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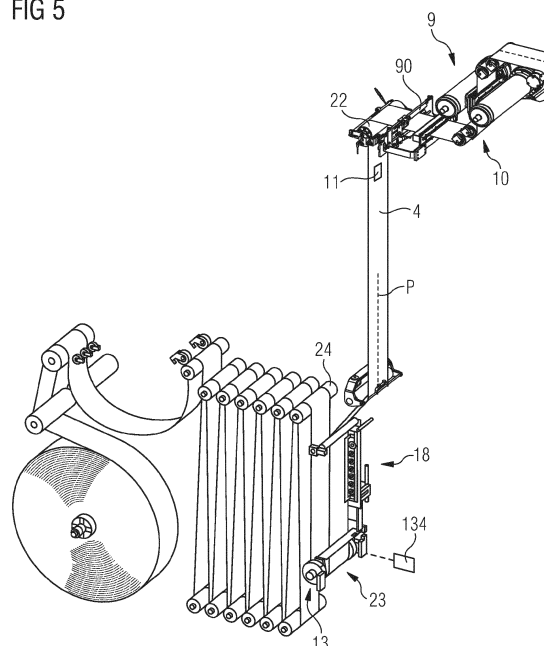
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(54) **PACKAGING MACHINE FOR PRODUCING SEALED PACKAGES OF A POURABLE PRODUCT FROM A WEB OF PACKAGING MATERIAL**

(57) There is described a packaging machine (1) for producing sealed packages (2) of a pourable product from a web (4) of packaging material, the packaging machine (1) comprising a sterilization apparatus (9) for sterilizing a web (4) of packaging material advancing along an advancement path (P) and comprising a first sterilizing device (10) configured to sterilize at least a first face (5) of the web (4) advancing through the first sterilizing device (10), a control unit (12) configured to, if an anomaly is detected, interrupt advancement of the web (4), an isolation chamber (14), a tube forming device (17), a sealing device (19), a filling unit (20), a package forming unit (21), a plurality of conveyors (22, 23, 24) configured to advance the web (4) of packaging material along the web advancement path (P) and for advancing the tube (3) along a tube advancement path (Q), wherein the plurality of conveyors (22, 23, 24) comprises at least one conveyor (22, 23, 24), upstream of the sterilization apparatus (9), comprising an actuator (13) configured to control a brake velocity of the advancing web (4) and/or control a tensioning of said advancing web (4).

FIG 5



Description

TECHNICAL FIELD

[0001] The present invention relates to a sterilization apparatus for sterilizing a web of packaging material, in particular a web of packaging material for the production of sealed packages of a pourable product, in particular a pourable food product.

[0002] The present invention also relates to a packaging machine for producing sealed packages of a pourable product, in particular a pourable food product, having a sterilization apparatus.

[0003] The present invention also relates to a method for sterilizing a web of packaging material, in particular a web of packaging material for the production of sealed packages of a pourable product, in particular a pourable food product.

BACKGROUND ART

[0004] 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.

[0005] 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.

[0006] Packages of this sort are normally produced on fully automatic packaging machines, which advance a web of packaging material from a magazine unit through a sterilization apparatus for sterilizing the web of packaging material and to an isolation chamber (a closed and sterile environment) in which the sterilized web of packaging material is maintained and advanced. During advancement of the web of packaging material through the isolation chamber, the web of packaging material is folded and sealed longitudinally to form a tube having a longitudinal seam portion, which is further fed along a vertical advancing direction.

[0007] In order to complete the forming operations, the tube is filled with a sterilized or sterile-processed pourable product, in particular a pourable food product, and is transversally sealed and subsequently cut along equally spaced transversal cross sections within a package forming unit of the packaging machine during advancement

along the vertical advancing direction.

[0008] Pillow packages are so obtained within the packaging machine, each pillow package having a longitudinal sealing band, a top transversal sealing band and a bottom transversal sealing band.

[0009] In the recent years, sterilization apparatuses have become available, which are configured to sterilize the web of packaging material by means of the application of physical irradiation, in particular electromagnetic irradiation, even more particular electron beam irradiation. In alternative, solutions are known of sterilization apparatus exploiting hydrogen peroxide, wherein the web of packaging material is sterilized by means of the introduction thereof in a hydrogen peroxide bath.

[0010] Even though known sterilization apparatus and, accordingly, also the packaging machine provide for good results, a desire is felt to improve performance of the sterilization apparatus.

[0011] A need is felt for efficiently and timely dealing with anomalies in operation of the sterilization apparatus, e.g. anomalies in temperature of a peroxide bath in case of hydrogen peroxide sterilization, an anomaly in radiation of UV lamps and/or an electric arc event in case of sterilization by means of an electron beam.

[0012] These anomalies result in a temporary interruption of production that in certain cases might last hours, leading to economic losses and time-consuming tasks for the machine operator. Accordingly, a need is felt for providing solutions facilitating minimizing the downtime of the machine. The need is also felt to facilitate minimization of the downtime while also meeting elevated sterilization performance.

[0013] For example, when an electric arc occurs in case of electron beam emitters, the packaging machine operation has to be interrupted. An operator then manually cuts and extracts a lower portion of the packaging material, connects a cleaning pipe for cleaning the filling means, cleans the sterilization apparatus and repositions the packaging material in the correct position. A further sterilization is then performed before resuming the normal packaging machine operation. Such operations are time-consuming and the downtime may last several hours.

DISCLOSURE OF INVENTION

[0014] It is therefore an object of the present invention to provide a packaging machine comprising a sterilization apparatus to facilitate overcoming, in a straightforward and low-cost manner, at least one of the aforementioned drawbacks.

[0015] In particular, it is an object of the present invention to provide a packaging machine able to react time-efficiently to an anomaly in operation.

[0016] According to the present invention, there is provided a packaging machine according to claim 1. Preferred embodiments are claimed in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] 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 details of a packaging machine having a sterilization apparatus according to one or more embodiments, with parts removed for clarity;

Figure 2 is a schematic view of a sterilization apparatus according to one or more embodiments, with parts removed for clarity;

Figures 3 and 4 are a schematic representation of the sterilization apparatus 9 when an anomaly is detected and after interruption of web advancement, respectively;

Figure 5 is a schematic view of details of a packaging machine having a sterilization apparatus according to one or more embodiments, with parts removed for clarity;

Figures 6 and 7 are representations of a conveyor and actuator according to aspects of the invention.

BEST MODES FOR CARRYING OUT THE INVENTION

[0018] 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 pasteurized milk, fruit juice, wine, tomato sauce, etc., from a tube 3 formed from a web 4 of packaging material. In particular, in use, tube 3 extends along a longitudinal axis, in particular having a vertical orientation.

[0019] Web 4 at least comprises a layer of fibrous material, in particular paper, covered on both sides with respective layers of heat-seal plastic material, e.g. polyethylene.

[0020] Preferably, web 4 also comprises a layer of gas- and light-barrier material, e.g. aluminum foil or ethylene vinyl alcohol (EVOH) film, and at least a first layer and a second layer of heat-seal plastic material. The layer of gas- and light-barrier material is superimposed on the first layer of heat-seal plastic material, and is in turn covered with the second layer of heat-seal plastic material. The second layer of heat-seal plastic material forms the inner face of package 2 eventually contacting the filled pourable food product.

[0021] More specifically, web 4 comprises a first face or surface 5 and a second face or surface 6, in particular first (sur)face 5 being the face of web 4 forming the inner face of the formed package 2 eventually contacting the filled pourable food product.

[0022] A typical package 2 obtained by packaging machine 1 comprises a longitudinal seam portion and a pair of transversal sealing bands, in particular a transversal top sealing band and a transversal bottom sealing band.

[0023] With particular reference to Figure 1, packaging machine 1 is configured to advance web 4 along a web

advancement path P, to sterilize web 4 during advancement along path P, to form tube 3 from web 4 and to fill tube 3 and to form single packages 2 from the filled tube 3.

[0024] Preferably, the packaging machine 1 comprises:

- a sterilization apparatus 9 comprising a first sterilizing device 10 configured to sterilize at least the first (sur)face 5, preferentially also the second (sur)face 6, of the web 4,
- an isolation chamber 14 separating an inner environment 15, in particular an inner sterile environment, from an outer environment 16,
- a tube forming device 17 arranged at least partially, preferably fully, within isolation chamber 14 and being configured to form tube 3 from the, in use, advancing and sterilized web 4,
- a sealing device 19 at least partially arranged within the isolation chamber 14 and being configured to longitudinally seal tube 3 formed by the tube forming device 17 so as to form a longitudinal seam portion of tube 3,
- a filling unit 20 configured to fill tube 3 with the pourable product, in particular the pourable food product,
- a package forming unit 21 configured to at least form and transversally seal tube 3, in particular the, in use, advancing tube 3, for forming packages 2, and
- a plurality of conveyors configured to advance in a known manner web 4 along path P and to advance tube 3 along a tube advancement path Q.

[0025] In particular, the sterilization apparatus 9 may receive the web 4 of packaging material from a host station (not visible in the figures).

[0026] For example, the plurality of conveyors may be configured to advance the web 4 of packaging material from the host station to the sterilization apparatus 9 and/or from the sterilization apparatus 9 to the tube forming device 17. For example, the plurality of conveyors may be configured to advance the tube 3 from the tube forming device 17 to the sealing device 19 and/or from the sealing device 19 to the filling unit 20 and/or from the filling unit 20 to the package forming unit 21.

[0027] Preferably, the plurality of conveyors is adapted to advance tube 3 and any intermediate of tube 3 in a manner known as such along path Q, in particular from tube forming device 17 towards and at least partially through package forming unit 21.

[0028] In one or more embodiments, the plurality of conveyors comprises a first conveyor 22, (immediately) upstream of the sterilization apparatus 9. In particular, the first conveyor 22 may be positioned immediately upstream of an inlet 90 of the sterilization apparatus 9.

[0029] Preferentially, packaging machine 1 also comprises pressure control means configured to control the pressure within at least isolation chamber 14 and within at least portions of sterilization apparatus 9.

[0030] The sterilization apparatus 9 may be arranged

upstream of the tube forming station 17, with respect to the web advancement path P.

[0031] The sterilization apparatus 9 may comprise an outlet 92. The outlet 92 may be positioned downstream with respect to the first sterilizing device 10 along the web advancing path P. The sterilized web 4 may advance through the outlet 92 towards the isolation chamber 14.

[0032] The isolation chamber 14 may comprise an inlet 140, wherein the inlet 140 of the isolation chamber 14 may be connected to the outlet 92 of the sterilization apparatus 9.

[0033] The isolation chamber 14 may comprise an outlet 142, wherein the tube 3, filled with pourable product, may exit the isolation chamber 14 at the outlet 142.

[0034] The package forming unit 21 may be arranged downstream of isolation chamber 14 and tube forming device 17 along path Q.

[0035] In one or more embodiments, as depicted with apparatur reference to figures 3 and 4, the sterilization apparatus 9 comprises:

- a first sterilizing device 10 configured to sterilize at least a first (sur)face 5, preferably also the second (sur)face 6, of the web 4 advancing through the first sterilizing device 10,
- a second sterilizing device 7,
- a monitoring device 8, configured to monitor operation of the first sterilizing device 10,
- a movement sensor 11 configured to monitor advancement of the web 4 along the advancement path P, and
- a control unit 12, connected to the monitoring device 8 and the movement sensor 11, the control unit 12 configured to, if an anomaly (e.g. a deviation from standard operation, such as an electric arc event) is detected in operation of the first sterilizing device 10:
 - interrupt advancement of the web 4,
 - identify a distance D traveled by the web (4) between detection of the anomaly and interruption of advancement, and
 - sterilize at least a portion P1, P2, P3 of the web 4 by means of the second sterilizing device 7, the portion P1, P2, P3 being associated (e.g. substantially corresponding) to the traveled distance D.

[0036] The first sterilizing device 10 may comprise an irradiation device configured to sterilize at least the first face 5, preferably also the second face 6, of the advancing web 4 by directing a sterilizing irradiation onto at least the first face 5 (and optionally second face 6).

[0037] A typical sterilization apparatus of this kind comprises an irradiation device typically having a pair of electron beam emitters spaced apart from one another. An advancement channel, through which, in use, the web 4 of packaging material advances, is interposed between the electron beam emitters. Each one of the electron

beam emitters is configured to direct the respective electron beam onto one respective face of the web of packaging material advancing through the advancement channel.

[0038] A drawback of this type of sterilizing device 10 is that electric arc events may occur. During operation of the electron beam emitters an electric discharge, i.e. an electric arc, may occur that may change a dose of irradiation directed towards face 5 and/or face 6. That is, the anomaly may comprise an electric arc event. The control unit 12 may be configured to detect whether a change occurs in a dose of irradiation directed to the first face 5 (and optionally second face 6) of the web 4.

[0039] In the annexed figures, the first sterilizing device 10 is depicted as an irradiation device as described previously, however it will be appreciated that a different kind of first sterilizing device 10 may be employed, e.g. a hydrogen peroxide bath. In this case, the anomaly may comprise e.g. a change in a temperature of a peroxide bath.

[0040] When an anomaly occurs in the operation of the first sterilizing device 10, the control unit 12 may be configured to interrupt operation of the packaging machine 1. In particular, the control unit 12 may interrupt operation of the first sterilizing device 10, the tube forming device 17, the sealing device 19, the filling unit 20, the package forming unit 21 and/or the plurality of conveyors, preferably at the same time.

[0041] According to one or more embodiments, the traveled distance D is smaller than a distance D1 between the first sterilizing device 10 and the outlet 92. That is, the traveled distance D may be smaller than the distance D1 traveled by the web 4 between the first sterilizing device 10 and the outlet 92 during normal operation.

[0042] For example, the portion P1, P2, P3 being associated (e.g. substantially corresponding) to the traveled distance D may comprise the portion of the web 4 that passes at (e.g. through) the first sterilization device 10 between detection of the anomaly and interruption of advancement. For example, the portion P1, P2, P3 may include a first portion P1-P2 that exits the first sterilizing device 10 between detection of the anomaly and interruption of advancement and a second portion P2-P3 present at (e.g. in) the first sterilizing device 10 when the web advancement is interrupted.

[0043] Accordingly, the step of sterilizing at least the portion P1, P2, P3 associated to the traveled distance D may comprise sterilizing at least the first portion P1-P2 substantially corresponding to the distance D and/or sterilizing the second portion P2-P3 at the first sterilizing device 10 during interruption of web advancement.

[0044] Advantageously, the advancement of the web 4 may be interrupted before the first portion P1-P2 of the web 4 reaches the outlet 92 of the sterilization apparatus 9. This way the first portion P1-P2 does not proceed into the isolation chamber 14.

[0045] Advantageously, thus, the control unit 12 may be configured to (exactly and efficiently) identify the por-

tion P1, P2, P3 that passes through the first sterilizing device 10 when a deviation from normal operation thereof is detected. As such, the portion P1, P2, P3 of the web 4 of packaging material that may be affected by the anomaly can be (accurately and precisely) identified.

[0046] For example, the movement sensor 11 may transmit a first sensor signal, e.g. indicative of speed of and/or position of and/or distance traveled by the web 4 of packaging material.

[0047] Advantageously, the web 4 of packaging material and the tube 3 present in the isolation chamber 14 and the sterilization apparatus 9 at the detection of the anomaly may be present (i.e. remain) in the packaging machine 1 before, during and after the sterilization by means of the second sterilizing device 7.

[0048] Advantageously, thanks to the identification of the traveled distance D and/or the portion P1, P2, P3 affected by the anomaly it is possible to significantly reduce the downtime due to such anomaly. The sterilization that ensues may be localized to the affected area and optionally to the neighboring area.

[0049] Figure 3 depicts the sterilization apparatus 9 according to one or more embodiments when an anomaly occurs.

[0050] The control unit 12 may be configured to receive a second sensor signal from the monitoring device 8, e.g. indicative of sterilization of the web 4 of packaging material.

[0051] The control unit 12 may be configured to detect the anomaly if the second sensor signal reaches (and optionally exceeds) a predetermined threshold. For example, in case the monitoring device comprises an irradiation sensor, the second sensor signal may be indicative of an irradiation dose emitted by the first sterilizing device 10. The control unit 12 may be configured to detect the anomaly if the dose of emitted radiation reaches (e.g. becomes lower than) the threshold, e.g. a lower dose value of radiation.

[0052] Preferably, the control unit 12 may be configured to detect the anomaly when the second sensor signal reaches (or exceeds) the predetermined threshold for a predetermined time period. The predetermined time period may be between 50 ms and 120 ms, preferably between 70 and 110 ms, even more preferably 80 and 100 ms. The predetermined time period may be dependent on the advancement speed of the web 4 of packaging material. For example, the predetermined time period may be indirectly proportional to the advancement speed, i.e. if the advancement speed lowers the predetermined time period can increase.

[0053] Even more preferably, the control unit 12 may be configured to detect the anomaly when the second sensor signal continuously reaches (or exceeds) the predetermined threshold for the predetermined time period. That is, the second sensor signal reaches (or exceeds) the threshold for the entire predetermined time period. Advantageously, the predetermined time period may facilitate detecting real anomalies and filtering out false

anomalies, e.g. fluctuations of the sensor signal due to electrical disturbances.

[0054] The control unit 12 may be configured to start identifying (e.g. calculating) the distance D at the beginning of the predetermined time period. The control unit 12 may be configured to interrupt advancement of the web 4 at the end of the predetermined time period.

[0055] Figure 4 depicts the sterilization apparatus 9 according to one or more embodiments when operation of the sterilization apparatus 9 (and packaging machine 1) is interrupted. The first portion P1-P2 may (substantially) correspond to the traveled distance D. The second portion P2-P3 may comprise the portion present at (e.g. within) the first sterilizing device 10 during interruption of advancement.

[0056] In one or more embodiments, the second sterilization device 7 may comprise a hydrogen peroxide spray tank 70 configured to spray vaporized hydrogen peroxide at least at the portion P1, P2, P3 of the web 4 associated to the traveled distance D between detection of the anomaly and interruption.

[0057] As depicted in the figures, the spray tank 70 may be connected to a tube 72 configured to convey the vaporized hydrogen peroxide at the first sterilizing device 10, in particular at an outlet thereof with respect to the web advancement path P.

[0058] The spray tank 70 may be configured, by means of the tube 72, to sterilize the portion P1-P3 of the web 4. Air (e.g. gas flow) exiting the tube 72 may pass through the first sterilizing device 10 and may be collected through tube 74 (only partially shown). Such air may thus flow through the first sterilizing device in an opposite direction with respect to a web advancement direction along the web advancement path P.

[0059] The second sterilizing device 7 may be configured to sterilize the portion P1, P2, P3 of the web 4 as well as the first sterilizing device 10 and/or generally the sterilization apparatus 9.

[0060] As a preferential further precaution, the second sterilizing device 7 may be configured to sterilize the isolation chamber 14.

[0061] The spray tank 70 may be connected to a further tube 76 configured to convey the vaporized hydrogen peroxide at the isolation chamber 14, in particular the tube 76 may end downstream with respect to the tube forming device 17.

[0062] The spray tank 70 may be configured, by means of the further tube 76, to sterilize the isolation chamber 14. Air (e.g. gas flow) exiting the further tube 76 may pass through the isolation chamber 14, the first sterilizing device 10 and may be collected through tube 74.

[0063] In other words, when the web advancement is interrupted, the second sterilizing device 7 may be configured to spray sterilizing air comprising hydrogen peroxide the first sterilizing device 10 and preferably through the isolation chamber 14.

[0064] The second sterilizing device 7 can be actioned only if the web advancement is interrupted and/or the

first sterilizing device 10 is deactivated.

[0065] According to one or more embodiments, the movement sensor 11 may comprise a rotative encoder, e.g. integrated within a conveyor, preferably upstream of the sterilization apparatus 9, in the plurality of conveyors configured to advance the web 4. Preferably, the first conveyor 22 may comprise the movement sensor 11, however any conveyor upstream of the sterilization apparatus 9 may comprise the movement sensor 11.

[0066] The conveyor comprising the movement sensor 11 may be free from actuating forces. In other words, the conveyor may include a free roller that rotates only thanks to the movement of the web 4. No external forces are applied to such conveyor for influencing the rotation thereof. This way, in the example, if the web 4 advances the first conveyor 22 rotates in a first direction, e.g. anti-clockwise in the figures, and if the web 4 recedes the first conveyor 22 rotates in a second direction opposite to the first direction, e.g. clockwise.

[0067] Advantageously, this may permit an even more accurate reading of the distance D, insofar as also possible backward movement of the web 4 of packaging material is taken into consideration.

[0068] A second conveyor may be in contact with the web 4 at the conveyor comprising the movement sensor 11, on an opposite side of the web 4 with respect to such conveyor comprising the movement sensor 11. This way, the web 4 of packaging material does not slide on the conveyors and a more accurate reading is performed.

[0069] According to one or more embodiments, one or more conveyors, e.g. (immediately) upstream of the sterilization apparatus 9, may comprise an actuator configured to control a brake velocity of the advancing web 4. Advantageously, this way the distance D traveled before interruption of the web 4 may be reduced.

[0070] In addition or in alternative, the actuator may be configured to control a tensioning of the advancing web 4. Advantageously, this way the web 4 of packaging material is kept in tension also when the packaging machine 1 stops, which facilitates sterilization and reduces a risk of damages on the web 4.

[0071] In one or more embodiments, the first conveyor 22 may comprise the movement sensor 11 and the actuator. In addition or in alternative, further conveyor(s) e.g. (immediately) upstream of the first conveyor 22 may comprise the actuator.

[0072] The control unit 12 may be configured to resume advancement of the web 4 of packaging material after the step of sterilizing by means of the second sterilizing device 7 is completed. That is, before, during and after the anomaly detection the web 4 of packaging material remains within the packaging machine 1.

[0073] At least the packages 2 formed with the packaging material present within the sterilization apparatus 9 and isolation chamber 14 during the step of sterilizing by means of the second sterilizing device 7 may be discarded.

[0074] According to one or more embodiments, the

control unit 12 may be configured to transmit an alarm signal, e.g. to an user interface, if the traveled distance D is greater than a predetermined distance, e.g. the distance D1 between the first sterilizing device 10 and the outlet 92 of the sterilization apparatus 9. A cleaning and re-sterilization process is then performed to the isolation chamber 14, filling unit 20 and sterilization apparatus 9.

[0075] One or more embodiments may relate to a method of sterilizing a web 4 of packaging material performed by a sterilization apparatus 9 according to one or more embodiments. The method may comprise:

- advancing the web 4 of packaging material along a web advancement path P,
- sterilizing at least a first face 5, preferably also a second face 6, of the advancing web 4 by means of a first sterilizing device 10,
- monitoring operation of the first sterilizing device 10,
- monitoring advancement of the web 4 along the advancement path P, and
- if an anomaly is detected in operation of the first sterilizing device 10:
 - interrupting advancement of the web 4,
 - identifying a distance D traveled by the web 4 between detection of the anomaly and interruption of advancement, and
 - sterilizing at least a portion P1, P2, P3 of the web 4 by means of the second sterilizing device 7, the portion P1, P2, P3 of the web being associated to the traveled distance D.

[0076] In figures 5 to 7, same reference numbers indicate the same features previously discussed with reference to figures 1 to 4. As the new embodiment described is similar to the previous ones, the following description is limited to the additional features, and using the same references, where possible, for identical or corresponding parts. A detailed discussion will be omitted for the sake of conciseness.

[0077] Figures 5 to 7 depict in more detail an embodiment of a packaging machine 1 comprising a sterilization apparatus 9 comprising the first sterilizing device 10, the isolation chamber 14 connected to the sterilization apparatus 9, the tube forming device 17, the sealing device 19, the filling unit 20, the package forming unit 21, and the control unit 12 (e.g. a packaging machine control unit controlling i.a. the sterilization apparatus 9) configured to, if an anomaly is detected, interrupt advancement of the web 4. The anomaly may comprise the arc event previously described or a different machine event, such as an anomaly detected in operation of one or more parts of the machine.

[0078] The packaging machine 1 may comprise also the second sterilizing device 7, the monitoring device 8, the movement sensor 11. The control unit 12 may be configured to, if an anomaly is detected in operation of the first sterilizing device 10, interrupt advancement of the web 4, identify the distance D, and sterilize at least

the portion P1, P2, P3 of the web 4.

[0079] The packaging machine 1 comprises a plurality of conveyors 22, 23, 24 configured to advance the web 4 of packaging material comprising at least one conveyor, e.g. first, second or third conveyors 22, 23, 24, upstream of the sterilization apparatus 9, comprising an actuator 13 configured to control a brake velocity of the advancing web 4 and/or control a tensioning of said advancing web 4. The first, second or third conveyors 22, 23, 24 are rotative conveyors.

[0080] The one or more conveyors comprising the actuator 13 may be the second conveyor 23 and/or the third conveyor 24. In addition or in alternative, the first conveyor 22 may comprise the movement sensor 11 as well as the actuator 13.

[0081] For the sake of simplicity, in the following description, the second conveyor 23 is described as comprising the actuator 13, however it will be appreciated that more than one actuator may be present or that the actuator 13 may be positioned at a different conveyor. As exemplified in the figures, the actuator 13 is integrated into the second conveyor 23. In alternative, the one or more conveyors 23, 24, 22 may comprise an actuator 13 positioned at the respective conveyor. For example, the actuator 13 may be in the proximity of the respective conveyor or the actuator 13 may be positioned (e.g. immediately) upstream or downstream of the respective conveyor.

[0082] The actuator 13 is configured to control a brake velocity of the advancing web 4. Advantageously, this way the distance D traveled before interruption of the web 4 may be reduced or maintained constant even in case of different web speeds.

[0083] In addition or in alternative, the actuator 13 may be configured to control a tensioning of the advancing web 4 if the advancing speed of the web 4 changes, such as during a braking of the web 4. The web 4 is maintained in contact with the respective conveyor, even when the speed of the web changes, if an anomaly is detected.

[0084] Advantageously, this way the web 4 of packaging material is kept in tension also when the packaging machine 1 stops or slows down, which facilitates sterilization and reduces a risk of damages on the web 4.

[0085] The actuator 13 may be activated if an event occurs. For example, the actuator 13 or parts thereof may be maintained at a distance from the web 4 if no anomaly is detected. For example, the actuator 13 or parts thereof may not apply any force to the respective conveyor if no anomaly is detected.

[0086] In other words, the conveyor, e.g. the second conveyor 23, may be free from actuating forces if no anomaly is detected.

[0087] Advantageously, the actuator 13 may facilitate the slowing down of the web of packaging material in case an anomaly has been detected, in particular in a more controlled way. This may in turn improve the operation of the packaging machine, in particular the longitudinal sealing station, a strip application station, the posi-

tioning of the packaging material in a transversal direction with respect to the web advancing direction, the positioning of the strip in a transversal direction with respect to the strip advancing direction.

[0088] The actuator allows a better control of the web of packaging material while not interfering with the stability of the web within the packaging machine, irrespective of its speed.

[0089] The conveyor comprising the actuator 13 is positioned upstream of the sterilization apparatus 9. For example, the first conveyor 22 positioned immediately upstream of the sterilization apparatus 9 may comprise the actuator 13.

[0090] The packaging machine 1 comprises a strip application station 18 configured to apply a longitudinal edge section of a protective strip onto a longitudinal edge section of the web 4. The second or third conveyors 23, 24 positioned upstream of the strip application station 18 may comprise the actuator 13. In particular, the second conveyor 23 is positioned immediately upstream of the strip application station 18.

[0091] According to one or more embodiments, the actuator 13 may comprise a brake 130, e.g. an electromagnetic brake, configured to apply a braking torque on the rotative conveyor, if an anomaly is detected.

[0092] The control unit 12 may be configured to, if an anomaly is detected, interrupt advancement of the web 4 also by means of the brake 130. In particular, the brake 130 may be activated only in case an anomaly is detected. The respective conveyor, e.g. the second conveyor 23 in the figures, may be free from actuating forces otherwise.

[0093] The applied braking torque may be such that slipping, pulling or tearing of the web 4 of packaging material is prevented. That is, the braking torque may allow the respective rotative conveyor to gradually slow down while also facilitating the deceleration. For example, the braking torque may have a value between 3 Nm to 7 Nm, preferably 5 Nm.

[0094] Advantageously, thanks to the brake 130 a control of the interruption of advancement of the web 4 can be improved.

[0095] According to one or more embodiments, the actuator 13 may comprise a counter roller 132 positioned at the rotative conveyor and configured to contact the web 4 of packaging material if an anomaly is detected.

[0096] In particular, the control unit 12 may be configured to, (only) if an anomaly is detected, activate the counter roller 132. The respective conveyor, e.g. the second conveyor 23 in the figures, may be free from actuating forces otherwise.

[0097] The second conveyor 23 faces the first face 5 of the web 4 of packaging material and the counter roller 132 faces the second face 6 of the web 4 of packaging material. The counter roller 132 is configured for contacting the second surface of the web 4 of packaging material only if an anomaly is detected. The counter roller 132, if no anomaly is detected, may be positioned at a distance

from the web 4.

[0098] Advantageously, thanks to the counter roller 132 a control of the tension of the web 4 during interruption of operation can be improved.

[0099] The counter roller 132 and the brake 130 may be activated simultaneously.

[0100] According to the instant embodiment, the packaging machine 1 may comprise a detector 134, e.g. a relay sensor or more in general a sensor configured to detect a parameter associated to operation of the actuator 13, e.g. an electric parameter indicative of the power supplied to the actuator 13. The detector 134 is coupled with the actuator 13 and is configured to detect if the actuator 13 is operative. For example, the detector 134 may detect if the brake 130 or counter roller 132 are operative when an anomaly is detected. In particular, the detector 134 may detect that a predetermined supply energy is absorbed by the brake 130 during its actuation.

[0101] The detector 134 is coupled with the control unit 12. For example, the control unit 12, the detector 134 and the actuator 13 may be in series. The control unit 12 is configured to receive a detector signal from the detector 134 and, if the detector signal indicates that the actuator 13 is not operative, the control unit 12 is configured to interrupt operation of the packaging machine 1. A cleaning and re-sterilization process is then performed to the isolation chamber 14, filling unit 20 and sterilization apparatus 9.

[0102] Advantageously, this way the anomaly detection and relative management can be more robust.

[0103] The control unit 12 may be configured to transmit an alarm signal, e.g. to a user interface, if the detector signal indicates that the actuator 13 is not operative.

[0104] The advantages of packaging machine 1 according to the present invention will be clear from the foregoing description.

[0105] Clearly, changes may be made to packaging machine 1 as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

Claims

1. A packaging machine (1) for producing sealed packages (2) of a pourable product from a web (4) of packaging material, the packaging machine (1) comprising a sterilization apparatus (9) for sterilizing a web (4) of packaging material advancing along an advancement path (P), the sterilization apparatus (9) comprising a first sterilizing device (10) configured to sterilize at least a first face (5) of the web (4) advancing through the first sterilizing device (10),
 - a control unit (12) configured to, if an anomaly is detected, interrupt advancement of the web (4),
 - an isolation chamber (14) connected to the
- sterilization apparatus (9) and separating an inner environment (15) from an outer environment (16),
 - a tube forming device (17) at least partially arranged within the isolation chamber (14) and being configured to form a tube (3) from the web (4) of packaging material,
 - a sealing device (19) at least partially arranged within the isolation chamber (14) and being configured to longitudinally seal the tube (3) formed by the tube forming device (17),
 - a filling unit (20) configured to fill the tube (3) with the pourable product,
 - a package forming unit (21) configured to form and to transversally seal the tube (3) for forming the packages (2),
 the packaging machine (1) further comprising a plurality of conveyors (22, 23, 24) configured to advance the web (4) of packaging material along the web advancement path (P) and for advancing the tube (3) along a tube advancement path (Q), wherein the plurality of conveyors (22, 23, 24) comprises at least one conveyor (22, 23, 24), upstream of the sterilization apparatus (9), comprising an actuator (13) configured to control a brake velocity of the advancing web (4) and/or control a tensioning of said advancing web (4).
2. The packaging machine (1) according to claim 1, comprising a strip application station (18) configured to apply a longitudinal edge section of a protective strip onto a longitudinal edge section of the web (4), wherein the at least one conveyor (23, 24) is positioned upstream of the strip application station (18).
3. The packaging machine (1) according to claim 1 or claim 2, wherein the at least one conveyor (22, 23, 24) is a rotative conveyor.
4. The packaging machine (1) according to 4, wherein the actuator (13) comprises a brake (130) configured to apply a braking torque to the rotative conveyor (22, 23, 24).
5. The packaging machine (1) according to 4, wherein the applied braking torque is such that slipping, pulling or tearing of the web (4) of packaging material is prevented.
6. The packaging machine (1) according to any of claims 3 to 5, wherein the rotative conveyor (22, 23, 24) faces the first face (5) of the web (4) of packaging material and wherein the actuator (13) comprises a counter roller (132) positioned at the rotative conveyor (22, 23, 24) and facing a second face (6) of the web (4) of packaging material, the second face (6) being opposite the first face (5).

7. The packaging machine (1) according to claim 6, wherein the counter roller (132) is configured for contacting the second face (6) of the web (4) of packaging material if an anomaly is detected. 5
8. The packaging machine (1) according to claims 4 and 6, wherein the brake (130) and the counter roller (132) are activated simultaneously.
9. The packaging machine (1) according to any of the previous claims, comprising a detector (134), coupled with the actuator (13), the detector (134) being configured to detect if the actuator (13) is operative. 10
10. The packaging machine (1) according to claim 9, wherein the control unit (12) is configured to receive a detector signal from the detector (134) and, if the detector signal indicates that the actuator (13) is not operative, the control unit (12) is configured to interrupt operation of the packaging machine (1). 15 20
11. The packaging machine (1) according to any of the previous claims, wherein the sterilization apparatus (9) further comprises: 25
- a second sterilizing device (7),
 - a monitoring device (8), configured to monitor operation of the first sterilizing device (10),
 - a movement sensor (11) configured to monitor advancement of the web (4) along said advancement path (P), wherein the control unit (12) is connected to the monitoring device (8) and the movement sensor (11) and is configured to, if an anomaly is detected in operation of the first sterilizing device (10): 30
 - interrupt advancement of the web (4),
 - identify a distance (D) traveled by the web (4) between detection of the anomaly and interruption of advancement, and
 - sterilize at least a portion (P1, P2, P3) of the web (4) by means of the second sterilizing device (7), the portion (P1, P2, P3) of the web being associated to said traveled distance (D). 35 40
12. The packaging machine (1) according to claim 11, wherein the plurality of conveyors (22, 23, 24) comprises a conveyor (22), upstream of the sterilization apparatus (9), wherein the movement sensor (11) comprises a rotative encoder integrated within the conveyor (22). 45 50
13. The packaging machine (1) according to claim 11 or claim 12, wherein the sterilization apparatus (9) comprises an outlet (92) and wherein said traveled distance (D) is smaller than a distance (D1) between said first sterilizing device (10) and said outlet (92). 55
14. The packaging machine (1) according to any of the
- previous claims, wherein the first sterilization device (10) comprises an irradiation device configured to sterilize at least the first face (5) of the advancing web (4) by directing a sterilizing irradiation onto at least the first face (5) and wherein the anomaly comprises an electric arc event.
15. The packaging machine (1) according to any of the previous claims, wherein the at least one conveyor (22, 23, 24) is free from actuating forces if no anomaly is detected.

FIG 1

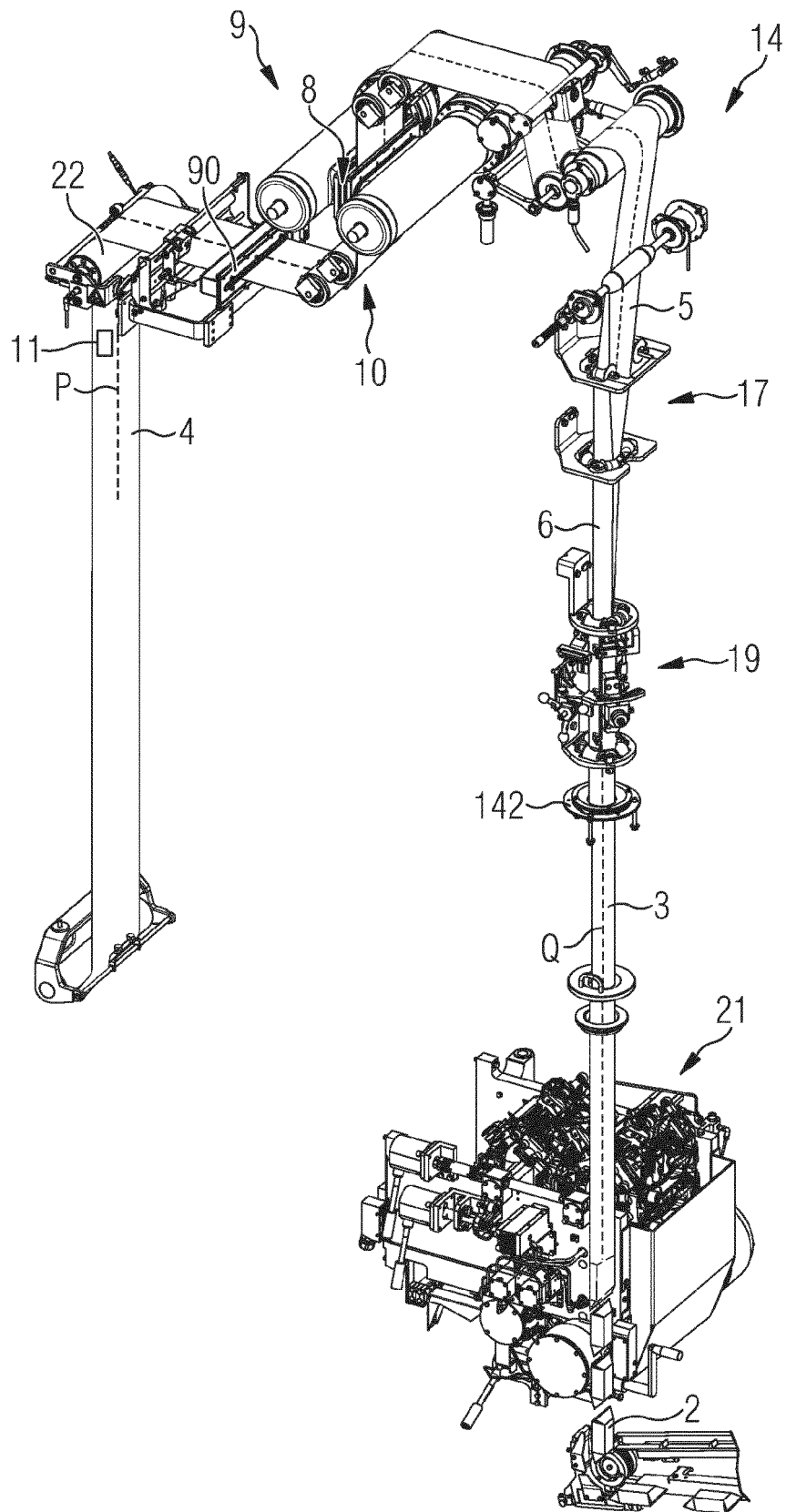


FIG 2

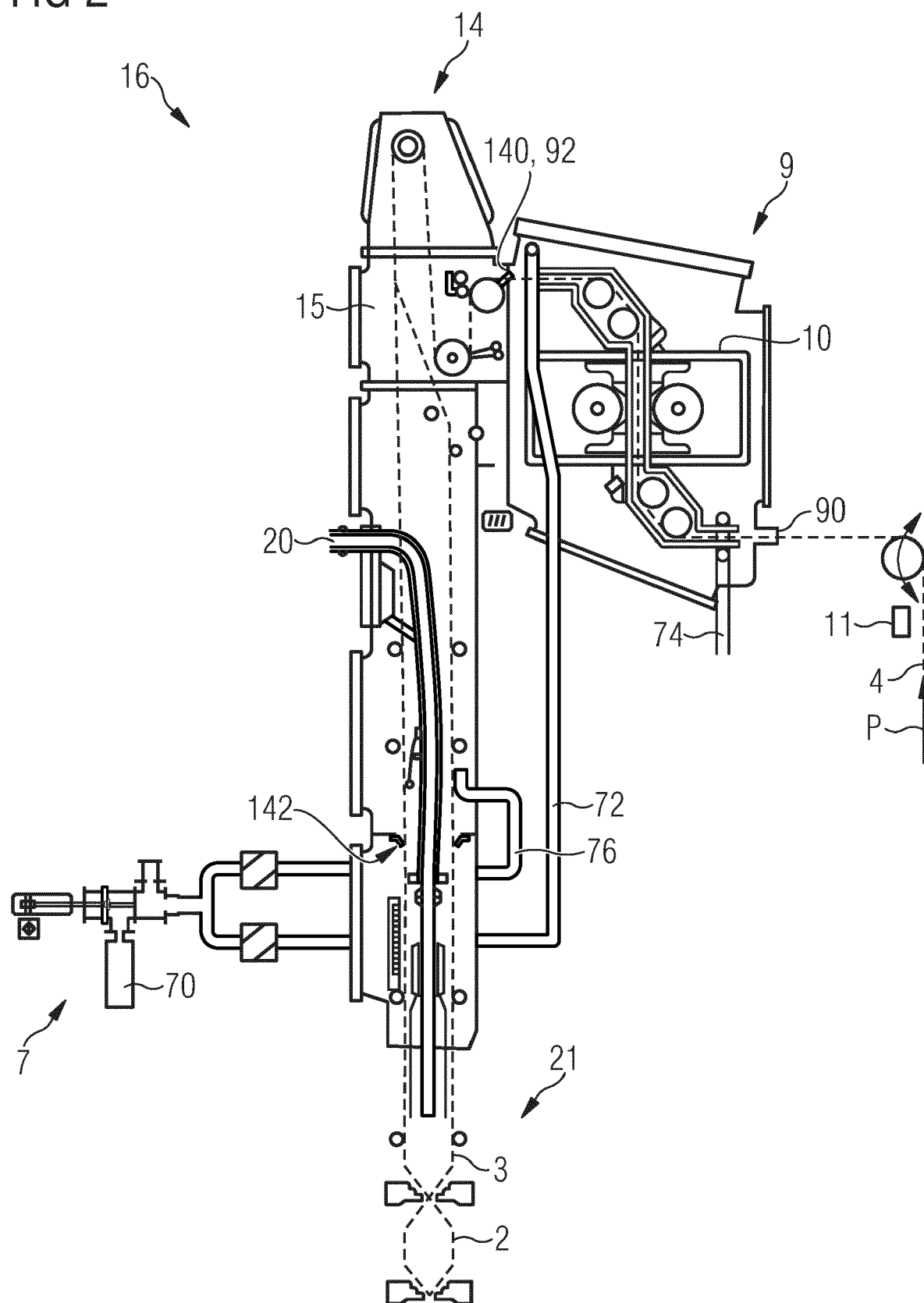


FIG 3

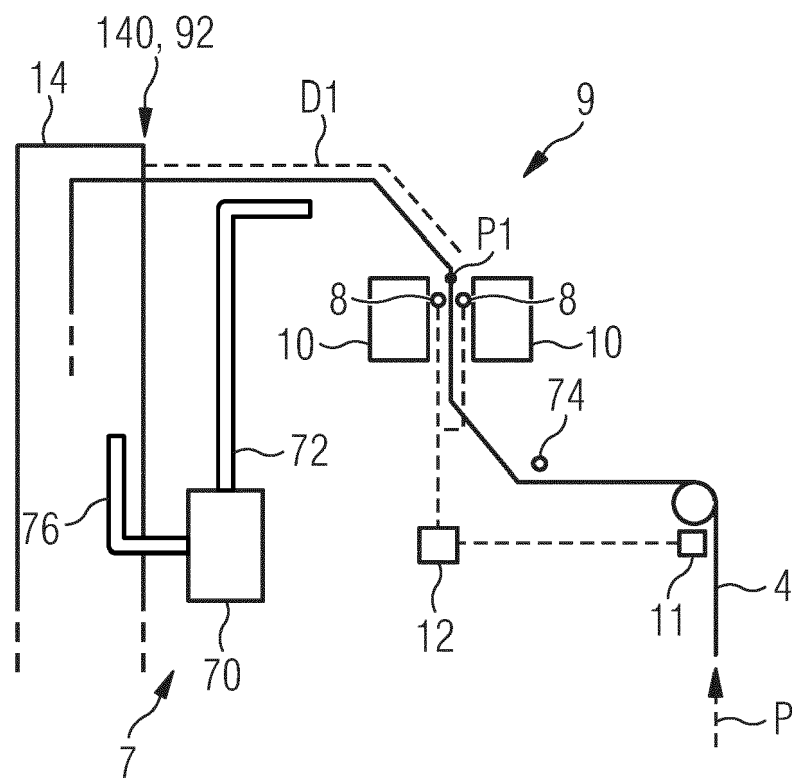


FIG 4

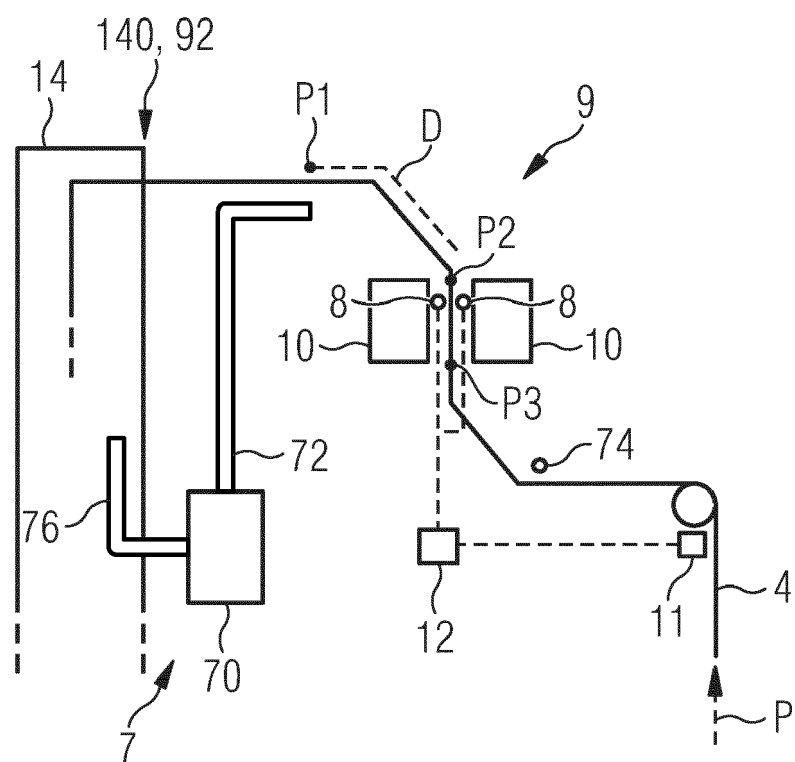


FIG 5

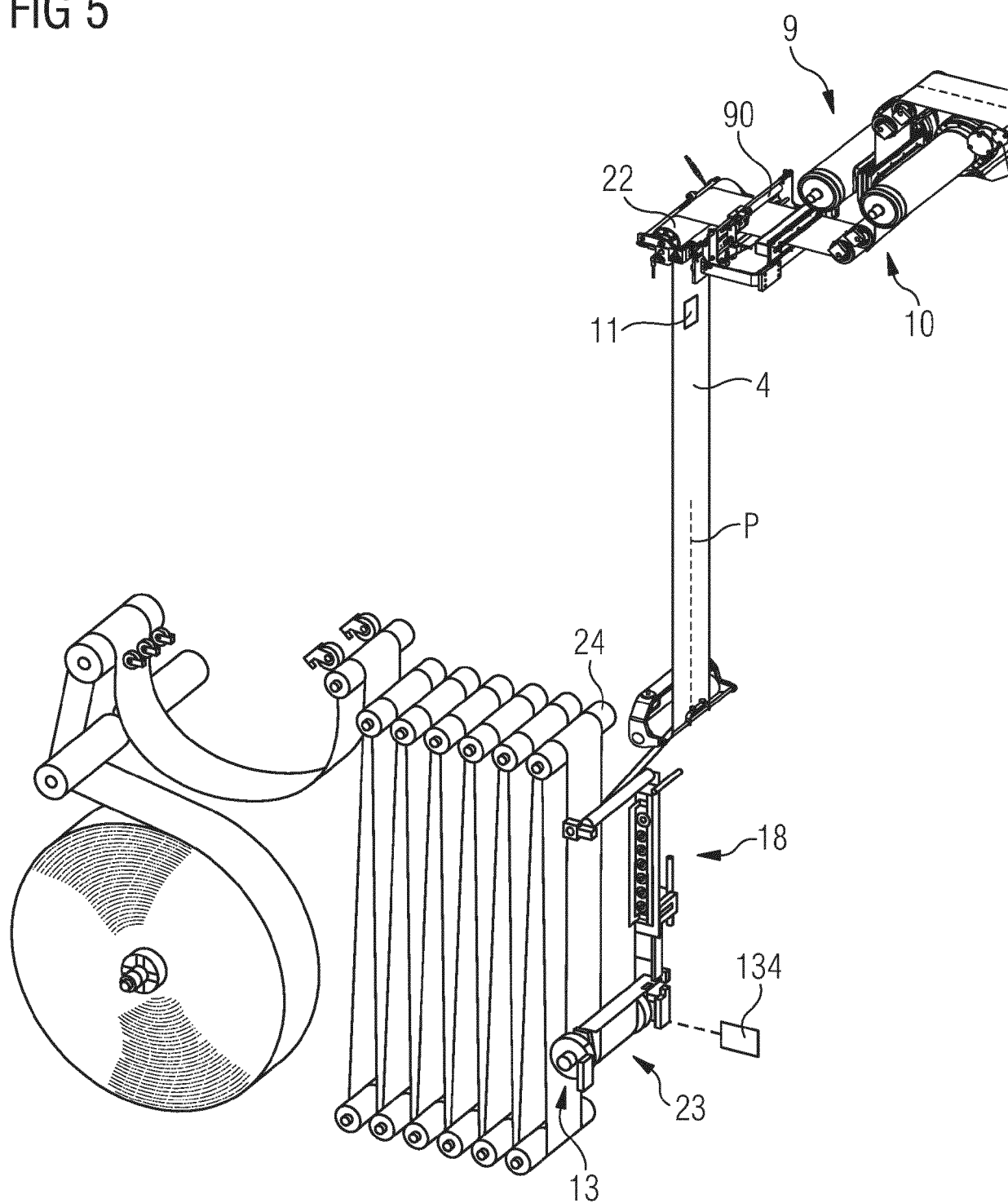


FIG 6

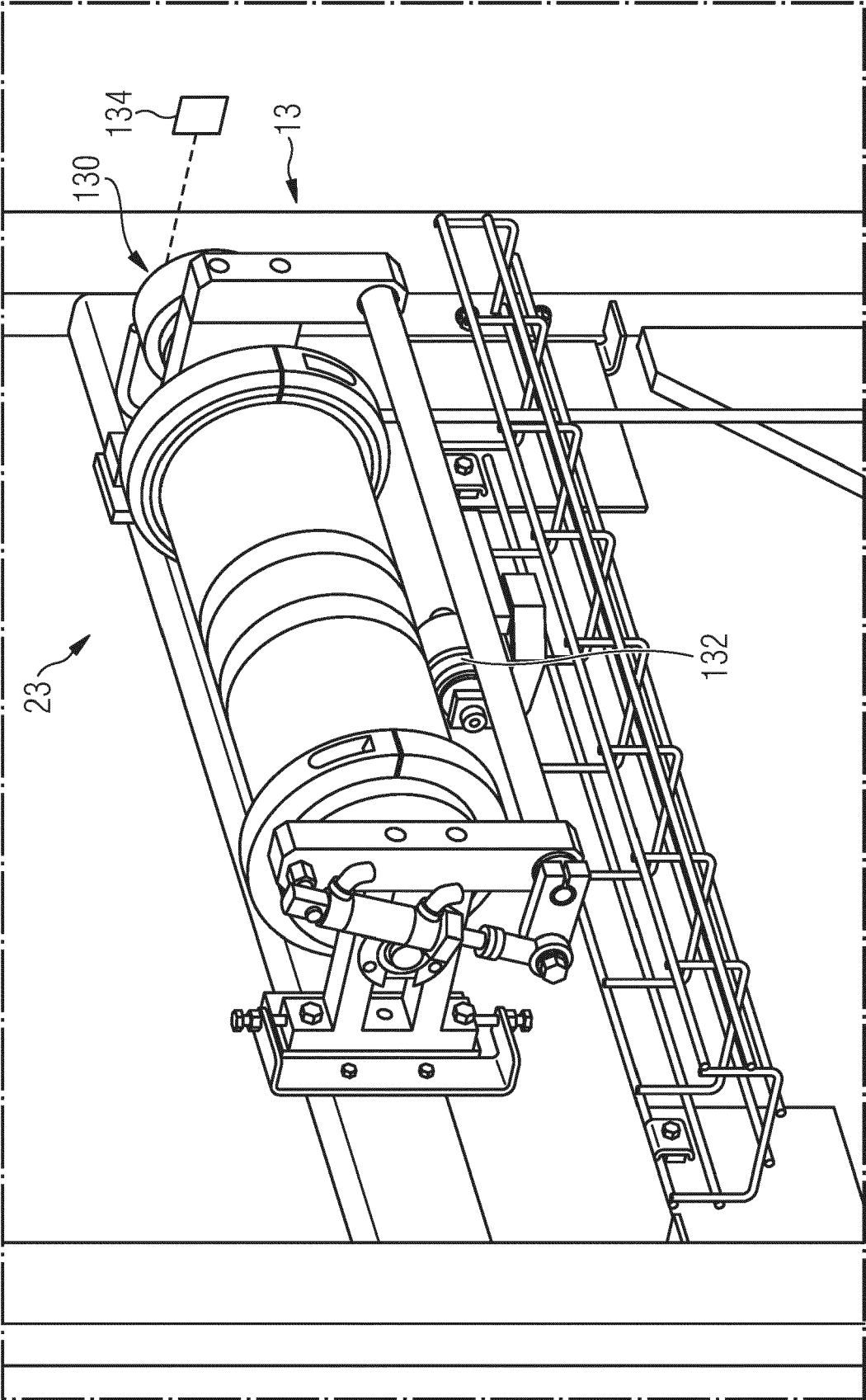
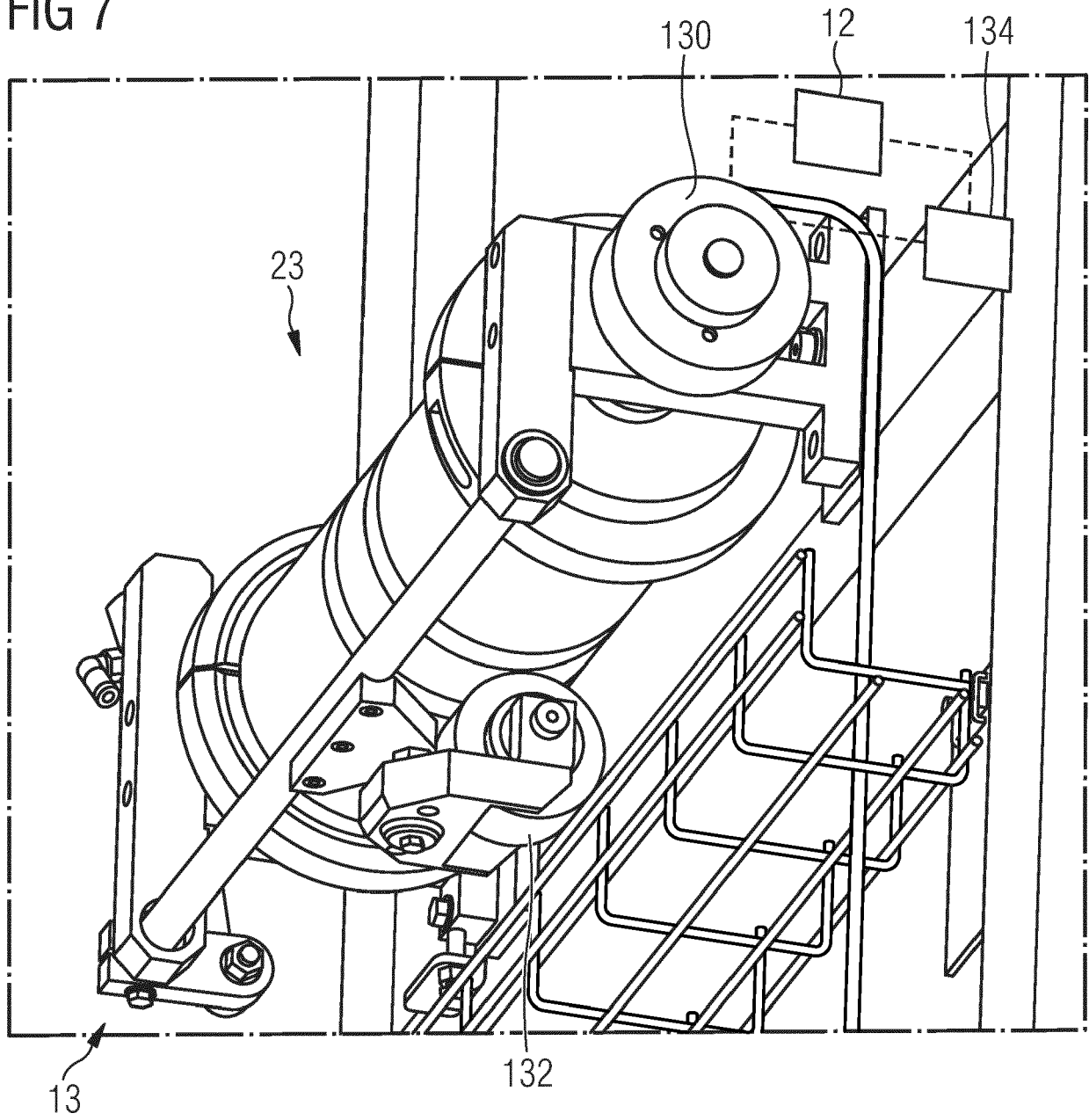


FIG 7





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Place of search Munich		Date of completion of the search 28 February 2024	Examiner Paetzke, Uwe
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