air. Preferentially but not necessarily, during the step of producing nitrogen, nitrogen generator 51 receives air from air distribution unit 62.

[0094] According to a preferred non-limiting embodiment, the method also comprises a step of evacuating and/or releasing gas from the flow circuit through control valve 19. Preferentially but not necessarily, the step of

evacuating and/or releasing gas is executed with packaging machine 1 being controlled, in particular by the control device, in the set-up configuration or the venting configuration.

5 **[0095]** Preferentially but not necessarily, during the step of evacuating and/or releasing, control valve 19 is selectively opened for allowing the evacuation and/or release of the gas (through control valve 19) and is selectively closed for impeding the evacuation and/or release of the gas (through control valve 19). In particular, control valve 19 is controlled, in particular when packaging machine 1 is controlled in the set-up configuration, as a function of the oxygen and/or nitrogen content within the gas flowing along flow path Q.

10 **[0096]** Preferentially but not necessarily, during the step of evacuating and/or releasing and with packaging machine 1 being controlled into the set-up configuration, control valve 19 is opened until the nitrogen content within the gas flowing along flow path is at least 90 volume%, in particular at least 95 volume%, even more particular at least 99 volume%.

15 **[0097]** Preferentially but not necessarily, with packaging machine 1 being controlled into the venting configuration control valve 19 is opened.

20 **[0098]** According to a preferred non-limiting embodiment, the method also comprises the step of determining and/or measuring, in particular by means of gas sensor 21, the nitrogen and/or oxygen content within the gas flowing along flow path Q.

25 **[0099]** According to a preferred non-limiting embodiment, the method also comprises a step of controlling the gas pressure within at least isolation chamber 5 and/or sterilization chamber 10.

30 **[0100]** Preferentially but not necessarily, the step of controlling the gas pressure is executed with packaging machine 1 being controlled in the operative configuration or the set-up configuration.

35 **[0101]** Preferentially but not necessarily, during the step of controlling the gas pressure, pressure control assembly 57 controls the pressure within inner environment 6 and/or inner space 11 to be above ambient pressure, in particular so that there is an overpressure of at least 20 Pa.

40 **[0102]** According to a preferred non-limiting embodiment, the method also comprises the step of sterilizing the gas flowing along flow path Q, in particular by means of gas sterilization assembly 58.

45 **[0103]** Preferentially but not necessarily, during the step of sterilizing, the gas is sterilized by gas sterilization assembly 58, in particular by at least main sterilization portion 59 and, even more particular also by pre-sterilization portion 60.

50 **[0104]** According to a preferred non-limiting embodiment, the method also comprises the step of directing air into the flow circuit, in particular into conduct assembly 15. Preferentially but not necessarily, the step of directing air, is executed with packaging machine 1 being controlled, in particular by the control device, into the venting

configuration.

[0105] According to a preferred non-limiting embodiment, the method also comprises the steps of:

- sterilizing web 4 within inner space 11; and/or
- forming tube 3 from web 4 within inner environment 6; and/or
- advancing web 4 along the web advancement path; and/or
- longitudinally sealing tube 3; and/or
- filling tube 3 with the pourable product; and/or
- advancing tube 3 along the tube advancement path; and/or
- obtaining single packages 2 from tube 3 by forming tube 3, transversally sealing tube 3 between successive packages 2 and transversally cutting tube 3 between successive packages 2 for obtaining single packages 2.

[0106] According to a preferred non-limiting embodiment, the steps of advancing web 4 and/or of forming tube 3 and/or of longitudinally sealing tube 3 and/or of filling tube 3 and/or of obtaining single packages is/are executed with packaging machine 1 being controlled, in particular by the control device, in the operative configuration.

[0107] According to a preferred non-limiting embodiment, during the step of advancing web 4, the conveying device advances web 4 along the web advancement path through sterilization apparatus 8, in particular through inner space 11, and into isolation chamber 5, in particular inner environment 6. In particular, the conveying device advances the sterilized web 4 to the tube forming device so as to form tube 3. In other words, the conveying device advances web 4 to sterilization station 9 and to tube forming station 23.

[0108] According to a preferred non-limiting embodiment, during the step of longitudinally sealing tube 3, the sealing device, in particular the sealing head, heats and/or directs thermal energy to the seam portion.

[0109] According to a preferred non-limiting embodiment, during the step of advancing tube 3, the conveying device advances tube 3 (and any intermediates of tube 3) along the tube advancement path to (and partially through) package forming unit 26.

[0110] According to a preferred non-limiting embodiment, during the step of filling tube 3, filling device 25 fills the pourable product into the longitudinally sealed tube 3. In particular, the pourable product is directed into tube 3 through filling pipe 39.

[0111] According to a preferred non-limiting embodiment, during the step of obtaining single packages 2, package forming unit 26, in particular the operative assemblies 40 and the respective counter-operative assemblies 40, at least forms and transversally seals tube 3 between successive packages 2 and, preferentially, also transversally cuts tube 3 between successive packages 2.

[0112] According to a preferred non-limiting embodiment, during the step of sterilizing web 4, at least a sterilizing irradiation, in particular electromagnetic irradiation, even more particular electron beam irradiation, is directed onto at least the first face, preferentially also onto the second face 6, of web.

[0113] The advantages of packaging machine 1 and the method for producing packages 2 according to the present invention will be clear from the foregoing description.

[0114] In particular, packaging machine 1 allows to obtain a nitrogen atmosphere within inner environment 6 and/or inner space 11 allowing to form and fill tube 3 and/or to sterilize web 4 in an inert gas atmosphere. With regard to the sterilization of web 4, this allows to avoid the formation of unwanted substances, in particular in the case of using an irradiation. With regard to the forming and filling of tube 3, this allows to avoid any oxidation processes or to provide for the nitrogen needed in the case of producing packages 2 with a nitrogen headspace.

[0115] Clearly, changes may be made to packaging machine 1 and/or the method as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

[0116] According to an alternative embodiment not shown, nitrogen distribution unit 16 is fluidically connected to a centralized nitrogen supply of e.g. the production facility within which packaging machine 1 is installed. According to such an alternative embodiment, nitrogen distribution unit 16 does not necessarily comprises nitrogen generator 51 and/or nitrogen storage tank 52.

Claims

1. A packaging machine (1) for producing sealed packages (2) of a pourable product from a web (4) of packaging material, the packaging machine (1) comprising:
 - an isolation chamber (5) having an inner environment (6) and within which, in use, the web (4) of packaging material is formed into a tube (3);
 - a conduct assembly (15) being in fluid connection with the inner environment (6); the conduct assembly (15) defining and/or forming together with the inner environment (6) at least a portion of a flow circuit of the packaging machine (1);
 - a nitrogen distribution unit (16) configured to inject and/or direct nitrogen into the flow circuit; and
 - a flow controlling device (18) configured to create a flow of gas along a flow path (Q) within the flow circuit from the inner environment (6) through at least a portion of the conduct assembly (15) back into the inner environment (6).

2. Packaging machine according to claim 1, and further comprising a control valve (19) connected to the conduct assembly (15) and configured to control an evacuation and/or release of a portion of the gas flowing along the flow path (Q) from the flow circuit. 5
3. The packaging machine according to claim 2, wherein the control valve (19) is positioned upstream of an injection station (17) at which, in use, the nitrogen distribution unit (16) injects and/or directs the nitrogen into the flow circuit, along the flow path (Q). 10
4. The packaging machine (1) according to any one of the preceding claims, and further comprising a sterilization apparatus (8) for sterilizing at least one face of the web (4) of packaging material and comprising a sterilization chamber (10) having an inner space (11), the inner space (11) being in fluid connection with the inner environment (6); 15
wherein the conduct assembly (15) is in fluid connection with the inner environment (6) and the inner space (11) and the conduct assembly (15) defines and/or forms together with the inner environment (6) and the inner space (11) the flow circuit; 20
wherein the flow controlling device (18) is configured to create the flow of gas along the flow path (Q) within the flow circuit from the inner environment (6) to the inner space (11) and from the inner space (11) to the inner environment (6) through at least a portion of the conduct assembly (15). 25 30
5. The packaging machine according to claim 4, and further comprising a control device configured to control the control valve (19) so as to selectively open and close the control valve (19) for respectively allowing or impeding the evacuation and/or release of gas from the flow circuit as a function of the nitrogen and/or oxygen content within the gas. 35
6. The packaging machine according to claim 4 or 5, wherein the isolation chamber (5) comprises an inlet opening (31) configured to allow, in use, the web (4) of packaging material to enter into the isolation chamber (5); and 40
wherein the sterilization chamber (10) comprises an outlet passage (35) configured to allow, in use, the web (4) of packaging material to exit from the sterilization chamber (10); 45
wherein the inlet opening (31) and the outlet passage (35) are adjacent to one another. 50
7. Packaging machine according to any one of claims 4 to 6, wherein the sterilization apparatus (8) comprises an irradiation device (33) positioned within the sterilization chamber (10) and being configured to sterilize at least one face of the web (4) of packaging material by means of a sterilization irradiation. 55
8. Packaging machine according to any one of the preceding claims, and further comprising a gas sterilization assembly (58) configured to sterilize and/or purify the gas to be introduced and/or inserted into the inner environment (6); 5
wherein the gas sterilization assembly (58) is integrated into the conduct assembly (15) and is arranged upstream of the isolation chamber (5) and/or the inner environment (6) along the flow path (Q).
9. Packaging machine according to claim 8, wherein the gas sterilization assembly (58) comprises at least a main sterilization portion (59) and a pre-sterilization portion (60) arranged upstream of the main sterilization portion (59) along the flow path (Q).
10. Packaging machine according claim 9, and further comprising a heating unit (61) configured to heat the gas flowing along the flow path (Q); 5
wherein the heating unit (61) is interposed between the main sterilization portion (59) and the pre-sterilization portion (60)
11. Packaging machine according to any one of the preceding claims, and further comprising: 25
- a tube forming device at least partially arranged within the isolation chamber (5) and being adapted to form a tube (3) from the web (4) of packaging material;
- a sealing device at least partially arranged within the isolation chamber (5) and being adapted to longitudinally seal the tube (3) formed by the tube forming device;
- a filling device (25) for filling the tube (3) with the pourable product;
- a package forming unit (26) adapted to form and to transversally seal the tube (3) for forming the packages (2);
- a conveying device for advancing the web (4) of packaging material along a web advancement path to the tube forming device and for advancing the tube (3) along a tube advancement path to the package forming unit (26) . 35 40 45 50
12. Method for producing sealed packages (2) of a pourable product within a packaging machine (1), the packaging machine (1) comprises at least: 55
- an isolation chamber (5) having an inner environment (6) and within which a web (4) of packaging material is formed or can be formed into a tube (3);
- a conduct assembly (15) being in fluid connection with the inner environment (6); the conduct assembly (15) defining and/or forming together with the inner environment (6) at least a portion of a flow circuit;

the method comprises at least the steps of:

- controlling a flow of gas along a flow path (Q) within the flow circuit and from the inner environment (6) through at least a portion of the conduct assembly (15) and back into the inner environment (6); and
- controlling the gas content of the gas flowing within the flow circuit and/or of the inner environment (6) and/or the inner space (11) by introducing nitrogen into the flow circuit.

- 13.** Method according to claim 12, wherein the packaging machine further comprises a sterilization apparatus (8) for sterilizing at least one face of the web (4) of packaging material and comprising a sterilization chamber (10) having an inner space (11), the inner space (11) being in fluid connection with the inner environment (6);
- wherein the conduct assembly (15) is in fluid connection with the inner environment (6) and the inner space (11) and the conduct assembly (15) defines and/or forms together with the inner environment (6) and the inner space (6) the flow circuit;
- wherein during the step of controlling a flow of gas, the gas flows from the inner environment (6) into the inner space (11) and from the inner space (11) through at least a portion of the conduct assembly (15) into the inner environment (6).
- 14.** Method according to claim 13, and further comprising the steps of:
- sterilizing the web (4) of packaging material within the inner space (11); and
 - forming a tube (3) from the web (4) of packaging material within the inner environment (6);
- wherein the step of forming the tube (3) and the step of sterilizing are executed if the gas present within the inner environment (6) and/or the inner space (6) has a nitrogen content of at least 90 volume%.
- 15.** Method according to claim 13 or 14, wherein during the step of controlling the flow of gas, a flow controlling device (18) creates a suction force within the inner space (11) so as to extract gas from the inner space (11) and to direct the gas extracted from the inner space (11) together with the injected nitrogen into the inner environment (6).
- 16.** Method according to any one of claims 12 to 15, and further comprising a step of evacuating and/or releasing gas from the flow circuit through a control valve (19).
- 17.** Method according to any one of claims 12 to 16, and further comprising the step of determining and/or

measuring the nitrogen and/or oxygen content within the gas flowing along the flow path (Q); wherein the step of evacuating and/or releasing is executed as a function of the determined and/or measured nitrogen and/or oxygen content.

- 18.** Method according to any one of claims 12 to 17, and further comprising the step of sterilizing the gas flowing along the flow path (Q) by means of a gas sterilization assembly (58) arranged within the conduct assembly (15).



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Application Number
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