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(54) PACKAGE FORMING APPARATUS FOR A PACKAGING MACHINE AND PACKAGING MACHINE FOR FORMING PACKAGES FILLED WITH A POURABLE PRODUCT

(57) There is described a package forming apparatus (10) configured to manipulate a tube (4) and comprising at least one operative device (25) having a first operative group (26) and a second operative group (27). The first operative group (26) and the respective second operative group (27) are configured to execute a relative movement with respect to one another. Each operative device (25) comprises at least one support group (33) carrying the respective first operative group (26) and the respective second operative group (27). Each first operative group (26) is mounted to the respective support group (33) in such a manner to be angularly movable about a rotation axis (B). Each first operative group (26) is coupled to the support group (33) by means of a respective shaft (34) rotatable about and/or defining the rotation axis (B). The package forming apparatus (10) comprises a sensor device (28) having a sensor body (40) fixed to the shaft (34) and a sensor head (41) configured to determine and/or measure an angular position (α) and/or an angular movement ($\Delta\alpha$) of the sensor body (40) for determining and/or measuring an angular position of the respective first operative group (26).

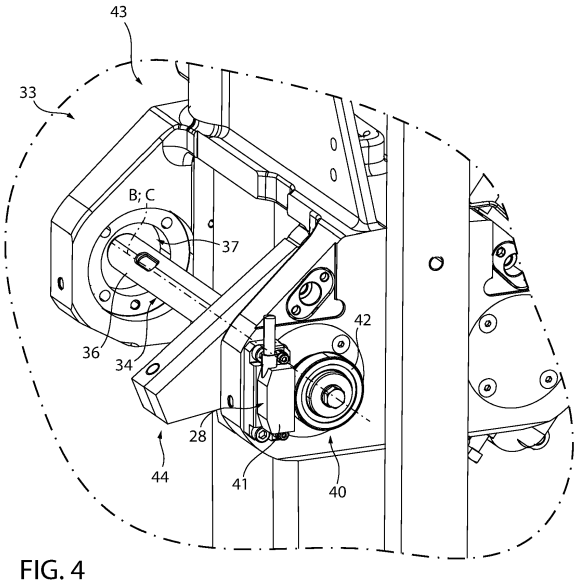

FIG. 4

EP 4 410 691 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a package forming apparatus for a packaging machine for forming packages filled with a pourable product, preferentially a pourable food product.

[0002] Advantageously, the present invention also relates to a packaging machine for forming packages filled with a pourable product, preferentially a pourable food product.

BACKGROUND ART

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

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

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

[0006] For completing the forming operations, the tube is filled with a pourable product, in particular a pourable food product, and is transversally sealed and subsequently cut along equally spaced transversal cross sections within a package forming apparatus of the packaging machine during advancement along the vertical advancing direction.

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

[0008] A typical packaging machine comprises a conveying device for advancing the web of packaging material along a web advancement path and the tube formed from the web of packaging material along a tube advancement path, the sterilization apparatus for sterilizing the web of packaging material prior to its formation into the tube, a tube forming and sealing device at least partially arranged within the isolation chamber and being configured to form the tube from the advancing web of packaging material and to longitudinally seal the tube, a filling device for filling the tube with the pourable product and the package forming apparatus adapted to form, transversally seal and cut individual packages from the tube of packaging material.

[0009] The package forming apparatus comprises at least one operative device, typically at least two operative devices, each having at least a first operative group and a second operative group configured to at least partially form and to transversally seal and cut in cooperation the, in use, advancing tube.

[0010] Moreover, each operative device comprises a support group movably coupled to a first guide and a second guide and cyclically moving up and down, in use, along the first guide and the second guide, thereby also inducing a respective movement of the respective first operative group and the respective second operative group.

[0011] Additionally, in use, each first operative group and the respective second operative group execute relative movements with respect to one another so as to cyclically move towards and withdraw from the tube. In particular, when the first operative group and the respective second operative group of a first operative device are spaced apart from one another a first passage is defined between the first operative group and the respective second operative group of the first operative device. In this way, the first operative group and the respective second operative group of a second operative device, which are arranged close to each other, can pass through the first passage. In a similar way, when the first operative group and the respective second operative group of the second operative device are spaced apart from one another a second passage is defined between the first operative group and the respective second operative group of the second operative device. In this way, the first operative group and the respective second operative group of the first operative device, which are arranged close to each other, can pass through the second passage.

[0012] Therefore, it must be ensured that each first operative group and the respective second operative group correctly execute the respective relative movements during their advancement resulting from the cyclic movement of the respective support group along the first guide and the second guide.

[0013] Even though the known package forming apparatuses and/or packaging machines work satisfactorily well, a desire is felt in the sector to further improve the known package forming apparatuses and/or the known

packaging machines.

DISCLOSURE OF INVENTION

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

[0015] Additionally, it is an object of the present invention to provide an improved packaging machine.

[0016] According to the present invention, there is provided a package forming apparatus as claimed in claim 1.

[0017] Preferred non-limiting embodiments of the package forming apparatus are claimed in the claims being directly and indirectly dependent on claim 1.

[0018] According to the present invention, there is also provided a packaging machine according to claim 15.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] 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 having a package forming apparatus according to the present invention, with parts removed for clarity;
Figure 2 is a schematic perspective view of a detail of the package forming apparatus of Figure 1, with parts removed for clarity;
Figure 3 is a perspective view of a detail of the package forming apparatus of Figure 1, with parts removed for clarity;
Figure 4 is an enlarged perspective view of a portion of the detail of Figure 3, with parts removed for clarity;
Figure 5 highlights some aspects of the portion of Figure 4, with parts removed for clarity; and
Figure 6 shows a determined time-dependent curve describing an angular movement of a portion of the detail of Figure 3 in comparison with a characteristic time-dependent curve;

BEST MODES FOR CARRYING OUT THE INVENTION

[0020] Number 1 indicates as a whole a packaging machine for producing sealed packages 2 of a pourable product, in particular a pourable food product, such as milk, milk drinks, yoghurt, yoghurt drinks, fruit juice, wine, tomato sauce, emulsions, beverages containing pulp, salt, sugar, etc.

[0021] In more detail, packaging machine 1 may be configured to produce packages 2 from a multilayer packaging material. Preferentially, a multilayer packaging material having heat seal properties (i.e. portions of the multilayer packaging material can be sealed to one another).

[0022] In further detail, the multilayer packaging material may comprise at least one layer of fibrous material, such as e.g. 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. Preferentially, one of these two layers of heat-seal plastic material may define the inner face of packages 2 contacting the pourable product.

[0023] Moreover, the multilayer packaging material may also comprise a layer of gas- and light-barrier material, e.g. aluminum foil or ethylene vinyl alcohol (EVOH) film, preferentially being arranged between one of the layers of heat-seal plastic material and the layer of fibrous material.

[0024] 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.

[0025] In further detail, the multilayer packaging material may be provided in the form of a web 3.

[0026] Furthermore, packaging machine 1 may be configured to produce packages 2 by forming a tube 4 from web 3, longitudinally sealing tube 4, filling tube 4 with the pourable product and to transversally seal, and preferentially transversally cut tube 4.

[0027] According to some possible non-limiting embodiments, each package 2 may extend along a longitudinal axis A.

[0028] According to some possible embodiments, each package 2 may comprise at least a first transversal sealing band 5, and preferentially also a second transversal sealing band arranged at opposite ends of package 2.

[0029] Preferentially, each first transversal sealing band 5 may be substantially spaced apart from the respective second transversal sealing band along the respective longitudinal axis A.

[0030] Preferentially, each first transversal sealing band 5 may define a transversal top sealing band and each second transversal sealing band may define a transversal bottom sealing band.

[0031] Moreover, each package 2 may also comprise a longitudinal seam portion 6. Preferentially, each first transversal sealing band 5 and/or each second transversal sealing band may be transversal, preferentially perpendicular, to the respective longitudinal seam portion 6.

[0032] With particular reference to Figure 1, packaging machine 1 may comprise a package forming apparatus 10 configured to manipulate, preferentially to transversally seal, and/or to transversally cut and/or to at least partially form, tube 4 for obtaining packages 2.

[0033] Preferentially, package forming apparatus 10 may comprise an advancement space within which, in use, tube 4 advances.

[0034] Moreover, packaging machine 1 may also comprise:

- a conveying device 11 configured to advance web 3 along a web advancement path P, preferentially to a tube forming station, at which, in use, web 3 is formed into tube 4, and configured to advance tube 4 along a tube advancement path Q;
- a tube forming and sealing device 12 configured to

form tube 4 from the, in use, advancing web 3 and to longitudinally seal tube 4; and

- a filling device 13 for filling tube 4 with the pourable product.

[0035] In further detail, packaging machine 1 may also comprise an isolation chamber 14, preferentially delimiting an inner environment 15 from an outer environment 16. Preferentially, inner environment 15 may be a sterile environment, preferably containing a controlled atmosphere.

[0036] Preferentially, tube forming and sealing device 12 may be at least partially arranged within isolation chamber 14, in particular inner environment 15, and being configured to fold and longitudinally seal tube 4 within isolation chamber 14, in particular inner environment 15.

[0037] Moreover, packaging machine 1 may also comprise a sterilization unit configured to sterilize the, in use, advancing web 3, preferentially the sterilization unit being arranged upstream of tube forming and sealing device 12 along web advancement path P.

[0038] In more detail, conveying device 11 may be configured to advance tube 4 and any intermediates of tube 4 along tube advancement path Q, preferentially from tube forming and sealing device 12 to and/or at least partially within package forming apparatus 10. Preferentially, with the wording intermediates of tube 4 any configuration of web 3 is meant prior to obtaining the tube structure and after folding of web 3 by tube forming and sealing device 12 has started. In other words, the intermediates of tube 4 are a result of the gradual folding of web 3 so as to obtain tube 4, preferentially by overlapping the (longitudinal) edges of web 3 with one another.

[0039] According to some possible non-limiting embodiments, tube forming and sealing device 12 may be arranged such that tube 4 may have a vertical orientation.

[0040] More specifically, tube forming and sealing device 12 may comprise at least two forming ring assemblies 17, preferentially arranged within isolation chamber 14, even more preferentially arranged within inner environment 15, being configured to gradually fold in cooperation with one another web 3 into tube 4, preferentially by overlapping the edges of web 3 with one another. Thereby, in use, seam portion 6 of tube 4 may be formed.

[0041] Additionally, tube forming and sealing device 12 may comprise a sealing head 18, preferentially arranged within isolation chamber 14, even more preferentially within inner environment 15, and configured to longitudinally seal tube 4, preferentially along longitudinal seam portion 6.

[0042] Moreover, tube forming and sealing device 12 may also comprise a pressure assembly configured to exert a mechanical force on longitudinal seam portion 6 to ensure sealing of tube 4 along longitudinal seam portion 6.

[0043] Preferentially, filling device 13 may comprise a filling pipe 19 being configured to direct, in use, the pourable product into tube 4. Preferentially, filling pipe 19 may, in use, be at least partially placed within tube 4 for feeding, in use, the pourable product into tube 4.

[0044] With particular reference to Figures 1 and 2, package forming apparatus 10 may comprise one or more, preferentially a plurality of, operative devices 25 (only partially shown to the extent necessary for the comprehension of the present invention), each one configured to manipulate, preferentially to at least transversally seal and/or transversally cut tube 4 and/or to form (shape), the, in use, advancing tube 4.

[0045] Preferentially, package forming apparatus 10 may be configured to control each operative device 25 such to transversally seal and transversally cut tube 4 along equally spaced transversal cross sections, preferentially thereby forming the respective first transversal sealing bands 5 and/or the respective second transversal sealing bands.

[0046] According to some possible non-limiting embodiments, package forming apparatus 10 may comprise at least two operative devices 25, preferentially exactly two.

[0047] In further detail and with particular reference to Figure 2, each operative device 25 may comprise at least a first operative group 26 and a second operative group 27 configured to cooperate with one another so as to manipulate tube 4, preferentially so as to transversally seal and/or transversally cut and/or to at least partially form, tube 4.

[0048] In particular, each first operative group 26 and the respective second operative group 27 may be movable with respect to one another, preferentially so as to move each first operative group 26 and the respective second operative group 27 towards and away from one another.

[0049] Preferentially, at least one of first operative group 26 and second operative group 27 of each operative device 25 may be rotatable (angularly movable) about a respective rotation axis B. Preferentially, each first operative group 26 and each second operative group 27 may be rotatable about a respective rotation axis B so as to control the relative position between each first operative group 26 and the respective second operative group 27.

[0050] In more detail, each operative device 25 may be controllable between an active configuration, in which the respective first operative group 26 and the respective second operative group 27 are moved towards one another for manipulating, preferentially transversally sealing and/or transversally cutting and/or for at least partially forming, tube 4 and a rest configuration, in which the respective first operative group 26 and the respective second operative group 27 are withdrawn from one another.

[0051] More specifically, each first operative group 26 and/or the respective second operative group 27 may be positioned in a respective first angular position with respect to the respective rotation axis B and a respective second angular position with respect to the respective

rotation axis B, different from the first angular position, with the respective operative device 25 being controlled in the respective active configuration and the respective rest configuration.

[0052] Preferentially, in use, each first operative group 26 and/or each second operative group 27 cyclically moves between the respective first angular position and the respective second angular position so as to cyclically control the respective operative device 25 between the respective active configuration and the respective rest configuration.

[0053] Moreover, package forming apparatus 10 may also comprise a conveying unit configured to advance each first operative group 26 and each second operative group 27 along a respective first advancement path and a respective second advancement path, respectively.

[0054] In more detail, each first advancement path and each second advancement path may comprise an operative portion along which each first operative group 26 and the respective second operative group 27 advance, in use, in a direction of advancement of tube 4, and a return portion along which each first operative group 26 and each second operative group 27 advance, in use, in a direction opposite to the direction of advancement of tube 4 so as to bring each first operative group 26 and each second operative group 27 back to the respective operative portion.

[0055] Moreover, each operative device 25 may be controlled from the respective rest configuration to the respective active configuration during advancement of the respective first operative group 26 and the respective second operative group 27 along the respective operative portion, preferentially to transversally seal, and preferentially to also transversally cut and to at least partially form, tube 4.

[0056] More specifically, each first operative group 26 and/or the respective second operative group 27 may move from the respective second angular position to the respective first angular position and from the respective first angular position to the respective second angular position during movement along the respective operative portion and the respective return portion, respectively.

[0057] In particular, when the respective first operative group 26 and the respective second operative group 27 of a first operative device 25 are spaced apart from one another (i.e. being in the rest configuration) a first passage is defined between the respective first operative group 26 and the respective second operative group 27 of the first operative device 25. In this way, the respective first operative group 26 and the respective second operative group 27 of a second operative device 25, which are arranged close to each other (i.e. being in the active configuration), can pass through the first passage. In a similar way, when the respective first operative group 26 and the respective second operative group 27 of the second operative device 25 are spaced apart from one another (i.e. being in the rest configuration) a second passage is defined between the respective first operative group 25 and the respective second operative group 26 of the respective second operative device 25. In this way, the respective first operative group 26 and the respective second operative group 27 of the respective first operative device 25, which are arranged close to each other (i.e. being in the active configuration), can pass through the second passage.

[0058] According to some preferred non-limiting embodiments, package forming apparatus 10 may comprise one or more actuation units configured to selectively control each operative device 25 between the respective active configuration and the respective rest configuration.

[0059] Advantageously and with particular reference to Figures 3 to 5, package forming apparatus 10 may comprise at least one sensor device 28 configured to determine an angular position and/or an angular movement of each first operative group 26 and/or of the respective second operative group 27.

[0060] Preferentially, package forming apparatus 10 comprises a respective sensor device 28 for each operative device 25.

[0061] With particular reference to Figure 3, package forming apparatus 10 may comprise a support structure 29 movably carrying operative devices 25.

[0062] According to some possible embodiments, support structure 29 may comprise one or more support assemblies 30 (only one shown), each one movably carrying at least one, preferentially exactly one, respective operative device 25.

[0063] According to some non-limiting embodiments, package forming apparatus 10 may comprise at least two, preferentially exactly two, operative devices 25, and support structure 29 may comprise at least two, preferentially exactly two, support assemblies 30.

[0064] Preferentially, support assemblies 30 may be spaced apart from one another.

[0065] Even more preferentially, support assemblies 30 may be arranged such that, in use, the advancing tube 4 may be interposed between support assemblies 30. More specifically, support assemblies 30 may define the advancement space within which, in use, tube 4 advances.

[0066] Advantageously, each support assembly 30 may comprise a respective first guide 31, preferentially having a linear shape, and a respective second guide 32, preferentially having a linear shape, spaced apart from the respective first guide 31.

[0067] With particular reference to Figures 3 to 5, each operative device 25 may comprise a respective support group 33.

[0068] Preferentially, each support group 33 may be movably coupled to one respective support structure 29, preferentially to one respective support assembly 30, more preferentially to one respective first guide 31 and to one respective second guide 32.

[0069] Preferentially, the conveying unit may be configured to move each support group 33 along, preferentially forward and backward, along the respective first

guide 31 and the respective second guide 32 so as to move the respective first operative group 26 and the respective second operative group 27 along the respective advancement path.

[0070] According to some preferred non-limiting embodiments, each support group 33 may comprise at least a respective first coupling structure and a respective second coupling structure (not specifically shown) coupling support group 33 to the respective first guide 31 and the respective second guide 32, respectively.

[0071] With particular reference to Figures 3 to 5, each operative device 25 comprises at least one shaft 34 angularly movably coupling the respective first operative group 26 to the respective support device 33. Preferentially, shaft 34 may be rotatable about and/or may define the respective rotation axis B.

[0072] Preferentially, each operative device 25 may comprises a further shaft 34 (not specifically shown), angularly movably coupling the respective second operative group 27 to the respective support device 33. Preferentially, the further shaft 34 may be rotatable about and/or may define the respective rotation axis B.

[0073] In more detail, each shaft 34 may be mounted to the respective support device 33 and may be rotatable about the respective rotation axis B.

[0074] Preferentially, each shaft 34 associated with the respective first operative group 26 may be parallel to the respective shaft 34 associated to the respective second operative group 27.

[0075] Preferentially, each shaft 34 may comprise a first end 35 and a second end 36 opposite to the respective first end.

[0076] Moreover, each support device 33 may comprise respective seats 37 for the respective first ends 35 and the respective second ends 36.

[0077] According to some preferred non-limiting embodiments, each shaft 34 may be transversal, preferentially perpendicular, to the respective first guide 31 and/or the respective second guide 32.

[0078] Advantageously, each sensor device 28 may comprise at least one sensor body 40 fixed to one respective shaft 34 and, in use, angularly moving together with the respective shaft 34, preferentially about the respective rotation axis B, and at least one sensor head 41 configured to determine and/or measure an angular position and/or an angular movement of sensor body 40, thereby also determining and/or measuring the angular position and/or the angular movement of the respective first operative group 26 and/or the respective second operative group 27.

[0079] According to some possible embodiments, sensor body 40 may be fixed to the respective shaft 34, preferentially to the respective first end 35, associated to the respective first operative group 26 or the respective second operative group 27.

[0080] According to some possible embodiments, each sensor device 28 may comprise two sensor bodies 40, one sensor body 40 being fixed to the shaft 34 associated to the respective first operative group 26 and the other sensor body 40 being fixed to the shaft 34 associated to the respective second operative group 27. Moreover, each sensor device 28 may also comprise two sensor heads 41, each one configured to determine and/or measure the angular position and/or the angular movement of one respective sensor body 40.

[0081] According to some preferred non-limiting embodiments, each sensor device 28 by determining the angular position and/or the angular movement of each respective sensor body 40 is able to determine the angular position and/or the angular movement of the respective first operative group 26 and/or the respective second operative group 27.

[0082] Accordingly, operation of each sensor device 28 allows to understand whether each operative device 25 correctly operates and/or whether one or both of the respective first operation group 26 and the respective second operation group 27 work in an undesired manner.

[0083] According to some preferred non-limiting embodiments, each sensor body 40 and the respective sensor head 41 may operate as a magnetic encoder.

[0084] In more detail, each sensor body 40 may comprise and/or consist of a magnetic element 42, preferentially a permanent magnet.

[0085] Preferentially, each magnetic element 42 may comprise a plurality of alternatingly arranged north poles and south poles. More preferentially, north poles and south poles may be arranged about a central axis C of magnetic element 42, preferentially central axis C being coaxial to the respective rotation axis B.

[0086] According to some preferred non-limiting embodiments, each magnetic element 42 may be ring-shaped.

[0087] Preferentially, each magnetic element 42 may have a magnetization in a radial direction.

[0088] According to some preferred non-limiting embodiments, each sensor head 41 is arranged adjacent to the respective sensor body 40, preferentially such to detect changes in the magnetic field of the respective sensor body 40.

[0089] According to some preferred non-limiting embodiments, each sensor head 41 may be fixedly mounted on the respective support group 33.

[0090] Preferentially, each sensor head 41 may be chosen from a group of comprising a magnetic sensor, a Hall effect sensor, an induction sensor, and a rotary potentiometer.

[0091] Most preferentially, each sensor head 41 may be configured to measure the angular movement of the respective sensor body 40, more preferentially by means of the Hall effect, and in order to determine the angular position from the angular movement.

[0092] According to some preferred non-limiting embodiments, package forming apparatus 10 may comprise a monitoring unit operatively connected to each sensor head 41 and configured to receive measurement signals from each sensor head 41.

[0093] Preferentially, the monitoring unit may be configured to (selectively) determine respective determined time-dependent curves (see the solid curve in Figure 6 as an example) of the angular position and/or the angular movement of the one or more sensor bodies 40.

[0094] According to some preferred non-limiting embodiments, the monitoring unit may be configured to compare the determined time-dependent curves with respective characteristic time-dependent curves and to assess differences between the determined time-dependent curve and the characteristic time-dependent curve and/or to assess whether or not the determined time-dependent curve lies within a tolerable range (with respect to the respective characteristic time-dependent curve). In particular, each characteristic time-dependent curve may correspond to an ideal and/or expected shape and/or course of the respective determined time-dependent curve.

[0095] Preferentially, the monitoring unit may be configured to issue an error message, e.g. a visual and/or audio and/or a text error message, and/or to control an interruption of the operation of package forming apparatus 10 if the differences between one or more determined time-dependent curves and the respective characteristic time-dependent curves are not acceptable and/or if the determined time-dependent curve fails to lie within a tolerable range (with respect to the respective characteristic time-dependent curve) .

[0096] According to some possible embodiments, the monitoring unit may be configured to issue, based on the comparison between one or more determined time-dependent curves with the respective characteristic time-dependent curves, an information message, e.g. a visual and/or audio and/or a text error message, about the necessity of performing a maintenance activity with respect to one or more operative devices 25.

[0097] With particular reference to Figure 3, each operative device 25 may comprise a connecting structure 43 carrying the respective first operative group 26 and the respective second operative group 27.

[0098] Moreover, each connecting structure 43 may be coupled to the respective support device 33 by means of at least the respective shafts 34.

[0099] Preferentially, each connecting structure 43 may comprise the respective shaft 34.

[0100] Preferentially, each connecting structure 43 may comprise a respective first portion 44 and a respective second portion 45 being movable with respect to one another.

[0101] Additionally, each first portion 44 and the respective second portion 45 may be rotatably coupled about the respective rotation axis B to the respective support device 33 by means of one respective shaft 34.

[0102] Moreover, an angular movement of each first portion 44 and of each second portion 45 corresponds to the respective angular movement of the respective shaft 34. Preferentially, each first portion 44 may be operatively coupled to the respective second portion 45 such that angular movement of first portion 44 and second portion 45 are synchronized with respect to one another, in other words, angular movement of one of first portion 44 and second portion 45 results in angular movement of the other one of first portion 44 and second portion 45.

[0103] Preferentially, the angular movement of each first operative group 26 about the respective rotation axis B and the angular movement of the respective second operative group 27 about the respective rotation axis B may be synchronized with respect to one another, more preferentially by coupling the respective first portion 44 and of the respective second portion 45 to one another.

[0104] In more detail, in use, an extent and a direction of the angular movement of each first operative group 26 corresponds to an extent and a direction of the angular movement of the respective second operative group 27.

[0105] Preferentially, as the angular movements of each first operative group 26 and the respective second operative group 27 may be synchronized, it may be possible to rely on each sensor device 28 having a single sensor body 40 and a single sensor head 41.

[0106] According to some preferred non-limiting embodiments, each first operative group 26 may be connected to and/or carried by the respective first portion 44 and the respective second operative group 27 may be connected to and/or carried by the respective second portion 45.

[0107] Preferentially, each first operative group 26 and the respective second operative group 27 may be laterally displaced from, respectively, the respective first portion 44 and the respective second portion 45, preferentially such that each first operative group 26 and the respective second operative group 27 may move within the advancement space.

[0108] Moreover, angular movement of each first portion 44 and of the respective second portion 45 leads to angular movement of the respective first operative group 26 and the respective second operative group 27, respectively.

[0109] Preferentially, each connecting structure 43 may comprise respective bars 48 (only one shown) connecting each first operative group 26 with the respective first portion 44 and each second operative group 27 with the respective second group 45.

[0110] In particular, the actuation unit may be configured to angularly move each first portion 44 and the respective second portion 45 so as to induce the angular movement of the respective first operative group 26 and the respective second operative group 27.

[0111] With particular reference to Figure 2, each operative device 25 may comprise a respective sealing element 46 and a respective counter-sealing element 47 configured to transversally seal in cooperation with one another tube 4.

[0112] According to some preferred non-limiting embodiments, one of first operative group 26 and the respective second operative group 26 may comprise the

respective sealing element 47 and the other one of first operative group 26 and the respective second operative group 26 may comprise the respective counter-sealing element 47.

[0113] More specifically, each sealing element 46 and the respective counter-sealing element 47 may be configured to at least transversally compress, in particular flat-lay and squeeze, and to transversally seal tube 4, in particular during advancement of tube 4 along tube advancement path Q.

[0114] Moreover, each sealing element 46 and the respective counter-sealing element 47 may be configured to engage tube 4 from opposite sides thereof.

[0115] In further detail, each sealing element 46 may comprise a source configured to generate the energy needed to obtain the sealing effect. For example, sealing element 46 may be a sonotrode having ultrasound-emitters or sealing element 46 may have an electromagnetic induction source. Each counter-sealing element 47 may be a passive element (i.e. not having an active source). For example counter-sealing element 47 may be a metal anvil or a deformable pad.

[0116] Additionally, each operative device 25 may comprise at least one cutting element configured to transversally cut tube 4. Preferentially, each cutting element may be configured to transversally cut tube 4 after sealing of tube 4 by means of the respective sealing assembly.

[0117] Preferentially, each sealing element 46 and the respective counter-sealing element 47 may be moved towards and withdrawn from one another with the respective first operative group 26 and the respective second operative group 27 moving from the respective second angular position to the respective first angular position and from the respective first angular position to the respective second angular position.

[0118] Each cutting element may be associated with one of the respective first operative group 26 and the respective second operative group 27.

[0119] According to some preferred non-limiting embodiments, each operative device 25 may also comprise a first half-shell and a second half-shell configured to form tube 4, preferentially to at least partially define the shape of packages 2. Preferentially, each first half-shell and the respective second half-shell may be configured to contact tube 4 from opposite sides thereof.

[0120] According to some preferred non-limiting embodiments one of the first half-shell and the second half-shell may be coupled to first operative group 26 and the other one of the first half-shell and the second half-shell may be coupled to second operative group 27.

[0121] In use, packaging machine 1 produces packages 2 filled with the pourable product.

[0122] In more detail, conveying device 11 advances web 3 along web advancement path P. Tube forming and sealing device 12 forms tube 4 from the advancing web 3 and longitudinally seals tube 4. Additionally, filling device 13 fills tube 4 with the pourable product and package forming apparatus 10 forms, transversally seals and transversally cuts tube 4 so as to obtain packages 2.

[0123] In further detail, during operation of package forming apparatus 10, operative devices 25 manipulate, preferentially transversally seal, transversally cut and at least partially form tube 4.

[0124] During operation of each operative device 25, the respective first operative group 26 and the respective second operative group 27 are cyclically moved between the respective first angular positions and the respective second angular positions. Each sensor device 28 allows to determine and/or measure the angular position and/or the angular movement of at least one of the respective first operative group 26 and/or of the respective second operative group 27.

[0125] The advantages of package forming apparatus 10 and/or packaging machine 1 according to the present invention will be clear from the foregoing description.

[0126] In particular, by monitoring the angular position α and/or the angular movement $\Delta\alpha$ of each sensor body 40 it is possible to monitor the angular positions and/or angular movements of first operative groups 26 and/or second operative groups 27. Additionally, this allows to understand whether first operative groups 26 and/or second operative groups 27 work as expected.

[0127] Moreover, it may be possible to execute a predictive maintenance protocol.

[0128] Clearly, changes may be made to package forming apparatus 10 and/or packaging machine 1 as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

Claims

1. Package forming apparatus (10) for a packaging machine (1) and configured to manipulate a tube (4) for obtaining packages (2) from the tube (4);

   wherein the package forming apparatus (10) comprises at least one operative device (25) having a first operative group (26) and a second operative group (27) configured to manipulate in cooperation with one another the tube (4) for forming respective packages (2);
   wherein each first operative group (26) and the respective second operative group (27) are configured to execute a relative movement with respect to one another;
   wherein each operative device (25) comprises at least one support group (33) carrying the respective first operative group (26) and the respective second operative group (27);
   wherein each first operative group (26) is mounted to the respective support group (33) in such a manner to be angularly movable about a rotation axis (B);
   wherein each first operative group (26) is cou-

pled to the support group (33) by means of a respective shaft (34) rotatable about and/or defining the rotation axis (B);
wherein the package forming apparatus (10) comprises at least one sensor device (28) having at least one sensor body (40) fixed to the shaft (34) and, in use, angularly moving together with the shaft (34) and at least one sensor head (41) configured to determine and/or measure an angular position (α) and/or an angular movement ($\Delta\alpha$) of the sensor body (40) for determining and/or measuring an angular position and/or an angular movement of the respective first operative group (26).

2. Package forming apparatus according to claim 1, wherein the sensor device (28) operates as a magnetic encoder.

3. Package forming apparatus according to claim 1 or 2, wherein the sensor body (40) comprises a magnetic element (42) .

4. Package forming apparatus according to claim 3, wherein the magnetic element (42) comprises a plurality of alternatingly arranged north poles and south poles.

5. Package forming apparatus according to claim 3 or 4, wherein the magnetic element (42) is ring-shaped.

6. Package forming apparatus according to any one of the preceding claims, wherein the sensor head (41) is fixedly mounted to the support group (33).

7. Package forming apparatus according to any one of the preceding claims, wherein the sensor head (41) is chosen from a group comprising magnetic sensors and Hall effect sensors, induction sensors, rotary potentiometers.

8. Package forming apparatus according to claim 7, and further comprising a monitoring unit operatively connected to the at least one sensor head (41) and configured to determine a determined time-dependent curve of the angular position (α) and/or the angular movement ($\Delta\alpha$) of the sensor body (40).

9. Package forming apparatus according to claim 8, wherein the monitoring unit is configured to compare the determined time-dependent curve with a characteristic time-dependent curve and to assess differences between the determined time-dependent curve and the characteristic curve and/or to assess on whether or not the determined time-dependent curve lies within a tolerable range.

10. Package forming apparatus according to claim 9, wherein the monitoring unit is configured to issue an error message and/or to control an interruption of the operation of the package forming apparatus if the differences between the determined time-dependent curve and the characteristic curve are not acceptable and/or if the determined time-dependent curve fails to lie within a tolerable range and/or to issue, based on the comparison between one or more determined time-dependent curves with the respective one or more characteristic time-dependent curves, an information message about the necessity of performing a maintenance activity.

11. Package forming apparatus according to any one of the preceding claims, wherein each operative device (25) comprises a sealing element (46) and a counter-sealing element (47) configured to transversally seal in cooperation the tube (4) and/or a cutting element for transversally cutting the tube (4) and/or a first half-shell and a second half-shell for at least partially forming in cooperation the tube (4);

wherein one of the first operative group (26) and the second operative group (27) comprises the sealing element (46) and/or the first half-shell and the other one of the first operative group (26) and the second operative group (27) comprises the counter-sealing element (47) and/or the second half-shell;
wherein one of the first operative group (26) and the second operative portion (27) comprises the cutting element.

12. Package forming apparatus according to any one of the preceding claims, wherein each operative device (25) comprises a connecting structure (43) connected to the support group (33) and having a first portion (44) and a second portion (45) being movable with respect to one another;

wherein the first operative group (26) and the second operative group (27) are connected to and are laterally displaced from, respectively, the first portion (44) and the second portion (45);
wherein each first portion (44) of the connecting structure (43) comprises the respective shaft (34) and is rotatable about the respective rotation axis (B) and/or each second portion (45) of the connecting structure (43) comprises the respective shaft (34) and is rotatable about the respective rotation axis (B).

13. Package forming apparatus according to any one of the preceding claims, and further comprising at least one first guide (31) and one second guide (32);

wherein the support group (33) is movably coupled to the first guide (31) and the second guide

(32);
wherein at least the first operative group (26) rotates, in use, about the respective rotation axis (B) during movement of the support group (33) along the first guide (31) and the second guide (32).

14. Package forming apparatus according to any one of the preceding claims, wherein each second operative group (27) is angularly movable about a respective further rotation axis (B), wherein, in use, an angular movement of each first operative group (26) about the respective rotation axis (B) and an angular movement of the respective second operative group (27) about the respective further rotation axis (B) are synchronized with respect to one another.

15. Packaging machine (1) for forming packages (2) of a pourable product from an advancing tube (4) formed and longitudinally sealed from a web of packaging material (4);
the packaging machine (1) comprises:

- a conveying device (11) configured to advance the web of packaging material (3) along a web advancement path (P) and for advancing the tube (4) along a tube advancement path (Q) ;
- a tube forming and sealing device (12) configured to form the tube (4) from the web of packaging material (3) and to longitudinally seal the tube (4);
- a filling device (13) for filling the tube (4) with the pourable product; and
- a package forming apparatus (10) according to any one of the preceding claims.

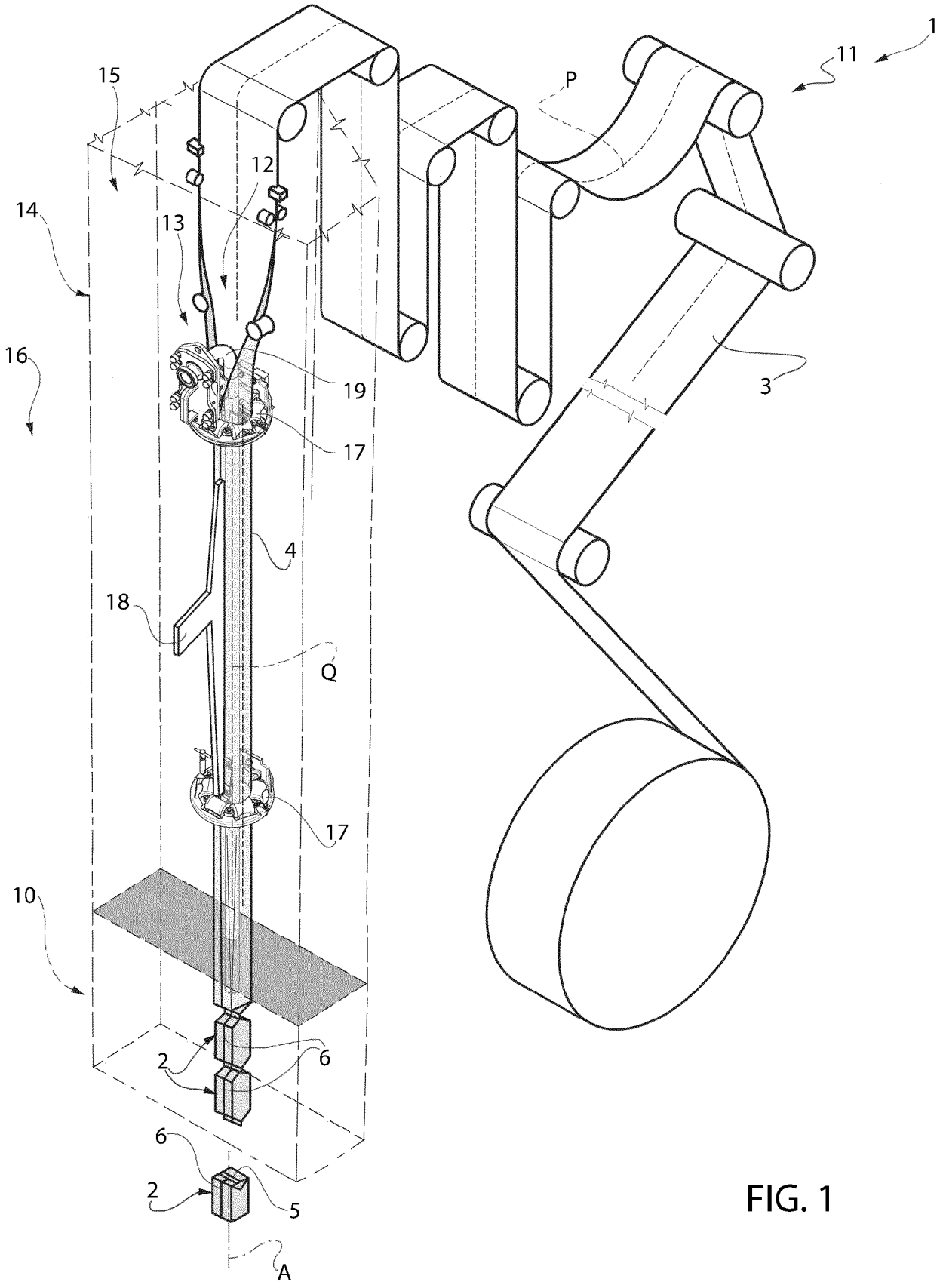

FIG. 1

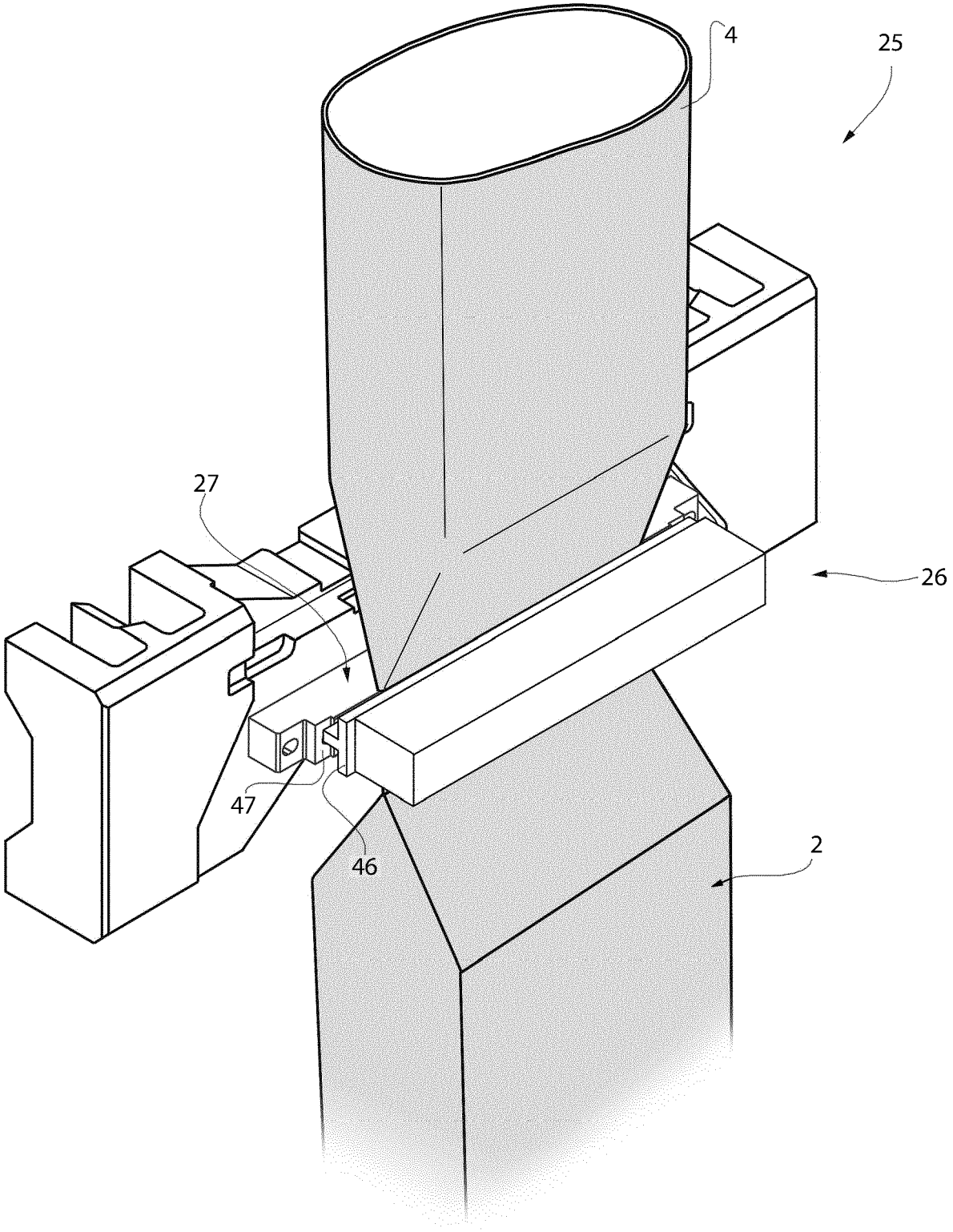

FIG. 2

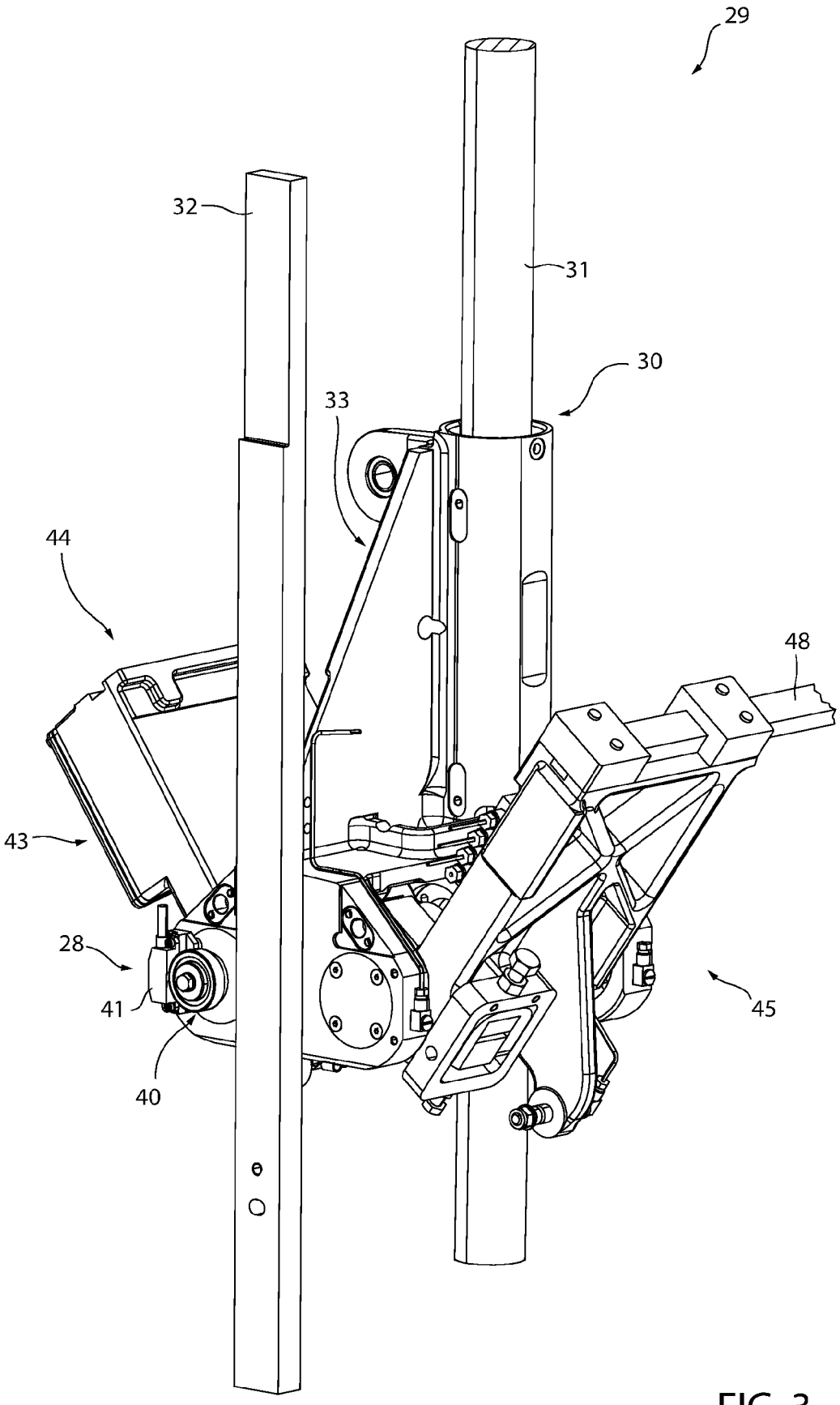

FIG. 3

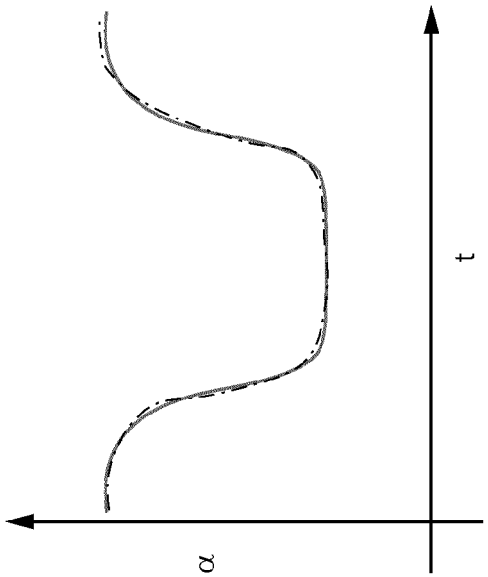

FIG. 6

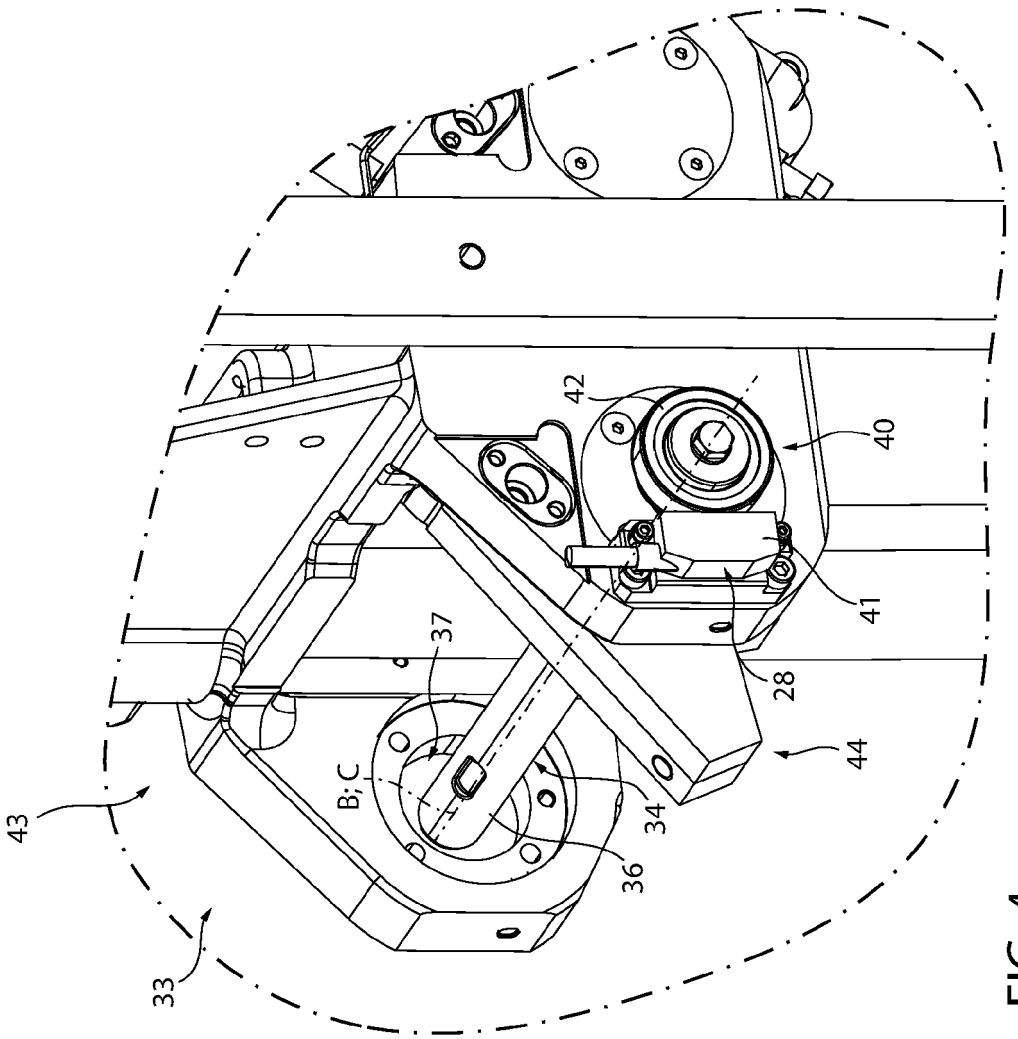

FIG. 4

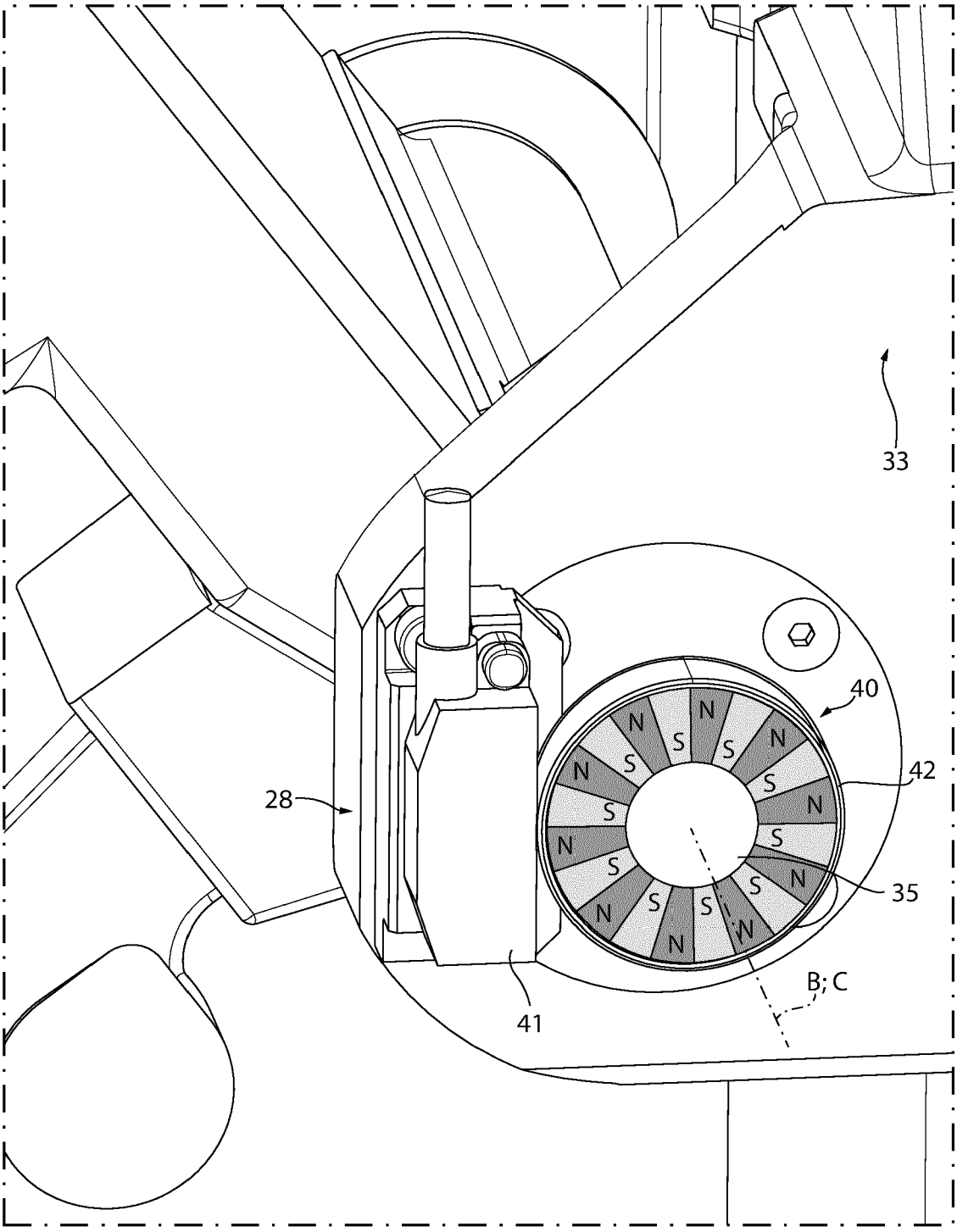

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 24 15 3893

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2010/018141 A1 (TETRA LAVAL HOLDINGS & FINANCE [CH]; ANDREOTTI STEFANO [IT] ET AL.) 18 February 2010 (2010-02-18) * figures 1,3,4 *	1,11-15	INV. B65B9/20
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TECHNICAL FIELDS SEARCHED (IPC)

B65B
B29C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 May 2024	Bridault, Alain

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22-05-2024

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