(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 332 008 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.03.2024 Bulletin 2024/10

(21) Application number: **23193887.9**

(22) Date of filing: **29.08.2023**

(51) International Patent Classification (IPC):
B65B 55/02 *(2006.01)* ***B65B 55/08*** *(2006.01)*
B65B 61/18 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B65B 55/022; B65B 55/08; B65B 61/186;
B65B 9/20; B65B 61/184

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **01.09.2022 IT 202200017994**

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(54) PACKAGING MACHINE AND METHOD FOR FORMING PACKAGES

(57) There is described a packaging machine (1) for forming packages (2) filled with a pourable product from a web of packaging material (5). The packaging machine (1) comprises a conveying device (6), a molding apparatus (7), a sterilization apparatus (9), and a preserving device (22) configured to preserve the cleanliness and/or sterility of at least the molded portions (4). The preserving device (22) comprises at least one air flow generator (39) configured to generate a first flow (F1) of a sterile fluid against at least a portion of the web of packaging material (5) and into a first direction (D1) opposite to an advancement direction (D2) of the web of packaging material (5) and a second flow (F2) of sterile fluid in a second direction (D3) opposite to the first direction (D1) and/or substantially parallel to the advancement direction (D2) and into the sterilization apparatus (9).

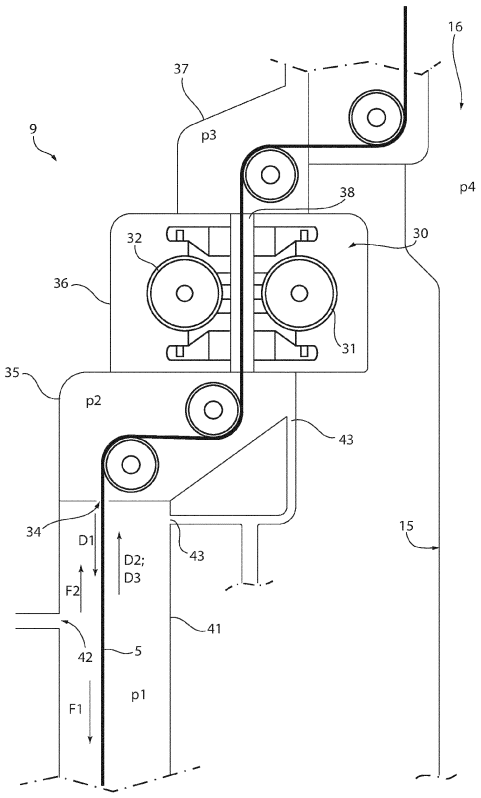

Fig. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to a packaging machine for forming packages of a pourable food product from a web of packaging material, in particular a web of packaging material having a multilayer structure. The packaging machine comprises a molding apparatus for molding molded portions, in particular opening devices, onto the web of packaging material.

BACKGROUND ART

[0002] 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.

[0003] 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 a laminated packaging material. The packaging material has a multilayer structure comprising a base layer, e.g. of paper or cardboard, 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.

[0004] Packages of this sort are normally produced on fully automatic packaging apparatuses, which advance and sterilize a web of packaging material, which is then formed into a tube and filled with the pourable pre/sterilized product under aseptic conditions before its formation into individual sealed packages.

[0005] It is known that some types of packages also comprise respective opening devices, which allow to be manipulated for accessing the pourable product.

[0006] In order to provide the packages with the opening devices, some automatic packaging apparatuses also comprise a molding apparatus for molding the opening devices onto the web of packaging material prior to the formation of the packages.

[0007] It is furthermore known that the automatic packaging apparatus may comprise an isolation chamber within which the web of packaging material is formed and filled with the pourable product. As the web of packaging material gets into contact with the pourable product one needs to guarantee the cleanliness and/or commercial sterility of the isolation chamber and of the web of packaging material.

[0008] Therefore, the typical automatic packaging apparatuses also comprise a sterilization apparatus arranged downstream of the molding apparatus and upstream of the isolation chamber so as to sterilize the packaging material.

[0009] It should be noted that the known sterilization apparatuses can be configured to sterilize the web of packaging material by means of chemical sterilization or by physical sterilization.

[0010] In the recent years, the Applicant has successfully established the use of the electron beam technology so as to sterilize the web of packaging material. While the sterilization of the flat web of packaging material by means of the electron beam technology is relatively easy, the situation becomes more challenging in the case of the presence of opening devices, which have been applied onto the web of packaging material. When sterilizing the web of packaging material being equipped with the opening devices, one may need to operate with rather high powers so as to obtain the desired sterility.

[0011] Thus, even though, the known packaging machine achieve excellent working results, a desire is felt in the sector to further improve the known packaging machines.

DISCLOSURE OF INVENTION

[0012] It is an object of the present invention to provide in a straightforward and low-cost manner an improved packaging machine having a molding apparatus.

[0013] It is a further object of the present invention, to provide in a straightforward and low-cost manner an improved method of forming packages filled with a pourable food product from a web of packaging material.

[0014] According to the present invention, there is provided a packaging machine as claimed in claim 1 and a method as claimed in claim 11.

[0015] Preferred non-limiting 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 drawings, in which:

Figure 1 is a schematic view of a packaging machine according to the present invention, with parts removed for clarity;

Figure 2 is a schematic lateral view of portions of the packaging machine of Figure 1, with parts removed for clarity; and

Figure 3 is an enlarged schematic view of a detail of the packaging machine of Figure 1, 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 of a pourable

food product such as pasteurized milk, fruit juice, wine, tomato sauce, emulsions, beverages with pulp etc.

[0018] Each packaging 2 may comprise a main body 3 and a molded portion 4, in particular an opening device, molded onto main body 3.

[0019] In particular, packaging machine 1 may produce packages 2, in particular the respective main bodies 3, from a web of packaging material 5.

[0020] In more detail, web of packaging material 5 may have a multilayer structure and may comprise 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.

[0021] Moreover, web of packaging material 5 may also comprise 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.

[0022] Additionally, web of packaging material 5 may also comprise 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.

[0023] Web of packaging material 5 may comprise a first face and a second face, in particular the first face being the face of web of packaging material 5 defining the inner face of the formed package 2 eventually contacting the filled pourable food product.

[0024] Preferentially, web of packaging material 5 may comprise a plurality of repeat units, in particular successively arranged (and equally spaced) with respect to one another along web of packaging material 5. In particular, each repeat unit may form the basis of one respective package 2. In other words, packaging machine 1 may be configured to produce packages 2 from web of packaging material 5 such that each package 2 results from one respective repeat unit.

[0025] In particular, each repeat unit may be defined by one respective pattern present on web of packaging material 5. Even more particular, the pattern is substantially identical for all repeat units and may also differ in minor details from the other ones - minor differences may e.g. be the presence of information tags indicating a production day, a production lot, personalized information or similar.

[0026] With particular reference to Figure 1, packaging machine 1 comprises:

- a conveying device 6 configured to advance web of packaging material 5 along a web advancement path P;
- a molding apparatus 7 arranged at a molding station 8 for molding molded portions 4, in particular the opening devices, onto web of packaging material 5;
- a sterilization apparatus 9 for sterilizing web of packaging material 5 and being arranged at a sterilization station 10 downstream of molding station 8 along web advancement path P;
- preferentially an isolation chamber 15 having an inner environment 16;
- preferentially a tube forming and sealing device 17 configured to form a tube 18 from the, in use, advancing web of packaging material 5 and to longitudinally seal tube 18 within inner environment 16 at a tube formation station 19 positioned downstream of sterilization station 10 along web advancement path P;
- preferentially a filling device 20 configured to fill tube 18 with the pourable food product; and
- preferentially a package apparatus unit 21 configured to at least form and transversally seal tube 18, preferentially to also transversally cut tube 18, for forming (sealed) packages 2.

[0027] The Applicant has seen that after termination of the molding process, molded portions 4 are clean and commercially sterile as a consequence of a number of factors including the high temperatures of plastic processing conditions needed during the molding process itself. Therefore, the Applicant wants to preserve (partially or in full) the cleanliness and/or sterility of molded portions 4 during advancement of web of packaging material 5 from molding station 8 to sterilization station 10.

[0028] Therefore, packaging machine 1 also comprises a preserving device 22 configured to preserve the cleanliness and/or sterility of molded portions 4, in particular opening devices, in particular after molding.

[0029] In particular, preserving device 22 is configured to preserve the cleanliness and/or sterility of molded portions 4, in particular opening devices, during advancement of web of packaging material 5 between molding station 8 and sterilization station 10.

[0030] In this way, one facilitates the operation of sterilization apparatus 9.

[0031] According to some preferred non-limiting embodiments, molding apparatus 7 molds at least one respective molded portion 4, in particular one respective opening device, onto each repeat unit of web of packaging material 3.

[0032] In particular, molding apparatus 7 is configured to mold molded portions 4 from a molten polymer.

[0033] In the most preferred embodiment, molding apparatus 7 molds opening devices onto web of packaging material 5.

[0034] In particular, each opening device may be configured to allow to access and/or to outpour, in particular after a manipulation of the opening device, the pourable food product packaged within the respective package 2. Preferentially, the manipulation of the opening device can be reversible or irreversible.

[0035] One example of an opening device is a lid-spout assembly, which comprises a spout and a lid, which is

configured to selectively close and open a pouring outlet of the spout. In order to access and/or outpour the pourable product from packages 2 being provided with such an opening device removal of the lid is required, which typically is reversible, meaning that the lid can be newly coupled to the spout.

[0036] Another example of an opening device is a strip, which can be removed from the respective package 2 for creating an outlet hole and/or for allowing to at least partially separating two portions of the respective package 2 from one another.

[0037] In further detail, molding apparatus 7 may comprise one or more molding units 11 each one configured to mold one or more molded portions 4, in particular one or more opening devices (at a time) onto web of packaging material 5, in particular onto at least one respective repeat unit.

[0038] According to some possible non-limiting embodiments, molding apparatus 7 may comprise one or more punching units configured to punch holes in web of packaging material 5, in particular prior to the operation of the one or more molding units 11. In other words, the punching unit may be arranged upstream of molding apparatuses 20 along web advancement path P.

[0039] In particular, the one or more molding units 11 may be configured to mold the molded portions 4, in particular the opening devices, onto web of packaging material 5 at the holes.

[0040] Advantageously, conveying device 6 may also be configured to advance tube 18 along a tube advancement path Q towards and at least partially through package forming apparatus 21.

[0041] In further detail, conveying device 6 may also be configured to advance tube 18 and any intermediate of tube 18 along tube advancement path Q. In particular, with intermediates of tube 18 any configuration of web of packaging material 5 is meant prior to obtaining the tube structure and after folding of web of packaging material 5 has been started. In other words, the intermediates of tube 18 are a result of a gradual folding of web of packaging material 5 so as to obtain tube 18, in particular by overlapping opposite lateral edges of web of packaging material 5 with one another.

[0042] Preferentially, conveying device 6 may also be configured to advance web of packaging material 5 at and/or within molding apparatus 7 intermittently.

[0043] Even more preferentially, conveying device 6 may be configured to intermittently advance and stop web of packaging material 5, and in particular each molding unit 11 may be configured to mold the respective molded portions 4 during a stop of web of packaging material 5.

[0044] Preferentially, conveying device 6 may be configured to intermittently advance web of packaging material 5 along a molding portion P1 of path P.

[0045] Advantageously, packaging machine 1 may also comprise a first buffer unit and a second buffer unit 24 arranged respectively upstream and downstream of molding station 8 along web advancement path P.

[0046] Preferentially, the buffer capacity of the first buffer unit and second buffer unit 24 can be (dynamically) varied.

[0047] Moreover, conveying device 6 may be configured to advance web of packaging material 5 to first buffer unit and withdraw web of packaging material 5 from second buffer unit 24 in a continuous manner.

[0048] In this way, one guarantees a continuous production of packages 2 while allowing an intermittent operation of molding apparatus 7.

[0049] With particular reference to Figure 1, isolation chamber 15 may be configured to protect inner environment 16 from an (hostile) outer environment.

[0050] Even more particular, isolation chamber 15 may be configured to allow for forming, longitudinally sealing and filling tube 18 in a sterile inner environment 16.

[0051] Preferentially, packaging machine 1 may also comprise a conditioning unit configured to define and control the atmosphere and conditions within inner environment 16. In particular, the conditioning unit may be configured to maintain and control sterility of inner environment 16. Additionally, the conditioning unit may also be configured to control temperature and/or humidity and/or pressure.

[0052] Moreover, the conditioning unit may also be configured to maintain sterility within inner environment 16.

[0053] Preferentially, prior to operation of packaging machine 1, inner environment 16 is subjected to a sterilization process, in particular a chemical and/or physical sterilization process, so as to establish sterility of inner environment 16. In particular, a sterilization-in-place (SIP) may be executed.

[0054] With particular reference to Figures 1 to 3, sterilization apparatus 9 may comprise an irradiation device 30 configured to direct a sterilizing irradiation, in particular electromagnetic irradiation, even more particular electron beam irradiation, onto the, in use, advancing web of packaging material 5. In particular, irradiation device 30 may be configured to direct the sterilizing irradiation onto the first face and the second face of web of packaging material 5.

[0055] In further detail, irradiation device 30 may comprise one or more e-beam emitters for emitting electron beam irradiation onto the, in use, advancing web of packaging material 5, in particular onto the first face and the second face.

[0056] More precisely, irradiation device 30 may comprise a pair of e-beam emitters, in particular a first e-beam emitter 31 and a second e-beam emitter 32. Moreover, first e-beam emitter 31 and second e-beam emitter 32 are spaced apparat from one another such that, in use, the advancing web of packaging material 5 advances between first e-beam emitter 31 and second e-beam emitter 32. In particular, first e-beam emitter 31 and second e-beam emitter 32 are arranged such to direct the electron beam irradiation onto respectively the first face

and the second face.

[0057] Alternatively, sterilization apparatus 9 could be configured to sterilize web of packaging material 5 by chemical sterilization.

[0058] Advantageously, sterilization apparatus 9 may comprise a housing 33 having an inlet opening 34 for receiving web of packaging material 5 to be sterilized and an outlet opening for allowing feeding out of the sterilized web of packaging material 5, preferentially into isolation chamber 15.

[0059] Preferentially, outlet opening may be adjacent to an inlet aperture of the isolation chamber 15 such that, in use, web of packaging material 5 exits, in use, sterilization apparatus 9 through the outlet opening and enters, in use, web of packaging material 5 through the inlet aperture.

[0060] In further detail and with particular reference to Figures 1 to 3, sterilization apparatus 9, preferentially housing 33, may comprise:

- an inlet chamber 35 configured to allow for introduction of the, in use, advancing web of packaging material 5 into sterilization apparatus 9; and
- preferentially a sterilization chamber 36 arranged downstream of inlet chamber 35 along web advancement path P; and
- even more preferentially an outlet chamber 37 arranged downstream of sterilization chamber 36 along web advancement path P.

[0061] Preferentially, sterilization apparatus 9 may be configured to sterilize web of packaging material 5 during advancement of web of packaging material 5 through sterilization chamber 36.

[0062] In more detail, irradiation device 30, in particular first e-beam emitter 31 and second e-beam emitter 32, may be placed within sterilization chamber 36.

[0063] According to some preferred non-limiting embodiments, sterilization apparatus 9, preferentially housing 33, may also comprise a sterilization channel 38 arranged within sterilization chamber 36. In use, during advancement of web of packaging material 5 through sterilization chamber 36, in particular sterilization channel 38, sterilization apparatus 9, preferentially irradiation device 30, may sterilize web of packaging material 5.

[0064] Preferentially, sterilization channel 38 may be in fluidic connection with inlet chamber 35 and outlet chamber 37.

[0065] Preferentially, sterilization channel 38 may be interposed between first e-beam emitter 31 and second e-beam emitter 32.

[0066] According to some preferred non-limiting embodiments, inlet chamber 35 and sterilization chamber 36 may be connected to one another.

[0067] Preferentially, outlet chamber 37 may be connected to sterilization chamber 36.

[0068] In use, web of packaging material 5 advances from inlet chamber 35 into sterilization chamber 36, and preferentially from sterilization chamber 36 into outlet chamber 37.

[0069] Moreover, in use, when web of packaging material 5 advances within sterilization chamber 36, web of packaging material 5 advances through sterilization channel 38.

[0070] Preferentially, inlet chamber 35 may comprise inlet opening 34.

[0071] Preferentially, outlet chamber 37 may comprise the outlet opening.

[0072] With particular reference to Figure 1, packaging machine 1 may comprise a further housing delimiting an inner space within which molding apparatus 7 is arranged and within which web of packaging material 5 advances, in use, between at least molding station 8 and sterilization station 10.

[0073] According to some preferred non-limiting embodiments, packaging machine 1, preferentially the housing, may comprise at least one advancement channel 41 within, which in use, web of packaging material 5 may advance. Preferentially, advancement channel 41 may be arranged upstream of (with respect to web advancement path P) and may be connected to sterilization apparatus 9, preferentially inlet chamber 35.

[0074] Additionally, advancement channel 41 may be arranged downstream (with respect to web advancement path P) of molding apparatus 7.

[0075] Preferentially, advancement channel 41 may extend between molding apparatus 7 and sterilization apparatus 9. In particular, web of packaging material 5 advances, in use, through advancement channel 41 after molding of molded portions 4.

[0076] Even more preferentially, in use, web of packaging material 5 may advance from molding apparatus 7 to sterilization apparatus 9 through advancement channel 41.

[0077] Preferentially, advancement channel 41 may delimit a portion of the inner space.

[0078] Advantageously, preserving device 22 comprises at least one at air flow generator 39, e.g. having and/or being defined by a blowing unit, configured to generate a first flow F1 of a sterile fluid, in particular of a sterile gas such as sterile air, and direct the flow of sterile fluid against at least a portion of web of packaging material 5 while web of packaging material 5 advances between molding station 8 and sterilization station 10.

[0079] Preferentially, the portion of web of packaging material 5 which receives the first flow F1 of sterile fluid is intended with regard to the relative position between molding station 8 and sterilization station 10.

[0080] In particular, by providing for air flow generator 39 and the generation of the first flow F1 of sterile fluid against web of packaging material 5, one achieves that the deposition of possible contaminations on web of packaging material 5 and molded portions 4 is hampered, which again renders the sterilization by means of sterilization apparatus 9 easier.

[0081] In particular, the inner space is not a sterile

space; i.e. the inner space is not part of inner environment 16.

[0082] According to some possible non-limiting embodiments, preserving device 22 may comprise more than one at least one air flow generator 39, each one configured to generate a respective first flow F1 of a sterile fluid, in particular of a sterile gas such as sterile air, against at least a portion of web of packaging material 5 while advancing along a respective portion of web advancement path P and between molding station 8 and sterilization station 10.

[0083] Preferentially, each at least one air flow generator 39 may be configured to introduce the respective first flow F1 of sterile fluid into advancement channel 41.

[0084] More specifically, each at least one air flow generator 39 may be positioned at a respective position different from the position of the other at least one air flow generators 39 so as to direct the respective flow of sterile fluid onto different portions of web of packaging material 5. In particular, each at least one air flow generator 39 may be arranged at respective positions along web advancement path P between molding station 8 and sterilization station 10, in particular such that one or more at least one air flow generators 39 may be placed at upstream positions between molding station 8 and sterilization station 10 and with regard to web advancement path P and one or more other at least one air flow generators 39 may be positioned at downstream positions between molding station 8 and sterilization station 10 and with regard to web advancement path P (i.e. one or more at least one air flow generators 39 may be arranged upstream of one or more other at least one air flow generators 39).

[0085] Preferentially, the at least one first flow F1 of sterile fluid and/or the plurality of first flows F1 of sterile fluid may be directed onto the first face and the second face of web of packaging material 5. This allows to preserve the cleanliness and/or sterility of the respective zones of molded portions 4 which are assessable from the first face and the second face, respectively.

[0086] According to some possible embodiments, each at least one air flow generator 39 may also be configured to generate two respective first flows F1 of sterile fluid. Thereby, a first first flow F1 of sterile fluid and a second first flow F1 of sterile fluid may be directed towards the first face and the second face, respectively.

[0087] According to some preferred non-limiting embodiments, each at least one air flow generator 39 may be configured to generate a first flow F1 of sterile fluid in a direction D1 transversal to and/or opposite to an advancement direction D2 of web of packaging material 5. In particular, each advancement direction D2 is the respective direction of advancement of web of packaging material 5 at the respective portion onto which the respective first flow F1 of sterile fluid is directed onto.

[0088] It should be noted that advancement direction D2 may locally vary and accordingly, the respective directions D1 of at least one air flow generators 39 may differ from one another in dependence of the local advancement direction D2.

[0089] In a most preferential embodiment, each at least one air flow generator 39 may be configured to generate the first flow F1 of sterile fluid such that the respective direction D1 is opposite to advancement direction D2.

[0090] It may be possible that an angle defined between directions D1 and the respective advancement directions D2 may vary. In other words, at least one air flow generators 39 may be configured such that at least one or more at least one air flow generators 39 may generate the respective first flow F1 of sterile fluid such that the angle defined with the respective advancement directions D2 may vary with regard to the respective angles defined by the respective first flows F1 of sterile fluid and the respective advancement directions D2 of other at least one air flow generators 39.

[0091] According to some preferred non-limiting embodiments, at least one of the at least one air flow generators 39 may be configured to also generate a second flow F2 of sterile fluid into a second direction D3 opposite to the respective first flow F1 of sterile fluid and/or opposite to the respective first direction D1 and/or substantially parallel and/or parallel to advancement direction D2.

[0092] Moreover, the at least one at least one air flow generator 39 is configured such that the second flow F2 of sterile fluid is directed into the sterilization apparatus 9, preferentially into inlet chamber 35.

[0093] It should be noted that substantially parallel means that second direction D3 may deviate from advancement direction D2, but still both web of packaging material 5 and the second flow F2 of sterile fluid are directed towards and into sterilization apparatus 9, preferentially inlet chamber 35.

[0094] In more detail, the at least one at least one air flow generator 39 may be configured to introduce the respective first flow F1 of sterile fluid and the respective second flow F2 of sterile fluid into advancement channel 41, preferentially at an inlet station 42.

[0095] Moreover, the respective second flow F2 of sterile fluid may be from advancement channel 41, preferentially inlet station 42, into sterilization apparatus 9, preferentially inlet chamber 35.

[0096] According to some preferred non-limiting embodiments, inlet station 42 may be adjacent to sterilization apparatus 9, in particular inlet chamber 35. Preferentially, meaning that inlet station 42 is closer to sterilization apparatus 9, in particular inlet chamber 35, than to molding apparatus 7 and such that the respective second flow F2 of sterile fluid can reach and enter sterilization apparatus 9, in particular inlet chamber 35.

[0097] According to some preferred non-limiting embodiments, the preserving device 22 may also be configured to control:

- a first pressure p1 within advancement channel 41, preferentially at least at inlet station 42;
- a second pressure p2 within inlet chamber 35; and

- preferentially a third pressure p3 within outlet chamber 37.

[0098] Preferentially, preserving device 22 may be configured to control first pressure p1 to be larger than second pressure p2. In other words, preserving device 22 may be configured to control a first pressure difference between first pressure p1 and second pressure p2 to be larger than 0 Pa.

[0099] According to some possible non-limiting embodiments, preserving device 22 may be configured to control the first pressure difference to be smaller than 3 Pa, preferentially smaller than 2 Pa, even more preferentially equal to 1 Pa.

[0100] According to some possible non-limiting embodiments, preserving device 22 may be configured to control the first pressure difference to equal or to be larger than 1 Pa.

[0101] According to some possible embodiments, preserving device 22 may be configured to control first pressure p1 to range between 15 Pa to 25 Pa, preferentially 18 Pa to 22 Pa, even more preferentially 19 Pa to 21 Pa, above ambient pressure.

[0102] According to some possible embodiments, the preserving device may be configured to control third pressure p3 to be larger than first pressure p1; i.e. a second pressure difference between third pressure p3 and first pressure p1 may be larger than 0 Pa.

[0103] Preferentially, preserving device 22 may be configured to control the second pressure difference to be larger than 3 Pa, preferentially larger than 4 Pa, even more preferentially larger than 5 Pa.

[0104] According to some example embodiments, the second pressure difference may equal 5 Pa.

[0105] According to some possible non-limiting embodiments, the conditioning unit may be configured to control a fourth pressure p4 within isolation chamber 15.

[0106] Preferentially, operation of the conditioning unit and of preserving device 22 may be executed in a coordinated manner and/or a complementary manner.

[0107] According to some possible embodiments, preserving device 22 and conditioning unit may define a conditioning apparatus configured to control first pressure p1 and/or second pressure p2 and/or third pressure p3 and/or fourth pressure p4 and/or conditions within inlet chamber 35 and/or sterilization chamber 36 and/or outlet chamber 37 and/or isolation chamber 15.

[0108] According to some possible non-limiting embodiments, fourth pressure p4 may be larger than third pressure p3 and/or first pressure p1.

[0109] Preferentially, a third pressure difference between fourth pressure p4 and first pressure p1 may be larger than 150 Pa, preferentially larger than 180 Pa, even more preferentially may equal or may be larger than 200 Pa.

[0110] In particular, by having p1 > p2 it is possible to guarantee the correct orientation of second direction D3. Additionally, by having p1 < p4 and p1 <p3 one obtains a desired flow of gases within sterilization apparatus 9.

[0111] Moreover, by having p4 > p3 one guarantees that no flow of gases from sterilization apparatus 9 into isolation chamber 15 may occur.

[0112] According to some possible embodiments, advancement channel 41 and/or inlet chamber 35 may comprise one or more outlets 43 configured to allow for an outflow of fluids (e.g. gases) from respectively advancement channel 41 and inlet chamber 35.

[0113] According to some possible non-limiting embodiments, preserving device 22 may also comprise one or more disinfection units for disinfecting at least portions, in particular the molded portions 4, of web of packaging material 5 while advancing between molding station 8 and sterilization station 10.

[0114] Disinfection unit may comprise one or more UV-light emitters.

[0115] In more detail and with reference to Figure 1, tube forming and sealing device 17 may comprise at least two forming ring assemblies 45, in particular arranged within inner environment 16, being configured to gradually fold in cooperation with one another web of packaging material 5 into tube 18, in particular by overlapping the edges of web of packaging material 5 with one another.

[0116] Additionally, tube forming and sealing device 17 may comprise a sealing head 46, in particular arranged within inner environment 16 and, configured to longitudinally seal tube 18.

[0117] Additionally, filling device 20 may comprise a filling pipe 47 being configured to direct, in use, the pourable product into tube 18. In particular, filling pipe 47 may, in use, be at least partially placed within tube 18 for feeding, in use, the pourable product into tube 18.

[0118] Moreover, package forming apparatus 21 may comprise:

- a plurality of forming and sealing assemblies, each one configured to at least form (shape) tube 18, to transversally seal tube 18, and in particular to also transversally cut tube 18; and
- a conveying unit so as to advance the forming and sealing assemblies.

[0119] In particular, package forming apparatus 12 may be configured to control the forming and sealing assemblies and the conveying unit such to transversally seal and cut tube 18 along equally spaced transversal cross sections.

[0120] In use, packaging machine 1 produces packages 2 of a pourable food product. In particular, packaging machine 1 forms tube 18 from web of packaging material 5, longitudinally seals tube 18, fills tube 18 with the pourable product and forms, transversally seals and transversally cuts tube 18 so as to obtain packages 2.

[0121] Prior to the formation of tube 18 from web of packaging material 5, web of packaging material 5 is sterilized by sterilization apparatus 9.

[0122] Additionally, prior to the sterilization, molding

apparatus 7 molds molded portions 4, in particular the opening devices, onto web of packaging material 5, in particular the respective repeat units.

[0123] In more detail, operation of packaging machine 1 comprises the following steps:

- advancing, in particular by means of conveying device 6, web of packaging material 5 along web advancement path P;
- molding, in particular by means of molding apparatus 7, molded portions 4 onto web of packaging material 5 at molding station 8;
- sterilizing, in particular by means of sterilization apparatus 9, web of packaging material 5 at sterilization station 10;
- forming, in particular by means of tube forming and sealing device 17, tube 18 from the, in use, advancing web of packaging material 5 within inner environment 16;
- longitudinally sealing tube 18, in particular by means of tube forming and sealing device 17, within inner environment 16;
- filling tube 18, in particular by means of filling device 20, with the pourable food product;
- producing, in particular by means of package forming apparatus 21, packages 2 from tube 18 by forming, transversally sealing and transversally cutting tube 18; and
- preserving the cleanliness and/or sterility of the molded portions 4.

[0124] Additionally, operation of packaging machine 1 may also comprise the step of conveying tube 18 along tube advancement path Q.

[0125] Preferentially, operation of packaging machine 1 may also comprise a first step of buffering, executed by first buffer unit and a second step of buffering executed by second buffer unit 24.

[0126] During the step of preserving, the first flow F1 of sterile fluid is directed against at least a portion, in particular at least against the molded portions 4, of web of packaging material 5 while web of packaging material 5 advances between molding station 8 and sterilization station 10. In particular, the first flow F1 of sterile fluid may be generated by the at least one at least one air flow generator 39.

[0127] Preferentially, during the step of preserving, a plurality of first flow F1s of a sterile fluid are generated. In particular, each at least one air flow generator 39 generates one respective first flow F1 of sterile fluid.

[0128] Moreover, each first flow F1 of sterile fluid, in particular as generated by the respective at least one air flow generators 39, may be directed against a respective portion distinct from the other portions of web of packaging material 5 while web of packaging material 5 advances along a respective portion of web advancement path P and while web of packaging material 5 advances between molding station 8 and sterilization station 10.

[0129] Preferentially, during the step of preserving, each first flow F1 of sterile fluid is such that the respective directions D1 are transversal to and/or opposite to the respective advancement direction D2 of the web of packaging material 5 (in particular at the specific location).

[0130] Additionally, each first flow F1 of sterile air may be directed onto one of the first face and the second face or onto both the first face and the second face. Preferentially, the overall first flow F1s of sterile air are such that at least one first flow F1 of sterile air is directed onto the first face and at least one first flow F1 of sterile air is directed onto the second face.

[0131] According to some preferred non-limiting embodiments, during the step of preserving, the one or more first flow(s) F1 of sterile fluid is/are directed into advancement channel 41.

[0132] According to some possible non-limiting embodiments, during the step of preserving, a sub-step of disinfecting may be executed during which at least portions, in particular molded portions 4, of web of packaging material 5 are disinfected while web of packaging material 5 advances between molding station 8 and sterilization station 10.

[0133] In particular, during the sub-step of disinfecting a UV-irradiation is directed onto web of packaging material 5, in particular onto the first face and/or the second face.

[0134] According to some possible embodiments, operation of packaging machine 1 may also comprise the step of generating the second flow F2 of a sterile fluid, preferentially by one respective at least one air flow generator 39. In particular, the second flow F2 of sterile fluid is in second direction D3 opposite to first direction D1 and/or substantially parallel to advancement direction D2. Moreover, the second flow F2 of sterile fluid is into the sterilization apparatus 9, preferentially inlet chamber 35.

[0135] Preferentially, the step of generating and the step of preserving may be executed simultaneously.

[0136] In more detail, the respective first flow F1 of sterile fluid and the respective second flow F2 of sterile fluid, preferentially of the at least one at least one air flow generator 39, may be introduced into advancement channel 41, preferentially at inlet station 42.

[0137] Preferentially, the second flow F2 of sterile fluid may be from advancement channel 41 into sterilization apparatus 9, preferentially inlet chamber 35.

[0138] According to some possible embodiments, operation of packaging machine 1 may also comprise the steps of:

- controlling first pressure p1, during which first pressure p1 is controlled within advancement channel 41; and/or
- controlling second pressure p2, during which second pressure p2 is controlled within inlet chamber 35; and/or
- controlling third pressure p3, during which third pres-

sure p3 is controlled within outlet chamber 37; and/or

- controlling fourth pressure p4, during which fourth pressure p4 is controlled within isolation chamber 15.

[0139] Preferentially, the steps of controlling first pressure p1 and/or controlling second pressure p2 and/or controlling third pressure p3 may be executed by means of the preserving device.

[0140] Preferentially, the step of controlling fourth pressure p4 may be executed by means of the conditioning unit.

[0141] In more detail, during the step of advancing, web of packaging material 5 is intermittently advanced at molding station 8 and/or within molding apparatus 7.

[0142] In particular, during the step of advancing, web of packaging material 5 is intermittently advanced between first buffer unit and second buffer unit 24.

[0143] Moreover, during the step of advancing, web of packaging material 5 is advanced along web advancement path P.

[0144] In more detail, during the step of molding, molding apparatus 7 molds molded portion 4, in particular the opening devices, onto web of packaging material 3.

[0145] In particular, during the step of molding, advancement of web of packaging material 5 at molding station 8 and/or within molding apparatus 7 is on halt.

[0146] In more detail, during the step of sterilizing, the sterilizing irradiation, in particular the electromagnetic irradiation, even more particular the electron beam irradiation, is directed onto web of packaging material 5, in particular onto the first face and the second face.

[0147] Advantageously, during the step of sterilizing, web of packaging material 5 advances through sterilization apparatus 9, in particular through sterilization chamber 36, even more particular through sterilization channel 38.

[0148] Preferentially, web of packaging material 5 advances through inlet chamber 35 and into sterilization chamber 36. Even more preferentially, web of packaging material 5 advances from sterilization chamber 36 to outlet chamber 37. Finally, web of packaging material 5 may advance out of outlet chamber 37 and into isolation chamber 15.

[0149] The advantages of packaging machine 1 and/or the method according to the present invention will be clear from the foregoing description.

[0150] In particular, by having preserving device 22 it is possible to maintain cleanliness and/or sterility of molded portions 4 or to at least reduce the contamination following the molding process as much as possible. This permits to facilitate the operation of the sterilization process.

[0151] Such a solution is of particular advantage in the case when sterilization apparatus 9 relies on sterilization by means of a sterilizing irradiation. This allows to operate at lower energies, which means a longer lifetime and lower energy consumption.

[0152] Another advantage resides in that the sterilization of molded portions 4 having a more complex geometry than a flat shape is rendered more efficient and/or easier.

[0153] An even other advantage is the possibility of controlling the atmosphere within sterilization apparatus 9.

[0154] Clearly, changes may be made to packaging machine 1 or the method as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

Claims

1. Packaging machine (1) for forming packages (2) filled with a pourable product from a web of packaging material (5);

the packaging machine (1) comprises:

- a conveying device (6) configured to advance the web of packaging material (5) along a web advancement path (P);
- a molding apparatus (7) arranged at a molding station (8) for molding molded portions (4) onto the web of packaging material (5);
- a sterilization apparatus (9) for sterilizing the web of packaging material (5) and being arranged at a sterilization station (10) downstream of the molding station (8) along the web advancement path (P); and
- a preserving device (22) configured to preserve the cleanliness and/or sterility of at least the molded portions (4) ;

wherein the preserving device (22) comprises at least one air flow generator (39) configured to generate:

- a first flow (F1) of a sterile fluid against at least a portion of the web of packaging material (5) while the web of packaging material (5) advances, in use, between the molding station (8) and the sterilization station (10) and in a first direction (D1) transversal to and/or opposite to an advancement direction (D2) of the web of packaging material (5); and
- a second flow (F2) of sterile fluid in a second direction (D3) opposite to the first direction (D1) and/or substantially parallel to the advancement direction (D2);

wherein the at least one air flow generator (39) is also configured to direct the second flow (F2) of sterile fluid into the sterilization apparatus (9).

2. Packaging machine according to claim 1, comprising an advancement channel (41) for the web of packaging material (5) arranged upstream from and being connected to the sterilization apparatus (9);

wherein the at least one air flow generator (39) is configured to introduce the first flow (F1) of sterile fluid and the second flow (F2) of sterile fluid into the advancement channel (41);
wherein the second flow (F2) of sterile fluid is from the advancement channel (41) into the sterilization apparatus (9).

3. Packaging machine according to claim 2, wherein the at least one air flow generator (39) is configured to introduce the first flow (F1) of sterile fluid and the second flow (F2) of sterile fluid into the advancement channel (41) at an inlet station (42) adjacent to the sterilization apparatus (9).

4. Packaging machine according to any one of the preceding claims, wherein the sterilization apparatus (9) comprises:

- an inlet chamber (35) through which the web of packaging material (5) enters, in use, into the sterilization apparatus (9); and
- a sterilization chamber (36) arranged downstream from the inlet chamber (35) along the advancement direction (D2) of the web of packaging material (5) and being connected to the inlet chamber (35);
wherein the sterilization apparatus (9) is configured to sterilize the web of packaging material (5) during advancement of the web of packaging material (5) through the sterilization chamber (36);
wherein the at least one air flow generator (39) is configured to direct the second flow (F2) of sterile fluid into the inlet chamber (35).

5. Packaging machine according to claim 4 and when depending on claim 2 or 3, wherein the preserving device (22) is configured to control a first pressure (p1) within the advancement channel (41) and a second pressure (p2) within the inlet chamber (35);
wherein the preserving device (22) is configured to control the first pressure (p1) to be larger than the second pressure (p2).

6. Packaging machine according to claim 5, further comprising an outlet chamber (37) arranged downstream from the sterilization chamber (36) along the advancement direction (D2) of the web of packaging material (5);
wherein the preserving device (22) is configured to control a third pressure (p3) larger than the first pressure (p1) within the outlet chamber (37).

7. Packaging machine according to any one of the preceding claims, wherein the preserving device (22) also comprises a disinfection unit (40) for disinfecting the web of packaging material (5) while advancing between the molding station (8) and the sterilization station (10).

8. Packaging machine according to claim 7, wherein the disinfection unit (40) comprises a UV-light emitter.

9. Packaging machine according to any one of the preceding claims, wherein the sterilization apparatus (9) comprises an irradiation device (30) configured to direct a sterilizing irradiation onto the, in use, advancing web of packaging material (5).

10. Packaging machine according to claim 9, wherein the irradiation device (30) comprises one or more e-beam emitters (31, 32) for emitting electron beam irradiation onto the, in use, advancing web of packaging material (5).

11. Packaging machine according to any one of the preceding claims, wherein the molding apparatus (7) comprises a plurality of molding units (11) configured to simultaneously mold molded portions (4) onto different sections of the web of packaging material (5).

12. Packaging machine according to any one of the preceding claims, further comprising:

- an isolation chamber (15) having an inner environment (16) ;
- a tube forming and sealing device (17) configured to form a tube (18) from the, in use, advancing web of packaging material (5) within the inner environment (16) at a tube formation station arranged downstream of the and to longitudinally seal the tube (4) within the inner environment;
- a filling device (20) for filling the tube (18) with the pourable product; and
- a package forming apparatus (21) configured to form, to transversally seal and to transversally cut the, in use, advancing tube (18) for forming the packages (2).

13. Method for forming packages (2) filled with a pourable food product from a web of packaging material (5);
the method comprises the step of:

- advancing the web of packaging material (5) along a web advancement path (P);
- molding molded portions (4) onto the web of packaging material (5) at a molding station (8);
- sterilizing the web of packaging material (5) at

a sterilization station (10) and by means of a sterilization apparatus (9), the sterilization station (10) being arranged downstream of the molding station (8) along the web advancement path (P); and

- preserving the cleanliness and/or sterility of the molded portions (4);

wherein during the step of preserving a first flow (F1) of a sterile fluid is directed against at least a portion of the web of packaging material (5) while advancing between the molding station (8) and the sterilization station (10); wherein the first flow (F1) of the sterile fluid is directed in a direction (D1) transversal to and/or opposite to an advancement direction (D2) of the web of packaging material (5) ;

the method further comprises the step of generating a second flow (F2) of sterile fluid in a second direction (D3) opposite to the first direction (D1) and/or substantially parallel to the advancement direction (D2);

wherein the second flow (F2) of sterile fluid is directed into the sterilization apparatus (9);

wherein the step of generating and the step of preserving are executed simultaneously.

14. Method according to claim 13, wherein during the step of preserving and the step of generating, the first flow (F1) of sterile fluid and the second flow (F2) of sterile fluid are introduced into an advancement channel (41) within which the web of packaging material (5) advances and being arranged upstream from and being connected to the sterilization apparatus (9);

wherein the second flow (F2) of sterile fluid is from the advancement channel (41) into the sterilization apparatus (9).

15. Method according to claim 14, further comprising the steps of

- controlling a first pressure (p1), during which a first pressure (p1) is controlled within the advancement channel (41); and
- controlling a second pressure (p2), during which a second pressure (p2) is controlled within an inlet chamber (35) of the sterilization apparatus (9);

wherein the first pressure (p1) is larger than the second pressure (p2).

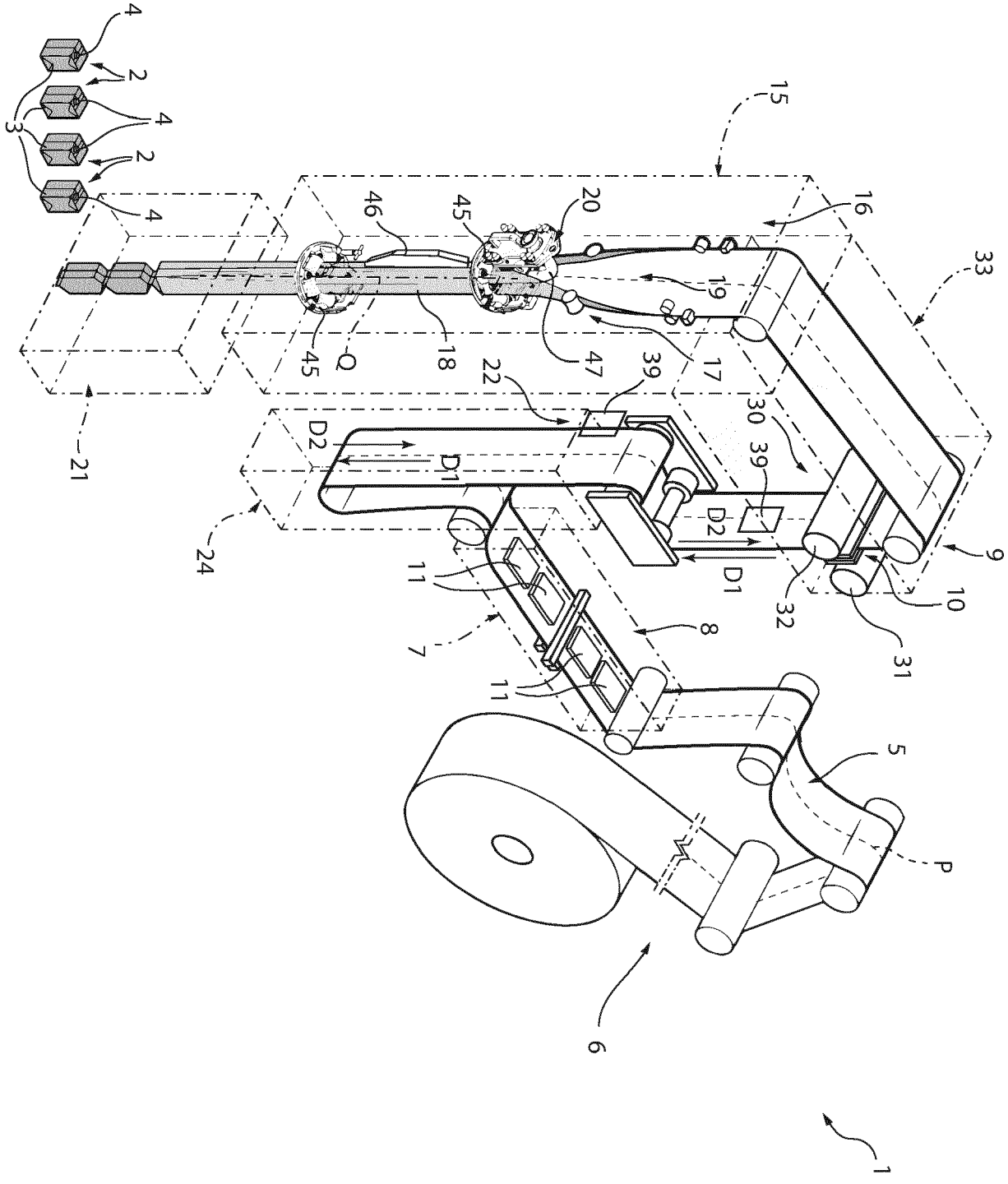
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Fig. 1

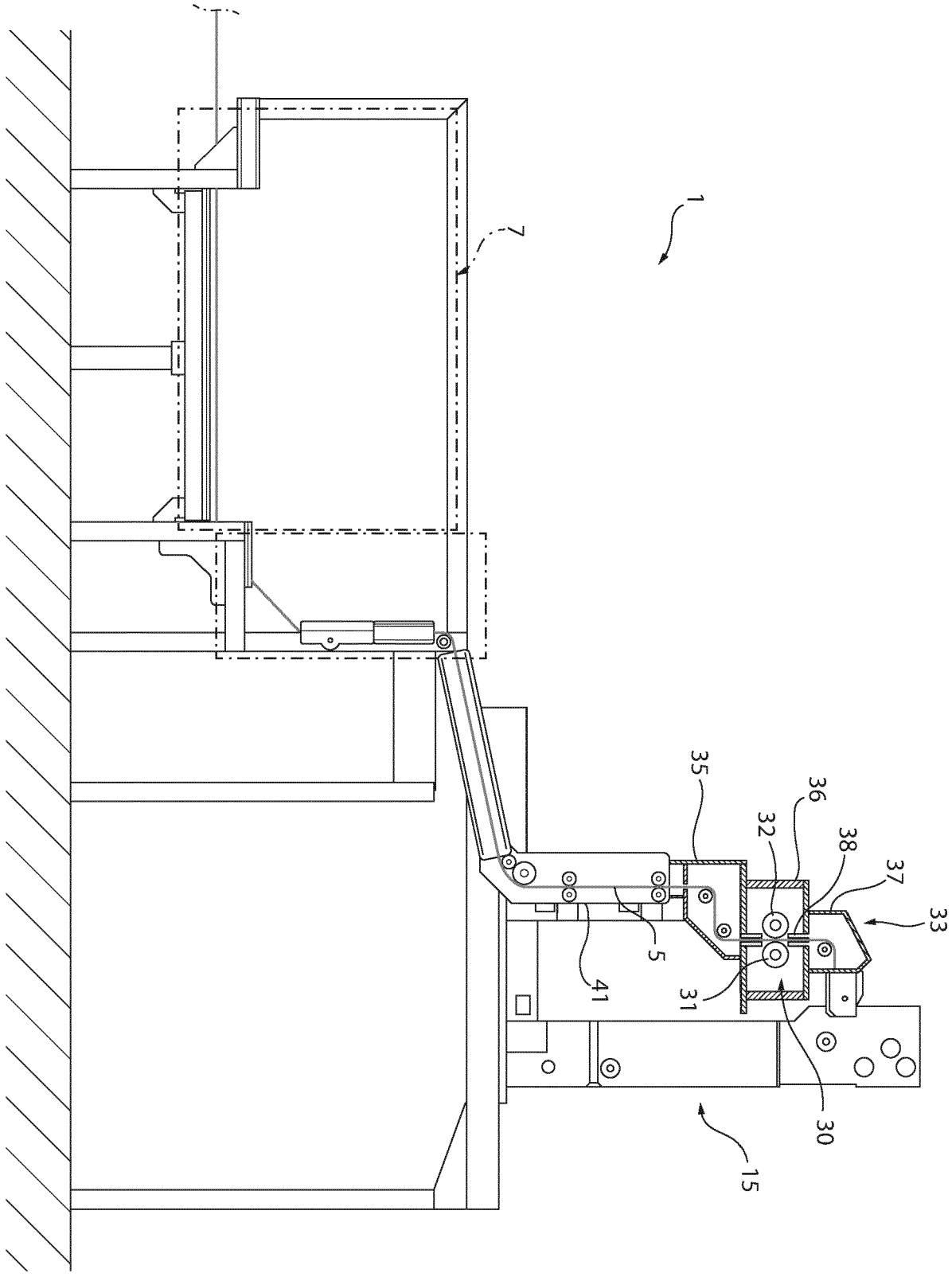

Fig. 2

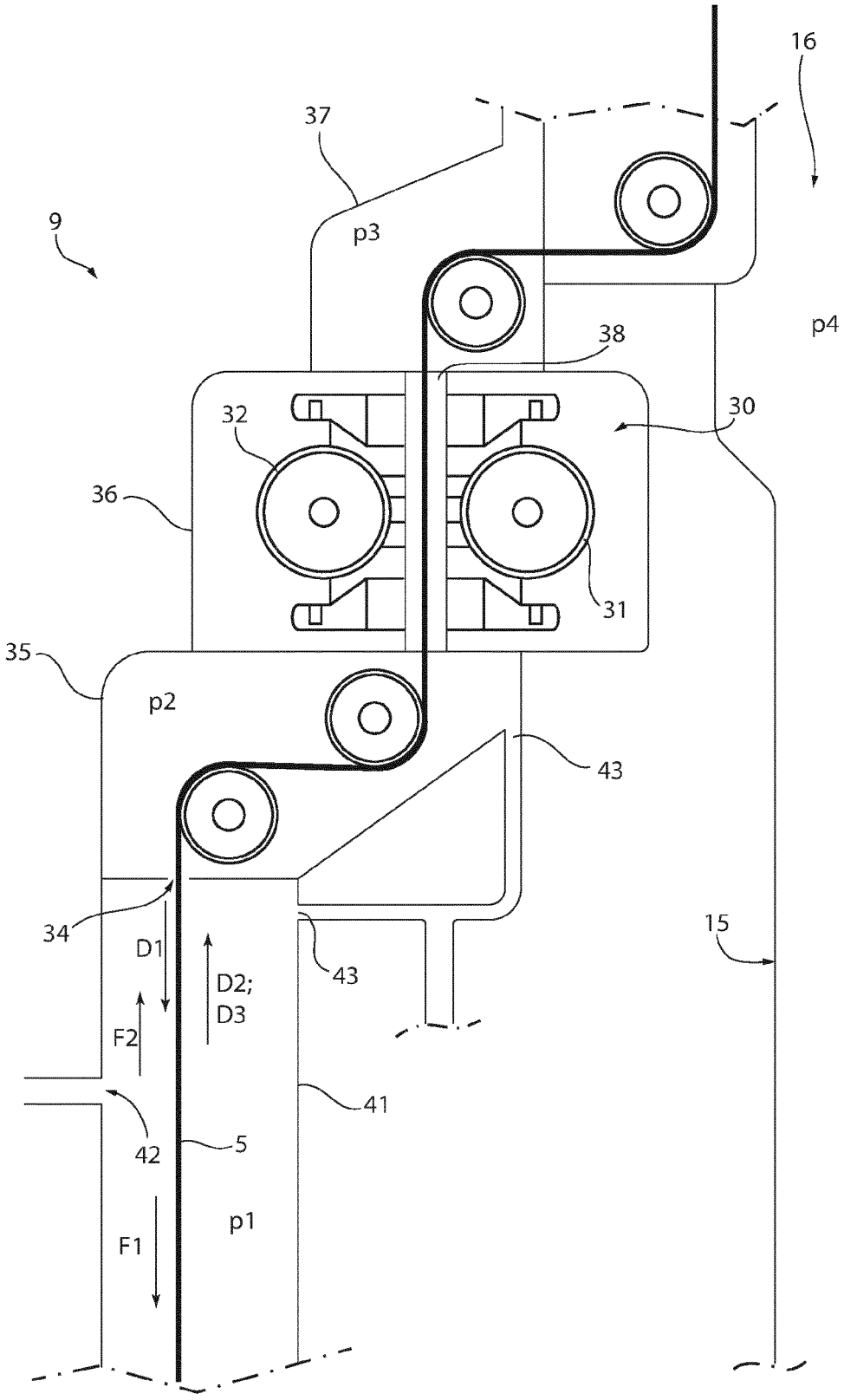

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 3887

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B65B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 January 2024	Damiani, Alberto

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