

(19)



(11)

EP 4 538 219 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.04.2025 Bulletin 2025/16

(51) International Patent Classification (IPC):
B67B 3/26 (2006.01) **B65B 7/28** (2006.01)
B65B 57/04 (2006.01) **B65B 61/18** (2006.01)

(21) Application number: **24192286.3**

(52) Cooperative Patent Classification (CPC):
B67B 3/264; B65B 7/2807; B65B 57/04;
B65B 61/186

(22) Date of filing: **01.08.2024**

(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:
GE KH MA MD TN

(72) Inventors:
• **SGRO', Roberto**
41123 Modena (IT)
• **MONTORSI, Maurizio**
41123 Modena (IT)

(74) Representative: **Tetra Pak - Patent Attorneys SE**
AB Tetra Pak
Patent Department
Ruben Rausinga gata
221 86 Lund (SE)

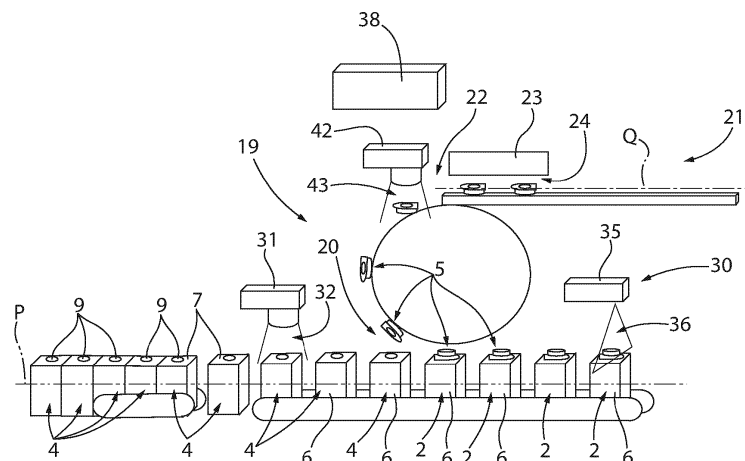
(30) Priority: **09.10.2023 IT 202300020940**

(71) Applicant: **Tetra Laval Holdings & Finance S.A.**
1009 Pully (CH)

(54) **INSPECTION APPARATUS FOR A CAPPING APPARATUS, CAPPING APPARATUS HAVING AN INSPECTION APPARATUS, PACKAGING MACHINE, METHOD OF INSPECTING CAPS AND METHOD OF APPLYING CAPS**

(57) There is described an inspection apparatus (30) for inspecting opening devices (5) applied to main bodies (4) advancing along an advancement path (P). The inspection apparatus (30) comprises a first imaging device (31) positioned at a first inspection station (32) and configured to acquire a first image (33) of an imaging portion (34) of the main body (4), the imaging portion (34) having a designated pour opening area (9) of each main body (4), a second imaging device (35) positioned at a second inspection station (36) arranged downstream from the

first inspection station (32) and configured to acquire at least one second image (37) of the respective opening device (4) applied to the respective inspection portion (34) and an analyzing unit (38) configured to analyze each first image (33) and the respective second image (38) and to determine a relative position between each opening device (5) and the respective designated pour opening area (9) from the analysis of each first image (33) and the respective second image (37).

**FIG.2**

Description

TECHNICAL FIELD

[0001] The present invention relates to an inspection apparatus for a capping apparatus.

[0002] Advantageously, the present invention also relates to a capping apparatus for applying opening devices onto main bodies of packages filled with a pourable product, preferentially packages formed from a multilayer packaging material.

[0003] Advantageously, the present invention also relates to a packaging machine for the packaging of pourable products, more specifically pourable food products, into packages, preferentially packages formed from a multilayer packaging material, and having at least one capping apparatus.

[0004] Advantageously, the present invention also relates to a method of inspecting packages having caps applied to respective main bodies.

[0005] Advantageously, the present invention also relates to a method of applying caps onto main bodies of packages.

BACKGROUND ART

[0006] 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, in particular sealed packages, made of sterilized packaging material.

[0007] A typical example is the parallelepiped-shaped package for pourable food products known as Tetra Brik Aseptic (registered trademark), which is made by sealing and folding a laminated strip of packaging material. The packaging material has a multilayer structure comprising a carton and/or paper base layer, covered on both sides with layers of heat-seal plastic material, e.g. polyethylene. In the case of aseptic packages for long-storage products, the packaging material also comprises a layer of oxygen-barrier material, 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.

[0008] Packages of this sort are normally produced on fully automatic packaging machines, which form and fill the packages starting from a multilayer packaging material.

[0009] Some packaging machines are configured to produce packages comprising a main body formed from the multilayer packaging material and an opening device arranged about a designated pour opening of the main body. The opening device is configured to allow for selectively opening and closing the pouring outlet. A typical opening device comprises a base frame connected to the main body, a collar extending from the base frame and being arranged about the pouring outlet and a

cap secured to the collar and being controllable between a closing position and an opening position.

[0010] Some packaging machines for producing packages having respective opening devices comprise a package forming machine configured to form and fill at least the respective main bodies from the multilayer packaging material and a capping apparatus configured to apply the opening device to the respective main body.

[0011] Some known capping apparatuses comprise a conveying device for advancing the main bodies along an advancement path, a feeding device for feeding the opening devices to a transfer station and through a gluing station at which an adhesive is applied onto the opening devices and one or more application device configured to receive the opening devices at the transfer station and to apply the opening devices onto the main bodies at an application station.

[0012] Even though the known capping apparatuses and/or packaging machines operate satisfyingly well, a desire for further improvements is felt in the sector.

DISCLOSURE OF INVENTION

[0013] It is therefore an object of the present invention to provide an improved inspection apparatus allowing to inspect the opening devices applied onto the main bodies.

[0014] It is therefore another object of the present invention to provide an improved capping apparatus.

[0015] It is a further object of the present invention to provide an improved packaging machine.

[0016] It is an even further object of the present invention, to provide an improved method of inspection.

[0017] Moreover, it is an object of the present invention, to provide an improved method of applying caps.

[0018] According to the present invention, there are provided an inspection apparatus and a method for inspecting the application of caps according to the respective independent claims.

[0019] Preferred embodiments of the inspection apparatus and the method are claimed in the claims being directly or indirectly dependent on the respective independent claims.

[0020] According to the present inventions, there is also provided a capping apparatus according to any one of claims 8 and 9.

[0021] According to the present invention, there is also provided a packaging machine according to claim 12.

[0022] According to the present invention, there is also provided a method according to any one of claims 13 to 16.

[0023] According to the present invention, there is also provided a method according to claim 17.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] A non-limiting embodiment of the present invention will be described by way of example with refer-

ence to the accompanying drawings, in which:

Figure 1 is a schematic view of a packaging machine having at least one capping apparatus, with parts removed for clarity;

Figure 2 is a schematic view of the capping apparatus of Figure 1, with parts removed for clarity;

Figures 3A and 3B are schematic top views of a portion of a main body prior (Figure 3A) and after (Figure 3B) the application of the opening device onto the main body.

BEST MODES FOR CARRYING OUT THE INVENTION

[0025] Number 1 indicates as a whole a packaging machine for producing packages 2 filled with a pourable product, in particular a pourable food product, such as (pasteurized) milk, fruit juice, wine, tomato sauce, salt, sugar, emulsions, yoghurt, milk drinks etc.

[0026] Packaging machine 1 may be configured to produce packages 2 filled with the pourable product.

[0027] In more detail, packaging machine 1 may be configured to produce packages 2 from a packaging material having a multilayer configuration.

[0028] In further detail, the packaging material may comprise at least one layer of fibrous material, such as e.g. a paper or cardboard, 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 may define the inner face of package 2 contacting the pourable product.

[0029] Moreover, the packaging material 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. Preferentially, the packaging material 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.

[0030] In further detail, the packaging material may be provided in the form of a web 3.

[0031] With particular reference to Figures 1 to 3B, each package 2 may comprise a respective main body 4 formed from the multilayer packaging material and an opening device 5 applied about a designated pour opening area 9 of the respective main body 4.

[0032] In more detail, main body 4 may extend along a longitudinal axis A, a first transversal axis B perpendicular to longitudinal axis A and a second transversal axis C perpendicular to first transversal axis B and longitudinal axis A. Preferentially, the size of package 2 along longitudinal axis A may be larger than the size of package 2 along first transversal axis B and second transversal axis C.

[0033] More specifically, main body 4 may be parallel-

lepiped-shaped.

[0034] According to some preferred non-limiting embodiments, main body 4 may comprise a first wall, preferentially being transversal, more preferentially perpendicular, to longitudinal axis A, from which main body 4 may extend along longitudinal axis A. More specifically, the first wall may define a support surface of package 2, preferentially main body 4, which may be designed to be put in contact with a support, such as e.g. a shelf, when, in use, being e.g. exposed within a sales point or when being stored.

[0035] The first wall may define a bottom wall of package 2, in particular main body 4.

[0036] More specifically, main body 4 may also comprise a side wall 6 being (fixedly) connected to first wall and extending, along longitudinal axis A, from first wall.

[0037] More specifically, main body 4 may also comprise a second wall 7 opposite to first wall and being (fixedly) connected to side wall 6.

[0038] More specifically, side wall 6 may be interposed between and integrally connected to the first wall and second wall 7.

[0039] More specifically, second wall 7 may define a top wall of package 2.

[0040] According to the shown non-limiting embodiment, the first wall and second wall 7 may be parallel with respect to one another.

[0041] According to some other possible embodiments not shown, second wall 7 and the first wall may be inclined with respect to one another, more specifically second wall 7 may be inclined with respect to the first wall and/or longitudinal axis A.

[0042] According to some non-limiting embodiments, second wall 7 may carry and/or comprise the designated pour opening area 9 and opening device 5 may be connected to second wall 7.

[0043] According to some possible embodiments, each designated pour opening area 9 may be covered by a separation membrane, the separation membrane may e.g. be formed from portions of the multilayer packaging material. E.g. separation membrane may comprise one or more layers of a heat-seal material, and possibly a layer of a gas-barrier material.

[0044] In further detail, each main body 4 may comprise one or more transversal seals 8.

[0045] More specifically, each second wall 7 may comprise one respective transversal seal 8.

[0046] Additionally, also each first wall may comprise one respective transversal seal (not visible).

[0047] According to some possible embodiments, transversal seals 8 may be (substantially) parallel to first transversal axis B.

[0048] In further detail, each transversal seal 8 may (substantially) linearly extend (i.e. each transversal seal 8 has a (substantially) linear shape).

[0049] According to some possible embodiments, each main body 4 may also comprise a longitudinal seal. More specifically, each longitudinal seal may be (sub-

stantially) perpendicular to the respective transversal seals 8.

[0050] In further detail, each opening device 5 may comprise a collar having an outlet opening and a cap 10 removably coupled to the collar. Additionally, each opening device 5 may also comprise a respective base frame 11 carrying the respective collar. More specifically, each collar extends from the respective base frame.

[0051] More specifically, each collar may be integral to the respective base frame 11.

[0052] According to some possible embodiments, each base frame 11 may be connected, e.g. sealed and/or bonded and/or adhesively bonded and/or glued, to the respective main body 4, more specifically the respective second wall 7.

[0053] In further detail, each cap 10 may be controllable between a respective closing position at which cap 10 closes the outlet opening (for impeding the outflow of the pourable product) and an opening position at which cap 10 frees the outlet opening (for allowing the outflow of the pourable product). Advantageously, each cap 10 is in the closing position when being delivered to an end user.

[0054] Advantageously, each cap 10 may be (repeatably) moveable between the respective closing position and the respective opening position.

[0055] According to some embodiments, each cap 10 may be controllable between the respective closing position and the respective opening position by means of a screw movement and/or an angular movement about a hinge axis. Cap 10 may be non-detachably connected to collar 11 through a tethering element in order to avoid that cap 10 is dispersed in the environment.

[0056] Moreover, each cap 10 may comprise a principal wall 13 configured to cover the outlet opening, in particular with cap 10 being in the closing position.

[0057] Advantageously, principal wall 13 may have a (substantially) circular shape.

[0058] Moreover, each principal wall 13 may have a center 14.

[0059] According to some possible embodiments, each principal wall 13 may have one or more auxiliary circular elements arranged between an outer edge and the respective center 14. E.g. one or more auxiliary circular elements may be defined by respective circular edges.

[0060] Additionally, each cap 10 may comprise a lateral wall protruding from the respective principal wall 13 and being configured to surround at least a portion of the respective collar, in particular with cap 10 being in the closing position.

[0061] According to some possible embodiments, each opening device 5 may also comprise a respective coupling element connected to and protruding from the respective separation membrane. Preferentially, each coupling element may be also connected to, preferentially sealed to, the respective cap 10.

[0062] In particular, during a first-time control of the respective cap 10 into the respective opening position,

the coupling element follows movement of the respective cap 10 leading to a detachment of the respective separation membrane from the respective main body 4.

[0063] According to some embodiments, each opening device 5 may comprise a cutting element configured to cut the separation membrane during a first-time movement of cap 10 from the respective closing position to the respective opening position.

[0064] In further detail, each collar may extend along a respective central axis.

[0065] Moreover, each collar may have an annular shape. More specifically, each collar may have a cylindrical shape.

[0066] With particular reference to Figure 1, packaging machine 1 may comprise:

- a package filling apparatus 17 configured to form and fill main bodies 4, in particular configured to form main bodies 4 from the multilayer packaging material and to fill main bodies 4 with the pourable product; and
- at least one capping apparatus 18 configured to at least apply one respective opening device 5 to each main body 4, more specifically at least to the respective second wall 7.

[0067] More specifically, main bodies 4 exiting from package filling apparatus 17 may comprise the respective designated pour opening area 9, possibly being covered by the respective separation membrane.

[0068] In more detail, capping apparatus 18 may be arranged downstream from package filling apparatus 17 and may be configured to receive formed and filled main bodies 4 from package filling apparatus 17.

[0069] With particular reference to Figure 1, capping apparatus 18 comprises:

- a conveying device configured to advance main bodies 4 along and advancement path P; and
- an opening device application apparatus 19 configured to apply one respective opening device 5 onto each main body 4, more specifically at least the respective second wall 7, even more specifically about the designated pour opening area 9, at an application station 20.

[0070] In further detail, the conveying device may comprise elements such as bars or the like configured to define the position of main bodies 4, in particular such that play into directions transversal to an advancement direction along advancement path P of main bodies 4 is (substantially) avoided.

[0071] Additionally, opening device application apparatus 19 may comprise:

- one or more opening device applicators configured to apply opening devices 5 onto main bodies 4 at application station 20; and

- preferentially but not necessarily, one or more adjustment devices configured to control a relative position of each opening device applicator with respect to the respective designated pour openings.

[0072] According to some possible non-limiting embodiments, capping application apparatus 18 may also comprise a feeding device 21 configured to feed opening devices 5 to a transfer station 22 at which opening devices 5 are transferred to one respective opening device applicator.

[0073] Additionally, feeding device 21 may be configured to advance opening devices 5 along a feeding path Q and to transfer station 22.

[0074] According to some possible embodiments, capping apparatus 18 may also comprise an adhesive application device 23 for applying a bonding agent such as an adhesive onto opening devices 5, preferentially the respective base frame 11 prior to application of opening devices 5 onto main body 4.

[0075] More specifically, adhesive application device 23 may be configured to apply the bonding agent and/or adhesive onto opening devices 5 at a gluing application station 24.

[0076] E.g. gluing application station 24 may be upstream from transfer station 22 along feeding path Q.

[0077] With particular reference to Figures 1 and 2, capping apparatus 18 may also comprise an inspection apparatus 30 configured to determine the relative positions of each opening device 5 with respect to the respective designated pour opening areas 9.

[0078] Moreover, inspection apparatus 30 may be configured to determine on whether each opening device 5 may be correctly arranged with respect to the respective designated pour opening area 9.

[0079] More specifically, inspection apparatus 30 may be configured to selectively determine for each opening device 5 on whether the relative position of each opening device 5 with respect to the respective designated pour opening area 9 lies within a desired range or on whether the relative position may fall out of the desired range.

[0080] Preferentially but not necessarily, inspection apparatus 30 may be configured to selectively determine for each package 2 on whether the respective opening device 5 is correctly aligned or misaligned with respect to the respective designated pour opening area 9 in dependence on whether the respective relative position of each opening device 5 with respect to the respective designated pour opening area 9 lies within the desired range (correctly aligned) or on whether the relative position may fall out of the desired range (misaligned).

[0081] Even more specifically, inspection apparatus 30 may be configured to determine on whether the relative position of the respective collar with respect to the respective designated pour opening area 9 may allow a correct opening of the respective designated pour opening area 9.

[0082] With particular reference to Figures 2, 3A and

3B, inspection apparatus 30 comprises:

- a first imaging device 31 positioned at a first inspection station 32 and configured to acquire a first image 33 (see Figure 3A) of an imaging portion 34 of main body 4, more specifically the respective second wall 7, each imaging portion 34 having the respective designated pour opening area 9; and
- a second imaging device 35 positioned at a second inspection station 36 arranged downstream from first inspection station 32 (along advancement path P) and configured to acquire at least one second image 37 (see Figure 3B) of the respective opening device 5 applied to the respective main body 4, in particular at the respective inspection portion 34.

[0083] Moreover, second imaging device 35 may be configured to substantially acquire the respective second images 37 (see Figure 3B) of substantially the respective imaging portions 34. While first imaging device 31 is configured to image the respective imaging portions 34 prior to the application of the respective opening devices 5 onto the respective main bodies 4, second imaging device 36 is configured to image the respective imaging portions 34 after the application of the respective opening devices 5 onto the respective main bodies 4.

[0084] In further detail, first imaging station 32 and second imaging station 36 may be arranged, respectively, upstream and downstream from application station 20.

[0085] When reverting again to Figure 2, inspection apparatus 30 also comprises an analyzing unit 38 configured to analyze each first image 33 and the respective second image 37 and to determine a relative position between each opening device 5 and the respective designated pour opening area 9 from an assessment of each first image 33 and the respective second image 37.

[0086] Advantageously, analyzing unit 38 may be configured to selectively determine for each package 2 on whether the respective opening device 5 is correctly aligned or misaligned in dependence on whether the relative position of the respective opening device 5 with respect to the respective designated pour opening area 9 lies, respectively, within a respective certain range or not.

[0087] In more detail, analyzing unit 38 may be configured to determine a measured first relative position of each designated pour opening area 9 with respect to a first reference station 39 from each respective first image 33.

[0088] First reference station 39 being the same for any acquired first image 33 as being an inherent feature of the position of first imaging device 31. E.g. first reference station 39 may be attributed to one or more specific pixels of first image 33, which are the same for any first image 33 taken.

[0089] In more detail, each first image 33 taken, in use, by first imaging device 33 has a defined size which is the same for each first image 33. Moreover, the respective

inspection portions 34 are visible within the respective first image 33.

[0090] Hence, the first reference station 39 is thereby a fixed point within each first image 33 and which remains the same for each first image 33. E.g. it can be considered that first reference station 39 defines a zero point.

[0091] In even further detail, analyzing unit 38 may be configured to determine the first relative position with reference to a first reference point 40 of each designated pour opening area 9, such as e.g. a center point of designated pour opening area 9.

[0092] Thus, while first reference station 39 is an inherent feature of any first image 33, which is independent of the specific visual effects present within first image 33, first reference point 40 corresponds to a specific point of each designated pour opening area 9.

[0093] E.g. when reverting to Figure 3A, it is possible to define the center of the designated pour opening area 9 as the first reference point 40 and analyzing unit 38 determines the relative position of the center with respect to first reference station 39. In the ideal case such a relative position would be the same for each first image 33. However, during normal production, deviations may occur for varying reasons. Thus, by having first reference station 39 being an inherent feature related to each first image 33 and being determined by the position of first imaging device 31 and by determining the relative position of the respective first reference points 40 with respect to such first reference station 39, it is possible to understand the real position of the respective designated pour opening area 9.

[0094] More specifically, analyzing unit 38 may be configured to determine the relative position of the respective first reference point 40 with respect to the first reference station 39 and such a relative position being indicative about the relative respective first relative position.

[0095] In other words, analyzing unit 38 sets, in use, a fixed first reference station 39 being the same for each first image 33.

[0096] Hence, the relative position of each first reference point 40 with respect to first reference station 39 describes a translation between first reference point 40 (e.g. the center of the designated pour opening area 9) and the respective first reference station 39 (e.g. the expected position of the center of the designated pour opening area 9 in an ideal situation).

[0097] In the example shown, first reference station 39 is set by analyzing unit 38 and for each first image 33 such that in the ideal case the respective centers of the respective designated pour opening areas 9 correspond to first reference station 39.

[0098] Even more specifically, analyzing unit 38 may be configured to attribute to first reference station 39 a first set of cartesian coordinates and to first reference point 40 a second set of cartesian coordinates. Thereby, the first set of cartesian coordinates is the same for each first image 33 and the second set of cartesian coordinates

corresponds to the effective measurement. Accordingly, the respective relative position of first reference point 40 with respect to first reference station 39 is expressed in terms of delta values.

[0099] E.g. first reference station 39 may define a zero point of the cartesian coordinate system.

[0100] In other words, first reference station 39 allows to define the position of the first reference point 40.

[0101] According to some embodiments, analyzing unit 38 may be configured to determine a measured second relative position of each opening device 5 with respect to a second reference station 41 from the respective second images 37.

[0102] In analogy to first images 33, first reference station 39 and first imaging device 31, also second reference station 41 is a station, which is inherently related to second imaging device 36 and its specific position.

[0103] Accordingly, also second reference station 41 is the same for each second image 41 and is independent on any visual features present within second images 41.

[0104] In more detail, analyzing unit 38 may be configured to determine the relative position of each opening device 5 with respect to the respective designated pour opening area 9 in dependence of the measured first relative position and the measured respective second relative position.

[0105] According to some embodiments, analyzing unit 38 may be configured to determine the second relative position with reference to a second reference point 44 of opening device 5, such as the respective center 14. In analogy to first images 33, first reference point 40 and first imaging device 31, also second reference point 40 is attributable to a feature of the specific visualized features. In this case, however, second reference point 40 corresponds to a point of opening device 5.

[0106] E.g. in the example shown, second reference station 41 is defined such that, in the ideal case, second reference point 44 is arranged at second reference station 41. However, in use, differences between second reference point 44 and second reference station 41 may occur.

[0107] Indeed, second reference point 44 may be translated from second reference station 41.

[0108] E.g. it may be possible to define second reference station 41 such that the respective centers 14 (as the respective second reference point 44) of the respective opening devices 5 correspond to second reference station 41 if the position of the respective opening device 5 within the respective second image 37 corresponds to the ideal case.

[0109] Even more specifically, analyzing unit 38 may be configured to attribute to second reference station 41 a third set of cartesian coordinates and to second reference point 44 a fourth set of cartesian coordinates. In particular, the third set of cartesian coordinates is fixed and the same for each second image 37 and the fourth set of cartesian coordinates depends on the effective measurement result.

[0110] E.g. second reference station 44 may define a 0 point of the cartesian coordinate system.

[0111] According to some preferred non-limiting embodiments, analyzing unit 38 may be also configured to calculate an expected relative position of each opening device 5 from the respective first relative position of the respective designated pour opening area 9 and to compare the measured second relative position (i.e. as obtained from the respective second image 37) with the expected relative position so as to determine the relative position between the designated pour opening area 9 and the respective opening device 5.

[0112] In other words, in use, analyzing unit 38 calculates from the respective first relative positions respective expected positions of each opening device 5 and compares the expected positions with the positions as determined from the respective second images 37.

[0113] Moreover, analyzing unit 38 may be also configured to determine any deviations of the position of opening device 5 from the expected relative position (i.e. the difference between the expected relative position and the measured relative position).

[0114] Additionally, analyzing unit 38 may be configured to determine a correctly and incorrectly aligned opening device 5 if the deviations are, respectively, smaller or equal to and larger than a threshold.

[0115] In other words, analyzing unit 38 calculates for each designated pour opening area 9 the respective first relative position. Then analyzing unit 38 calculates from the first relative position the expected position of the respective opening device 5 and compares the expected position to the effective position. If the effective position stays within a certain limit with respect to the expected position, opening device 5 is considered to be correctly aligned and if the effective position with respect to the expected position is outside from the certain limit, opening device 5 is incorrectly aligned.

[0116] According to some preferred non-limiting embodiments, analyzing unit 38 may be configured to compare the relative position of the respective second reference point 44 with respect to the respective first reference point 41.

[0117] More specifically, analyzing unit 38 may be configured to:

- identify in each first image (33) the center of the respective designated pour opening area (9);
- identify in the respective second image (38) center 14 of the respective opening device 5 applied around the respective designated pour opening area 9; and
- determine a relative position between the respective center of the designated pour opening area 9 and the respective center 14 of the respective opening device 5.

[0118] Moreover, analyzing unit 38 may be configured to determine if the respective opening device 5 is applied correctly or not by comparing the relative position be-

tween the center of the respective designated pour opening area 9 and the respective center 14 of the respective opening device 5 with a predetermined expected relative position.

[0119] In particular, the expected relative position provides that the respective center of the respective designated pour opening area 9 and the respective center 14 of the respective opening device 5 are superposed or distanced from each other by a predetermined threshold.

[0120] According to some preferred non-limiting embodiments, first imaging device 31 may comprise a 2D camera configured to acquire first images 33.

[0121] According to some preferred non-limiting embodiments, second imaging device 35 may comprise a 3D camera, more specifically a digital video camera, more specifically a 3D digital video camera, configured to acquire second images 37. More, specifically, first imaging device 35 may be configured to acquire a three-dimensional image.

[0122] E.g. second imaging device 35 may be configured to execute a 3D profiling (laser triangulation).

[0123] According to some preferred non-limiting embodiments, adjustment devices may be configured to control the relative position of opening device applicators in dependence of the respective first images 33, more specifically of the first relative position of the respective designated pouring outlet 9 as obtained from the respective first images 33.

[0124] In this way, it is possible to reduce any misalignments of opening devices 5.

[0125] According to some preferred non-limiting embodiments, inspection apparatus 30 may also comprise a third imaging device 42 configured to acquire third images of opening devices 5 together with the bonding agent and/or the adhesive applied to opening device 5 at a third imaging station 43.

[0126] Third images may be logged.

[0127] According to some possible embodiments, analyzing unit 38 may be configured to log together the respective first image 33, the respective second image 37 and, preferably, the respective third image of the same package 2, in order to render them e.g. available for further analysis aimed at understanding the source of possible defective applications of an opening device 5.

[0128] More specifically, third imaging station 43 may be interposed between gluing application station 24 and transfer station 22.

[0129] With particular reference to Figure 1, package filling apparatus 17 may be configured to produce main bodies 4 and to fill main bodies 4 with the pourable product.

[0130] In more detail, package filling apparatus 17 may be configured to produce main bodies 4 by forming a tube 50 from web 3, longitudinally sealing tube 50, filling tube 50 with the pourable product and to form and transversally seal and cut tube 50.

[0131] In use, packaging machine 1 produces packages 2 filled with the pourable product.

[0132] Operation of packaging machine 1 comprises at least the steps of:

- forming and filling main bodies 4 with the pourable product, in particular executed by package filling apparatus 17; and
- applying caps 10 onto main bodies 4, more specifically at least onto second walls 7.

[0133] Operation of packaging machine 1 also comprises a step of inspecting, during which relative position of opening devices 5 are determined with respect to the respective designated pour opening area 9.

[0134] Even more particular, during the step of forming and filling, tube 50 is formed from advancing web 3, is longitudinally sealed, filled with the pourable product and transversally sealed and cut.

[0135] According to some preferred embodiments, operation of packaging machine 1 may also comprise a step of feeding, during which main bodies 4 are fed, in particular from package filling apparatus 7, to capping apparatus 18.

[0136] In more detail, during the step of applying, the following sub-steps are executed:

- advancing main bodies 4 along the advancement path; and
- applying opening devices 5 onto the respective main bodies 4.

[0137] In more detail, during the sub-step of applying, opening devices 5 are applied onto the respective main bodies 4 by the respective opening device applicators at glue application station 23.

[0138] Moreover, during the sub-step of applying, a bonding agent and/or an adhesive is applied onto opening devices 5.

[0139] The method comprises the step of inspecting opening device 5 so as to selectively determine the relative position between designated pour openings 9 and the respective opening devices 5.

[0140] The method comprises the steps of:

- acquiring, in particular by means of first imaging device 31, the respective first images 33 at first inspection station 32 of the respective imaging portions 34;
- acquiring, in particular by means of second imaging device 35, the respective second images 37 at second inspection station 36 of each imaging portion 34 together with the respective opening devices 4 applied to the respective main bodies 4; and
- analyzing, in particular by means of analyzing unit 38, each first image 33 and the respective second image 38 and to determine the respective relative positions between each opening device 5 and the respective designated pour opening area 9 from the analysis of each first image 33 and the respective

second image 37.

[0141] In more detail, during the step of analyzing, the measured first relative position of each designated pour opening area 9 with respect to first reference station 39 of the respective first image 33 is determined and a measured second relative position of each opening device 5 with respect to a second reference station 41 from the respective second images 37 is determined, too.

[0142] Moreover, during the step of analyzing the relative position of each opening device 5 with respect to the respective designated pour opening area 9 is determined in dependence of the measured first relative position and the measured respective second relative position.

[0143] Additionally, during the step of analyzing, each first relative position is determined with reference to the respective first reference point 40 of the respective designated pour opening area 9 and the second relative position is determined with reference to the respective second reference point 41.

[0144] In further detail, during the step of analyzing, the expected relative positions of each opening device 5 are calculated from the respective first relative positions of the respective designated pour openings 9. Then, the respective second relative positions obtained from the respective second image 37 are compared with the respective expected relative positions so as to determine the relative positions between the respective designated pour openings 5 and the respective opening devices 5.

[0145] According to some possible embodiments, during the step of analyzing, each opening device 5 may be classified as correctly or incorrectly aligned with respect to the respective designated pour openings 9.

[0146] According to some possible embodiments, packages 2 having incorrectly aligned opening devices 5 may be discarded.

[0147] The advantages of inspection apparatus 30 and the method according to the present invention will be clear from the foregoing description.

[0148] In particular, inspection apparatus 30 and/or the method of inspection allow to determine with high precision the relative position of each opening device 5 with respect to the respective designated pour opening area 9. In such a way, it is possible to identify incorrectly applied opening devices 5 with greater precision, since the position of the opening device 5 is evaluated with respect to the designated pour opening area 9. So, if an opening device 5 is not aligned with its respective pour opening area 9, then it is identified as incorrectly applied.

[0149] In particular, it is possible to identify packages 2 having misaligned opening devices 5, which allows to avoid that these are delivered to the consumer.

[0150] Clearly, changes may be made to inspection apparatus 30 and/or capping apparatus 18 and/or packaging machine 1 and/or the method as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

Claims

1. - Inspection apparatus (30) for inspecting opening devices (5) applied to main bodies (4) advancing along an advancement path (P);
wherein the inspection apparatus (30) comprises:
 - a first imaging device (31) positioned at a first inspection station (32) and configured to acquire a first image (33) of an imaging portion (34) of the main body (4), the imaging portion (34) having a designated pour opening area (9) configured to receive a respective opening device (5) ;
 - a second imaging device (35) positioned at a second inspection station (36) arranged downstream from the first inspection station (32) and configured to acquire at least one second image (37) of the opening device (4) applied to the respective imaging portion (34) of the main body (4); and
 - an analyzing unit (38) configured to analyze each first image (33) and the respective second image (38) and to determine a relative position between each opening device (5) and the respective designated pour opening area (9) by analyzing each first image (33) and the respective second image (37).
2. - Inspection apparatus according to claim 1, wherein the analyzing unit (38) is configured to determine a measured first relative position of each designated pour opening area (9) with respect to a first reference station (39) from the respective first image (33), and to determine a measured second relative position of each opening device (5) with respect to a second reference station (41) from the respective second images (37);
wherein the analyzing unit (38) is configured to determine the relative position of each opening device (5) with respect to the respective designated pour opening area (9) in dependence of the measured first relative position and the measured respective second relative position.
3. - Inspection apparatus according to claim 2, wherein the analyzing unit (38) is configured to determine the measured first relative position with reference to a first reference point (40) of the designated pour opening area (9) and to determine the second measured relative position with reference to a second reference point (44).
4. - Inspection apparatus according to claim 3, wherein the first reference point (40) corresponds to a center of the designated pour opening area (9) and/or the second reference point (44) corresponds to a center (14) of the opening device (5).
5. - Inspection apparatus according to any one of claims 2 to 4, wherein the analyzing unit (38) is also configured to calculate an expected relative position of each opening device (5) from the respective first relative position of the respective designated pour opening area (9) and to compare the respective second relative position obtained from the respective second image (37) with the expected relative position so as to determine the relative position between the designated pour opening (5) and the opening device (5).
6. - Inspection apparatus according to any one of the preceding claims, wherein the first imaging device (31) comprises a 2D camera.
7. - Inspection apparatus according to any one of the preceding claims, wherein second imaging device (35) comprises a 3D camera and/or is configured to execute a three-dimensional profiling.
8. - Inspection apparatus according to any one of the preceding claims, wherein the inspection apparatus (30) is configured to selectively determine for each opening device (5) on whether the relative position of each opening device (5) with respect to the respective designated pour opening area (9) lies within a desired range or on whether the relative position may fall out of the desired range.
9. - Capping apparatus (18) for applying opening devices onto main bodies (4) advancing along an advancement path (P) comprising:
 - an opening device application apparatus (19) configured to apply respective opening devices (5) onto the main bodies (4) at an application station (20); and
 - an inspection apparatus (30) according to any one of the preceding claims configured to determine the relative positions of each opening device (5) with respect to the respective designated pour openings (9);
 wherein the application station (20) is interposed between the first inspection station (32) and the second inspection station (36).
10. - Capping apparatus (18) according to claim 9, wherein the opening device application apparatus (19) comprises one or more opening device applicators and one or more adjustment devices configured to adjust a position of each opening device applicator in dependence of respective relative positions of each designated pour opening area (9) as determined from the respective first images (33).
11. - Capping apparatus (18) according to claim 9 or 10,

wherein the opening device application apparatus (19) also comprises an adhesive application device (23) for applying a bonding agent and/or an adhesive onto the opening devices (5) prior to application of opening devices (5) onto the respective main bodies (4);

wherein the inspection apparatus (30) further comprises a third imaging device (42) configured to acquire at least one respective third image of each opening device (5) and the bonding agent and/or adhesive applied to the respective opening device (5).

- 12.** - Packaging machine (1) for producing packages (2) having each a main body (4) and an opening device (5) applied onto the main body (4) and being filled with a pourable product comprising:

- a package filling apparatus (17) for forming and filling the main bodies (4) with the pourable product; and
- at least one capping apparatus (18) according to any one of claims 9 to 11 and being configured to apply respective opening devices (5) onto main bodies (4).

- 13.** - Method of inspecting opening devices (5) applied onto main bodies (4) filled with a pourable product comprising the steps of:

- acquiring a first image (33) at a first inspection station (32) of an imaging portion (34) of the main body (4), the imaging portion (34) having a designated pour opening area (9) of each main body (4);
- acquiring a second image (37) at a second inspection station (36) arranged downstream from the first inspection station (32) of the respective opening device (4) applied to the respective imaging portion (34); and
- analyzing each first image (33) and the respective second image (38) and determining a relative position between each opening device (5) and the respective designated pour opening area (9) from the analysis of each first image (33) and the respective second image (37).

- 14.** - Method according to claim 13, during the step of analyzing a measured first relative position of each designated pour opening (9) with respect to a first reference station (39) of the respective first image (33) and to determine a measured second relative position of each opening device (5) with respect to a second reference station (41) from the respective second images (37);
- wherein during the step of analyzing the relative position of each opening device (5) with respect to the respective designated pour opening (9) is deter-

mined in dependence of the measured first relative position and the measured respective second relative position.

- 15.** - Method according to claim 14, wherein during the step of analyzing the first relative position is determined with reference to a first reference point (40) of the designated pour opening (9) and the second relative position is determined with reference to a second reference point (44) .

- 16.** - Method according to any one of claims 13 to 15, wherein during the step of analyzing unit an expected relative position of each opening device (5) is calculated from the respective first relative position of the respective designated pour opening (9) and the respective second relative position obtained from the respective second image (37) is compared with the expected relative position so as to determine the relative position between the designated pour opening (5) and the opening device (5).

- 17.** - Method of applying opening devices (5) onto main bodies (4) filled with a pourable product comprising the steps of:

- advancing main bodies (4) along an advancement path (P) ;
- applying opening devices (5) onto the main bodies (4); and
- executing a method according to any one of claims 13 to 16.

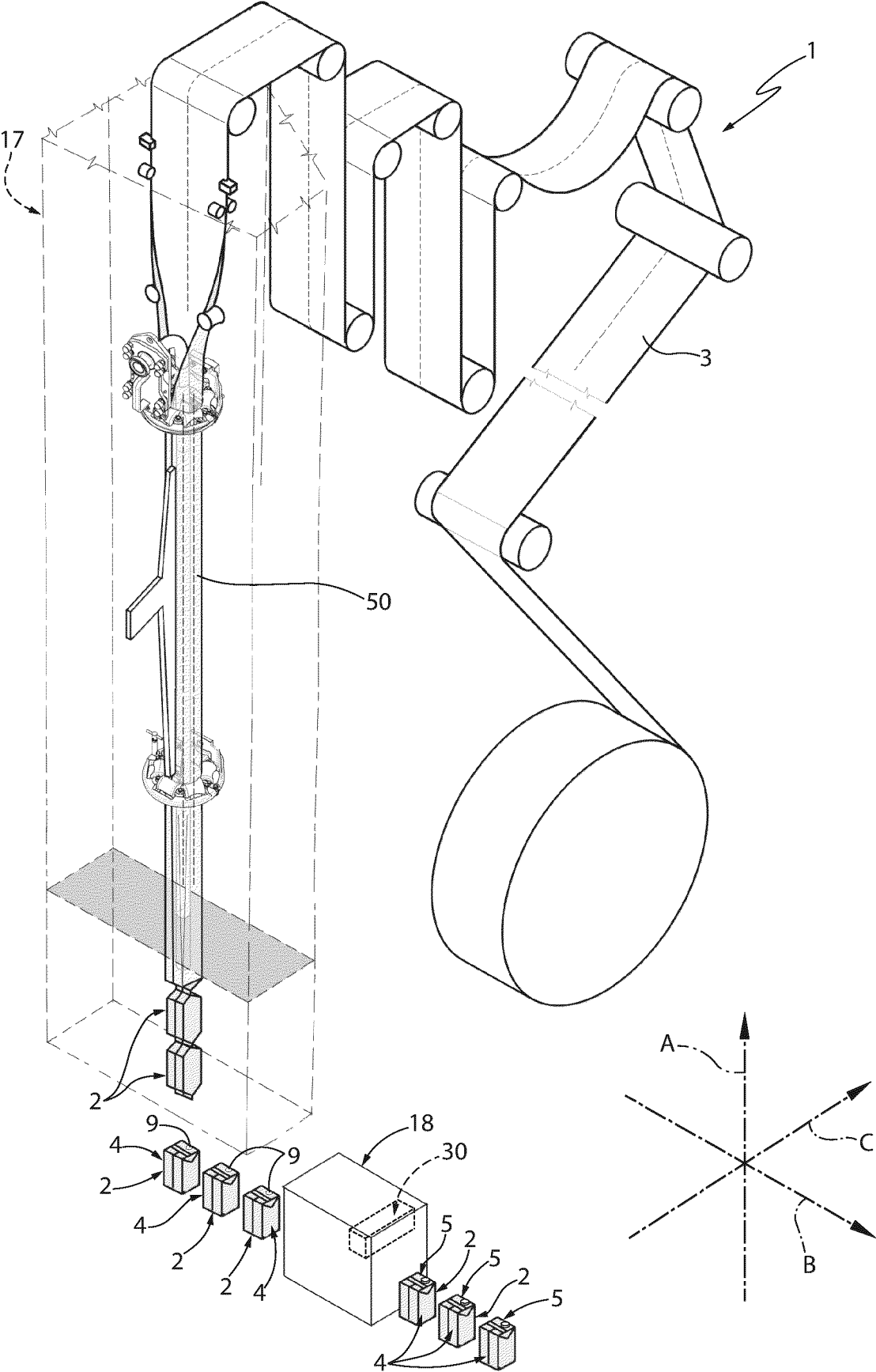


FIG.1

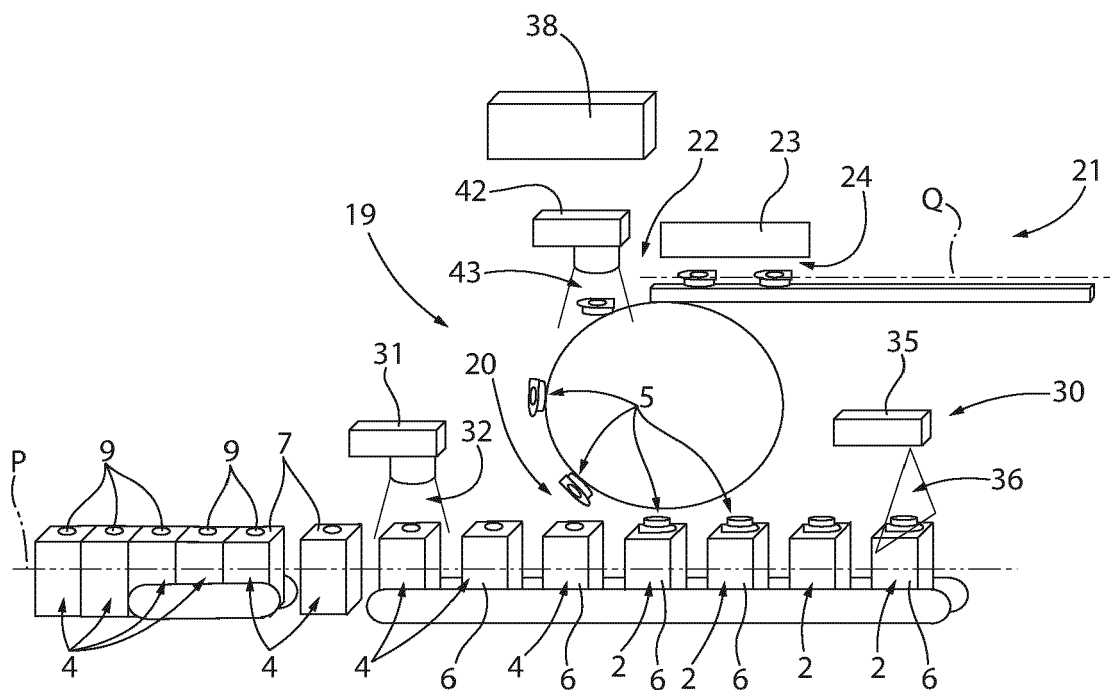


FIG. 2

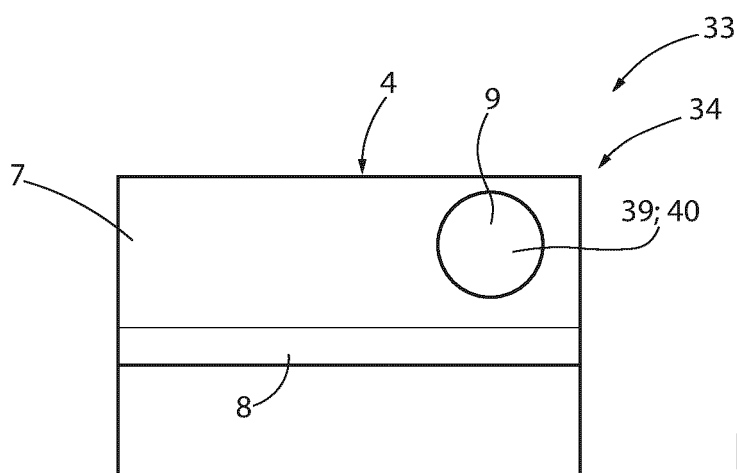


FIG. 3A

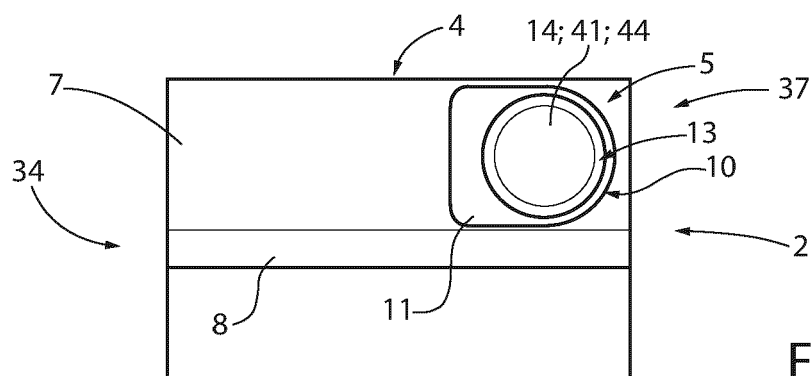


FIG. 3B



EUROPEAN SEARCH REPORT

Application Number

EP 24 19 2286

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2021/229912 A1 (SHIKOKU KAKOKI CO LTD [JP]; KOEI CO LTD [JP]; USHIO LIGHTING INC [JP]) 18 November 2021 (2021-11-18) * abstract; figures 1,12-15 * -----	1-17	INV. B67B3/26 B65B7/28 B65B57/04 B65B61/18
A	US 2023/086224 A1 (BASSISSI FABIO [IT] ET AL) 23 March 2023 (2023-03-23) * abstract; figure 1 * -----	1-17	
A	DE 42 39 238 A1 (KHS MASCH & ANLAGENBAU AG [DE]) 26 May 1994 (1994-05-26) * column 6, lines 8-58; figure 1 * -----	1-17	
			TECHNICAL FIELDS SEARCHED (IPC)
			B67B B65B G01N
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		10 October 2024	Wartenhorst, Frank
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 24 19 2286

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-10-2024

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2021229912 A1	18-11-2021	JP WO2021229912 A1	18-11-2021
		WO 2021229912 A1	18-11-2021

US 2023086224 A1	23-03-2023	CN 115315393 A	08-11-2022
		EP 3882164 A1	22-09-2021
		JP 2023518384 A	01-05-2023
		US 2023086224 A1	23-03-2023
		WO 2021185698 A1	23-09-2021

DE 4239238 A1	26-05-1994	NONE	

15

20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82