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(54) A METHOD FOR DETECTION OF TILTED CAPS, AND A DETECTION SYSTEM

(57) A method for detection of tilted caps (22), comprising: activating an electrical motor (32) such that the cap (22) is screwed onto a neck of an associated package (24), and determining, based on a signal from the electrical motor (32), if the cap (22) is tilted or not, recording a series of data samples of an operational parameter of the electrical motor (32) during an entire capping operation, calculating a residual from the recorded data sample, and comparing the residual with a determined limit, wherein the determined limit is indicative if the cap (22) is tilted or not, wherein the operational parameter of the electrical motor (32) is the total angle of rotation of a rotational shaft of the electrical motor (32) during the entire capping operation.

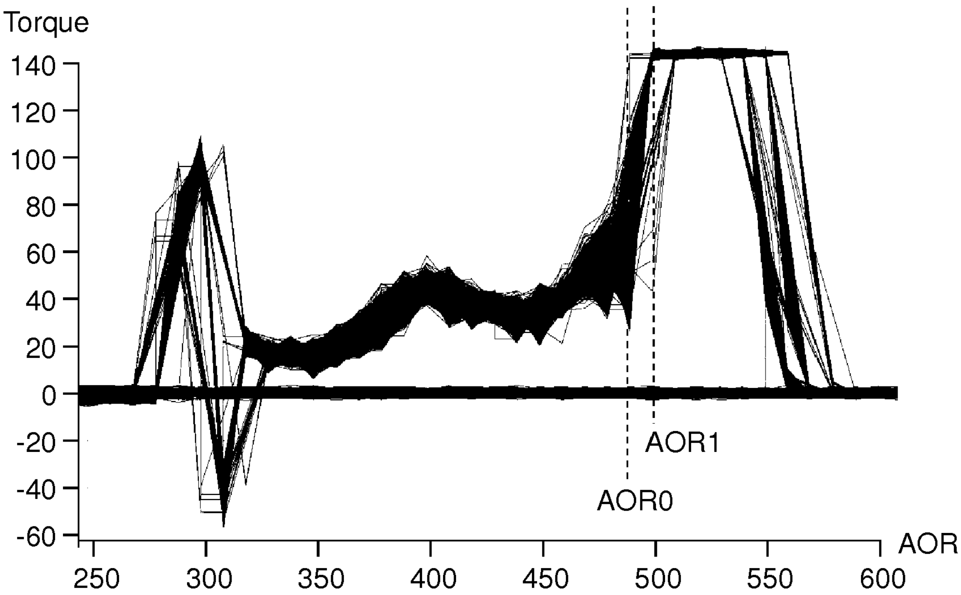

Fig. 5

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Description

Technical Field

[0001] The invention relates to a method, as well as a system, for detecting tilted caps. More particularly, the present invention relates to a method and system for detecting tilted caps of packages being transported through a filling machine.

Background Art

[0002] Filling machines are typically configured for producing filled packages. The packages may e.g.be filled with liquid food products such as dairy products, juices, etc. Such filling machines may include equipment for producing the packages from a carton-based packaging material, either provided in the form of a continuous web or as separate blanks.

[0003] As is evident, packages being produced according to the above-described principle may have a vast amount of configurations in terms of dimensions as well as in terms of package design features. For example, the package may be equipped with a screw cap for allowing simple and reliable reclosing.

[0004] During manufacturing of the package it is important that the screw cap is positioned correctly onto the package opening. Should the cap for some reason not be applied in the predetermined manner the package integrity would possibly be negatively affected. In modern production, packages having a wrongly applied cap will therefore be wasted.

[0005] Several techniques for monitoring mounting of screw caps exist. One such system includes the use of vision units configured to detect if the cap is tilted, thereby indicating a potential risk in terms of package integrity. Although such vision systems may be programmed to be automatic and relatively accurate, there are some major disadvantages which are difficult to overcome.

[0006] For example, such vision systems are sensitive to reflected light. Sudden reflections will cause an increase in unnecessary waste, and these existing vision systems may also have problems when the package design is changed, making it difficult to determine a tilted cap accurately. Additionally, as these vision systems are mounted external to the already existing parts of the filling machine they may be damaged by moving objects in the production facility, such as trucks, staff, etc.

Summary

[0007] It is an object of the invention to at least partly overcome one or more of the above-identified limitations of the prior art. In particular, it is an object to provide a method and system configured to detect a tilted cap which can be implemented to existing filling machines without major hardware modifications.

[0008] To solve these objects a method for detection of tilted caps is provided. The method comprises activating an electrical motor such that the cap is screwed onto a neck of an associated package and determining, based on a signal from the electrical motor, if the cap s tilted or not. The method also comprises recording a series of data samples of an operational parameter of the electrical motor during an entire capping operation, calculating a residual from the recorded data sample and comparing the residual with a determined limit wherein the determined limit is indicative if the cap is tilted or not. Here, the operational parameter of the electrical motor is the total angle of rotation of a rotational shaft of the electrical motor during the entire capping operation.

[0009] The method may comprise recording at least one data sample of an operational parameter of the electrical motor, and comparing a residual corresponding to the recorded data sample with a determined limit indicative if the cap is tilted or not.

[0010] Besides the total angle of rotation during an entire capping operation, another operation parameter of the electrical motor may be the torque and/or the speed of the electrical motor during the capping operation.

[0011] According to an embodiment, the data samples referred to earlier may e.g. be evenly distributed during the entire capping operation.

[0012] In an embodiment comparing a residual with a determined limit is performed by applying a Kalman filter to said at least one recorded data sample.

[0013] According to a second aspect a detection system is provided. The detection system comprises an electrical motor configured to apply a cap onto a neck of a package upon activation and a control unit configured to determine, based on a signal from the electrical motor, if the cap (22) is tilted or not. The control unit is further configured to record a series of samples of an operational parameter of the electrical motor and to compare a residual corresponding to the recorded data sample with a determined limit indicative if the cap is tilted or not. Such a control unit further comprises an input module configured to record the total angle of rotation of the electrical motor 'during an entire capping operation.

[0014] According to a third aspect, a capping station is provided. The capping station is configured to apply external screw caps on the upper part of a series of consecutive packages, and comprises a detection system according to the second aspect.

[0015] According to a fourth aspect a filling machine is provided. The filling machine comprises a capping station according to the third aspect.

[0016] Still other objectives, features, aspects and advantages of the invention will appear from the following detailed description as well as from the drawings.

Brief Description of the Drawings

[0017] Embodiments of the invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig. 1 is a perspective view of parts of a filling machine, including a detection system according to an embodiment.

Fig. 2 is a schematic view of a method according to an embodiment.

Fig. 3 is a schematic view of a detection system according to an embodiment.

Fig. 4 is a diagram showing sampled data representing motor position as a function of time.

Fig. 5 is a diagram showing sampled data representing motor torque as a function of motor position.

Fig. 6 is a schematic view of a detection method according to an embodiment.

Fig. 7 is a schematic view of a detection method according to a further embodiment.

Detailed Description

[0018] With reference to Fig. 1 parts of a filling machine 10 is illustrated. In particular, the shown parts of the filling machine 10 forms a capping station 20 configured to apply external screw caps 22 on the upper part of a series of consecutive packages 24. As is understood from Fig. 1, the packages are fed in the direction F indicated by the block arrow.

[0019] In the shown example the packages 24 have already been formed, filled and sealed in the filling machine provided upstream of the capping station 20. In other embodiments, a capping station may be arranged to apply caps to non-filled packages, preferably to packages having a carton-based sleeve and a plastic top. In such embodiments the bottom end of the sleeve is still open when the cap is applied to the plastic top, whereby filling and sealing of the package is performed after capping.

[0020] Each package 24 has, in the embodiment shown, a substantially parallelepiped body and a slanted top wall, i.e. a top wall that is inclined with respect to a base wall of the package 24. In another embodiment, not shown, each package 24 has a substantially parallelepiped body and a top wall substantially parallel to the base wall. In still further embodiments the packages have a plastic top arranged on a carton-based sleeve. In general, the capping station 20 may work with packages 24 having different shapes and/or dimensions.

[0021] According to the shown example the capping station 20 comprises a conveying device (not shown) for advancing the packages 24 in the feeding direction F. The capping station 20 further comprises a distribution unit 26 for feeding the caps 22 to the packages 24, and to position a cap loosely on top of an associated package 24.

[0022] The capping station 20 further comprises a group of applying heads 28 for applying the caps 22 to the respective packages 24, particularly by screwing each cap 22 onto a corresponding neck 25 of a package 24. Each applying head 28 is provided with one or more grippers 30 which, upon actuation, will move downwards to engage the cap 22. Control of each applying head 28 further comprises rotation of the grippers 30 in order to securely screw the cap 22 on the neck 25.

[0023] Such gripper rotation, also including a linear movement in the normal direction of the cap 22, is effected by means of an electrical motor 32. Each applying head 28 is therefore provided with such electrical motor 32.

[0024] Preferably, during activation of the applying heads 28 they may move in the feeding direction F, such that the packages 24 may move continuously during capping.

[0025] More details of the above-described capping station 20 are disclosed in WO2017060059 by the same applicant.

[0026] However, according to the embodiments described within this specification the capping station 20 is also provided with a detection system 40 configured to monitor the capping operation and to determine that the caps 22 are applied correctly to the packages 24.

[0027] The detection system 40 is configured to perform a method 60, schematically shown in Fig. 2. The method 60 comprises a first step 62 of activating the electrical motor 32 such that the cap 22 is screwed onto a neck of an associated package 24, and a second step 64 of determining if the cap 22 is tilted or not based on a signal from the electrical motor 32.

[0028] As will be further explained below, the method 60 may also comprise a step 63a of recording one or more data samples of an operational parameter of the electrical motor 32, and a step 63b of comparing a residual corresponding to the recorded data sample(s) with a determined limit indicative if the cap 22 is tilted or not. Data sampling may e.g. be performed by storing analog or digital samples, wherein each sample contains a value indicative of an operational parameter of the electrical motor. A sample may thus be a value or set of values of a motor signal, such as a position signal, a drive current signal, a torque signal, etc.

[0029] A detection system 40, adapted to perform the method 60, is schematically shown in Fig. 3. It should be noted that the various embodiments of detection systems 40 described herein are not exclusively for use with the capping station 20 described above with reference to Fig. 1, but the detection system 40 could be used with any kind of capping station as long as it utilizes an electrical motor for screwing a cap onto a package.

[0030] The detection system 40 comprises the electrical motor 32 forming part of an applying head 28, and a control unit 50 in communication with the electrical motor 32. The control unit 50 comprises an input module 52, a data processing module 54, as well as an output module 56.

[0031] As is indicated in Fig. 3 each electrical motor 32 may be connected to a unique control unit 50,or a single control unit 50 may be connected to several electrical motors 32. In such embodiment the control unit 50 may be provided with several input modules 52, 52b as indicated by the dashed lines in Fig. 3, the additional input module 52b being in communication with a second electrical motor 32b.

[0032] For activation of the electrical motor 32 a controller (not shown) may be provided, or such activation control may provided by the control unit 50. The control unit 50 may for such purpose be provided with suitable power electronics (not shown) in order to power the electrical motor 32 correctly.

[0033] The input module 52 is configured to sample data from the electrical motor 32. The sample rate may be set depending on the particular application, such as between 10-100 samples per capping operation. It should however be understood that the sample frequency could be adjusted to be far higher than 100 samples per capping operation, as well as in some cases even lower than 10 samples per capping operation.

[0034] The sampled data may be data representing one or more operational parameters of the electrical motor 32. In one embodiment, the sampled data is data representing the angular position of the electrical motor 32. In another embodiment, the sampled data is data representing the torque of the electrical motor 32. In a further embodiment, the sampled data is data representing the rotational speed of the electrical motor 32. In a yet further embodiment the sampled data is data representing any combination of the above-mentioned operational parameters of the electrical motor 32.

[0035] The sampled data is forwarded to the data processing module 54. As for the case of the input module 52 the data processing module 54 may be provided as a single module or as several separate modules; it should be noted that the data processing module(s) may be hardware implemented, software implemented, or a combination of hardware and software implemented.

[0036] The data processing module 54 is configured to process the sampled data in order to provide a signal indicative if the cap 22 is applied correctly or not. As will be explained further below, such processing may typically include filtering as well as data analysis, preferably performed by implementing Kalman filtering or the like. The data processing module 54 typically provides a residual value which is compared with a computed limit; if the residual value is higher than the limit, a waste output signal is generated to the output module 56, which thereby is configured to issue a command signal to additional equipment capable of removing the specific package 24.

[0037] The computed limit may in some embodiments be a single value defining the upper limit of the residual. In other embodiments the computed limit may be an interval defining the allowable upper and lower limits of the residual. The computed limit may be a specific value, or a relative value compared to a fixed value.

[0038] Now turning to Fig. 4 an example of a set of residual values is illustrated in a diagram. Each black dot in the diagram corresponds to a recorded data sample, and represents the total angle of rotation (AOR) for a single capping operation. As can be seen in the diagram most capping operations were performed by activating the electrical motor 32 for 580-600°.

[0039] The Kalman filter is used to determine a moving mean value, represented by the line CL. For each recorded data sample a residual is calculated, preferably as the absolute value of the difference between the recorded data sample and the mean value at the time the data sample was recorded. It should however be noted that the residual could be calculated using other formulas as well.

[0040] The computed limits are indicated by references UL, and LL. As explained above the mean value of the residuals is indicated as CL, while the upper limit is indicated by UL. The lower limit is consequently indicated by LL. The upper and lower limit may be absolute values, or they may be represented as their absolute distance from the mean value.

[0041] As can be seen the limit values UL and LL are dynamic, i.e. they change in time as a response to the variations of the data samples. The upper limit UL is preferably determined as a function of the moving mean value CL; either in fixed values, such as CL+15°, or as a relative value, such as 1.025*CL. The same applies for the lower limit LL, it may be determined as a function of the moving mean value CL in a similar manner.

[0042] Preferably the moving mean value CL, as well as the upper and lower limits UL, LL are computed by applying a Kalman filter to the set of data samples. The specific value of the data samples are varying in time; this is typically due to the fact that machine parameters are changing during operation, or the package dimensions are changing during operation. For example, between t1 and t2 a first type of package is capped. Between t2 and t3 a second type of package is capped requiring a slightly less total angle of rotation, while between t3 and t4 a third type of package is capped requiring a slightly higher total angle of rotation.

[0043] In Fig. 4 two capping operations are determined to be faulty, indicated by the data samples X1 and X2. Their corresponding residual values both lie above the upper limit UL for that particular data sample. Again returning to Fig. 3 and the control unit 50, for these two values X1, X2 the output module 56 transmits a waste command whereby the packages corresponding to these values are removed from the production line.

[0044] In Fig. 5 another example is shown, illustrating the electrical motor torque as a function of angle of rotation for a series of capping operations. Initially there is almost no torque, increasing only when the cap engages with the threads of the neck of the package. Slowly increasing, the torque exhibits a maximum value at t1 at which point final tightening of the cap is performed.

[0045] Each line corresponds to a single capping operation, represented by a series of data samples. Data samples of one capping operation may be processed to determine the specific angle of rotation at which the maximum torque is reached. As can be seen in Fig. 5, for most capping operations the maximum torque is reached at AOR1. There are however some capping operations for which the maximum torque is reached earlier, at AOR0. This is an indication of the cap being tilted, whereby these capping operations can be identified and wasted by transmitting a waste output signal to the output module 56 of the control unit 50.

[0046] Although not shown in more detail, in the same manner the electrical motor speed may be used as a parameter in order to determine if the cap is applied correctly or not.

[0047] Now turning to Fig. 6 an example of a method 100 for detection of tilted caps is shown schematically. The method 100 is preferably performed by the detection system 40 described above with respect to Fig. 3. In a first step 102 the control unit 50 is in an idle state, ready to receive a new data sample from the electrical motor 32. When a new data sample is received, e.g. at specific time intervals, in step 104 it is determined if the detection system 40 is in a screening mode or not. Such screening mode is performed in order to determine where the threads of the cap engage with the threads of the neck.

[0048] For example, there may be three lead entrances in the threads of the neck, and the threads thereby consists of three sections spaced apart by 120°. Corresponding sections are found in the cap. When capping, the most desirable situation is if a section of the cap engages with the neck approximately in between two thread entries. Hence the cap should preferably not engage with the thread immediately upon a rotation of the cap relative the neck but the thread section would instead need to slide along at least parts of the entire thread section of the neck before the cap gains a real grip on the neck. Since the thread on the neck is relatively soft, it will thus be vitally important that the thread section of the cap is not given the chance to press against the thread section of the neck. This risk is eliminated by ensuring that the thread pitch is followed.

[0049] If step 104 determines that screening is active, the method 100 proceeds to step 106 in which another initial rotational position is set before repeating steps 102, 104, and 106 until the screening process is finished. It should be noted that the screening process could be scheduled at regular intervals, or when any machine parameter is changed. Screening could also be activated when the package design is changed.

[0050] If screening is not active, the method 100 proceeds to step 108 in which data samples for the specific capping operation are collected. For example, the collected data samples may comprise torque values of the electrical motor throughout the capping operation, sampled at regular intervals thus representing a torque curve. In another embodiment the collected data samples comprise the total angle of rotation of the electrical motor, i.e. a single data value. In a yet further embodiment the collected data samples comprise speed values of the electrical motor throughout the capping operation, sampled at regular intervals thus representing a speed curve.

[0051] In step 110 the sampled data is transmitted to a filter, such as a Kalman filter or similar, configured to compute limits for the data values. Also, the filter is configured to determine a residual which can be compared with the computed limits, as explained above. For the example shown in Fig. 4, the residual may be the actual data value of the total angle of rotation while the limits may be the upper and lower limits UL, LL. For the example shown in Fig. 5 the residual may be the angle of rotation at which the maximum torque level is reached for the specific capping operation, while the limits may be the mean angle of rotation AOR1 for a series of capping operations. Alternatively, the residual may be an absolute value while the limit may correspond to a maximum allowable value of the residual.

[0052] In step 112 the residual is compared with the limit. If the residual is beyond the limit, the method 100 proceeds to step 114 in which a waste output signal is generated. Consequently, the package having a tilted cap is wasted while the method 100 is repeated by returning to the idle state in step 102. On the other hand, if the residual is within the limit no waste output signal is generated and the method returns to step 102.

[0053] Now turning to Fig. 7 another example of a method 200 for detection of tilted caps is shown schematically. As for the method 100 described earlier the method 200 is preferably performed by the detection system 40 described above with respect to Fig. 3.

[0054] In this method 200 the steps 202, 204, 206, 208, 210 and 212 are identical to steps 102, 104, 106, 108, 110, and 112 of the method 100; these will not be described further.

[0055] When comparing the residual with the limit in step 212, the method 200 may conclude if the residual is above or below the limit. If above, the method 200 may proceed to step 214 in which the package is wasted by generating a waste output signal.

[0056] If below, the method 200 may proceed to step 216 in which new data samples for the specific capping operation are collected. These data samples may preferably represent another operational parameter of the electrical motor 32. For example, if data samples representing values of the total angle or rotation were collected in step 208, step 216 may include collecting data samples representing the motor torque, or motor speed. After fetching these values the method 200 proceeds to step 218 in which the sampled data is filtered, e.g. using a Kalman filter. The filter output, i.e. the residual as well as the limit, is thereafter used in step 220 for comparison purpose. If the residual is above the limit, the method 200 proceeds to step 214 generating a waste output signal. If the residual is below the limit, the method 200 may either return to the idle state 202, or repeating steps 216, 218, 220 (optionally using another operational parameter for the electrical motor 32).

[0057] From the description above follows that, although various embodiments of the invention have been described and shown, the invention is not restricted thereto, but may also be embodied in other ways within the scope of the subject-matter defined in the following claims.

Claims

1. A method for detection of tilted caps (22), comprising:

    activating an electrical motor (32) such that the cap (22) is screwed onto a neck of an associated package (24), and
    determining, based on a signal from the electrical motor (32), if the cap (22) is tilted or not,

    recording a series of data samples of an operational parameter of the electrical motor (32) during an entire capping operation,
    calculating a residual from the recorded data sample, and comparing the residual with a determined limit, wherein the determined limit is indicative if the cap (22) is tilted or not,
    wherein the operational parameter of the electrical motor (32) is the total angle of rotation of a rotational shaft of the electrical motor (32) during the entire capping operation.

2. The method according to claim 2, wherein the residual is calculated as the absolute value of the difference between the recorded data sample and a mean value of previously recorded data samples.

3. The method according to claim 2 or 3, wherein comparing a residual with a determined limit is performed by applying a Kalman filter to said at least one recorded data sample.

4. The method according to claim 3 and 4, wherein the Kalman filter is configured to determine a moving mean value of recorded data samples.

5. The method according to any one of claims 2 to 5, wherein the step of determining if the cap (22) is tilted or not is based on the step of comparing the residual with the determined limit.

6. The method according to any one of claims 1-5, wherein the operational parameter of the electrical motor (32) is the torque of the electrical motor (32).

7. The method according to any one of claims 1-5, wherein the operational parameter of the electrical motor (32) is a speed of the electrical motor (32).

8. The method according to any one of the preceding claims, wherein recording at least one data sample comprises recording a series of data samples during the capping operation.

9. A detection system (40), comprising an electrical motor (32) configured to apply a cap (22) onto a neck of a package (24) upon activation, and a control unit (50), wherein said control unit (50) is configured to determine, based on a signal from the electrical motor (32), if the cap (22) is tilted or not,
characterized in that the control unit (50) is further configured to record a series of samples of an operational parameter of the electrical motor (32), and to compare a residual corresponding to the recorded data sample with a determined limit indicative if the cap (22) is tilted or not, wherein said control unit (50) further comprises an input module (52) being configured to record the total angle of rotation of the electrical motor (32) during an entire capping operation.

10. The detection system (40) according to claim 8, wherein said input module (52) is further configured to record the torque of the electrical motor (32) during an entire capping operation.

11. The detection system (40) according to claim 8, wherein said input module (52) is further configured to record the speed of the electrical motor (32) during an entire capping operation.

12. The detection system (40) according to any one of claims 10 or 11, wherein said input module (52) is further configured to record digital samples of the operational parameter of the electrical motor (32).

13. The detection system (40) according to any one of claims 10-12, wherein said input module (52) is configured to record a series of data samples during the capping operation.

14. The detection system (40) according to any one of claims 9-13, wherein the control unit (50) further comprises a data processing module (54) being configured to apply a Kalman filter to said at least one data sample.

15. A capping station (20) configured to apply external screw caps (22) on the upper part of a series of consecutive packages (24), comprising a detection system according to any one of claims 9-14.

16. A filling machine (10), comprising a capping station (20) according to claim 15.

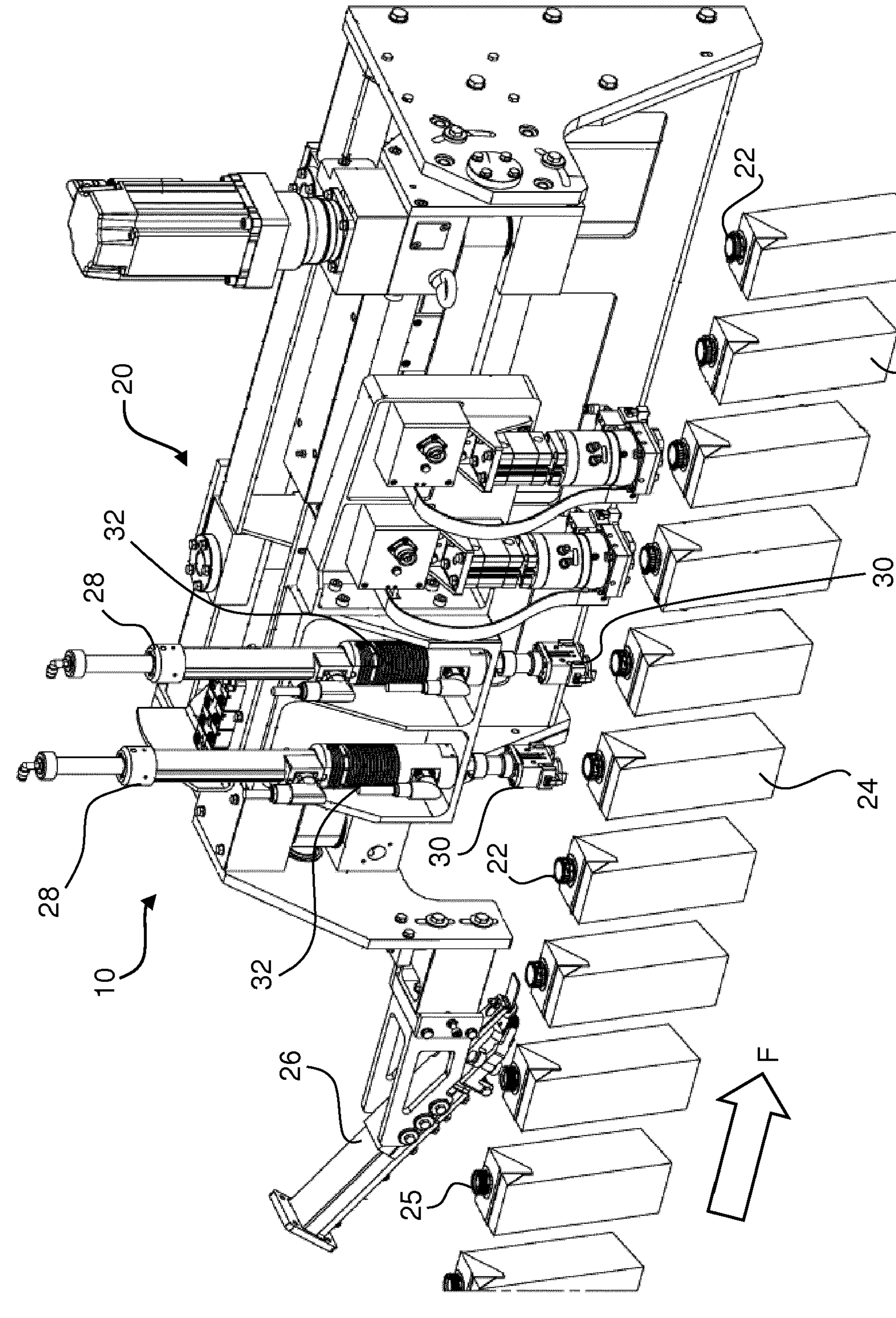

Fig. 1

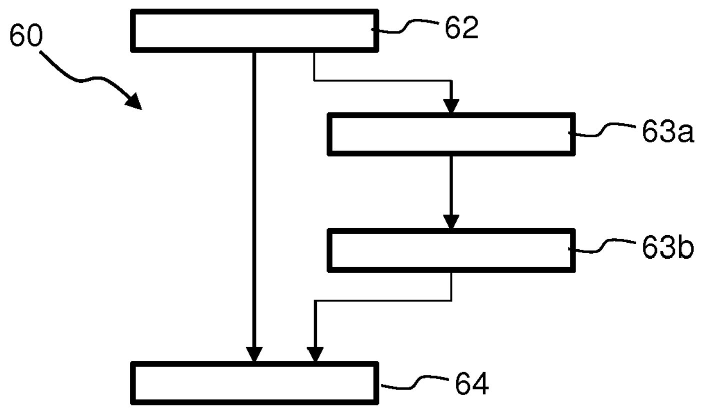

Fig. 2

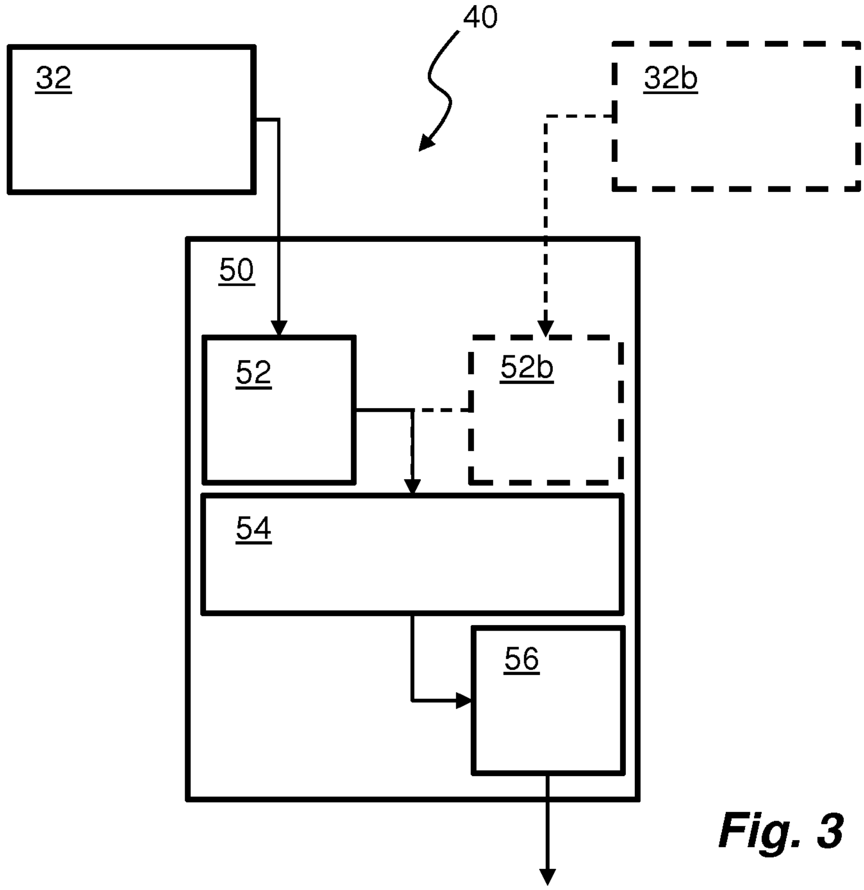

Fig. 3

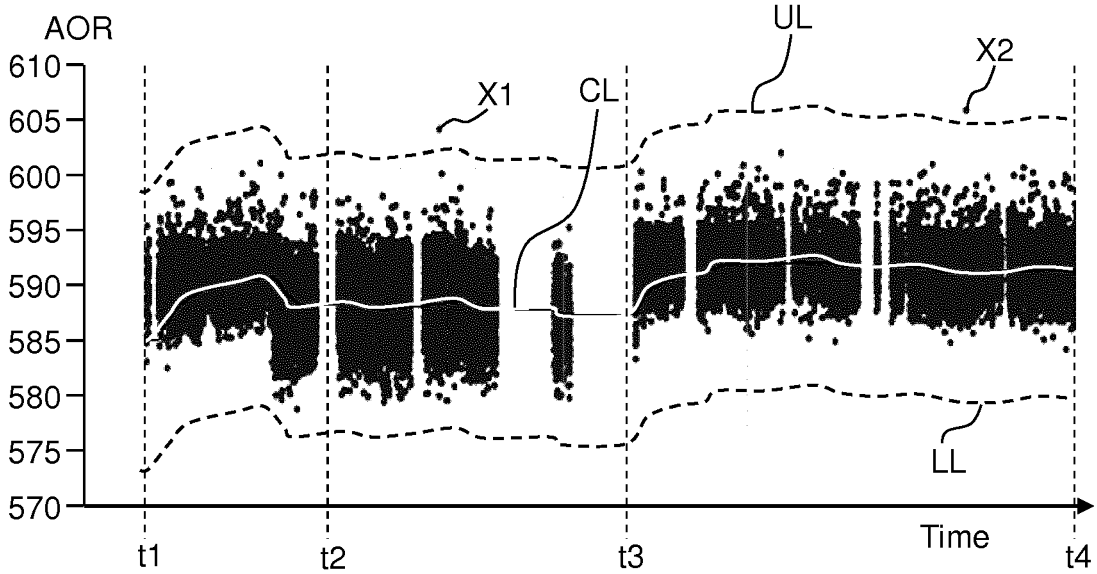
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Fig. 4

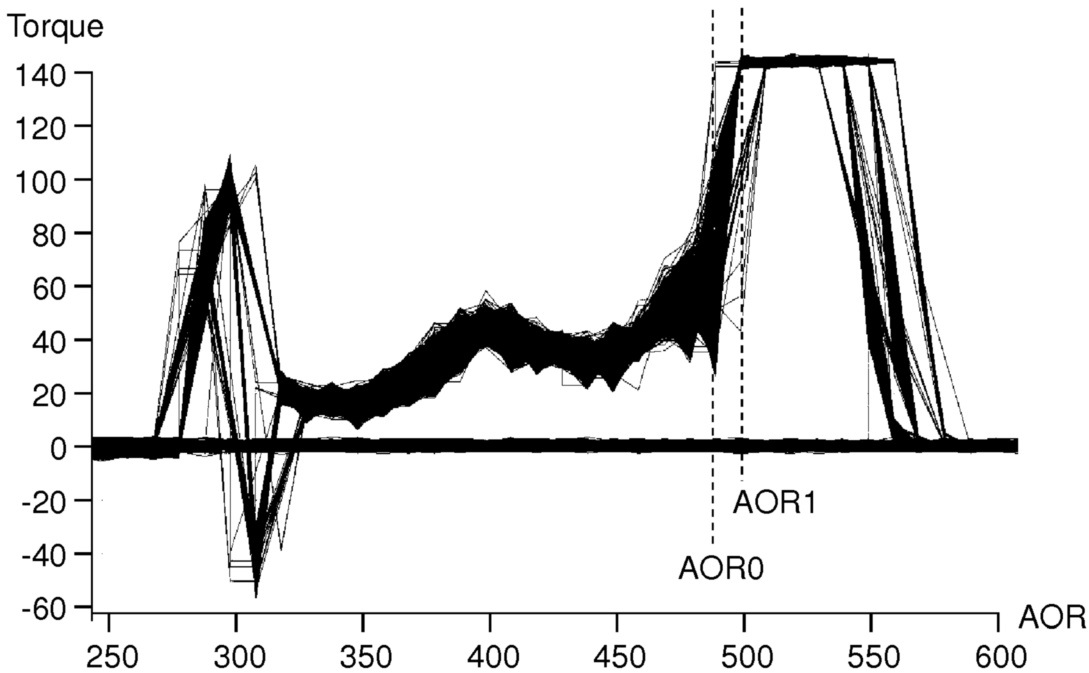
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Fig. 5

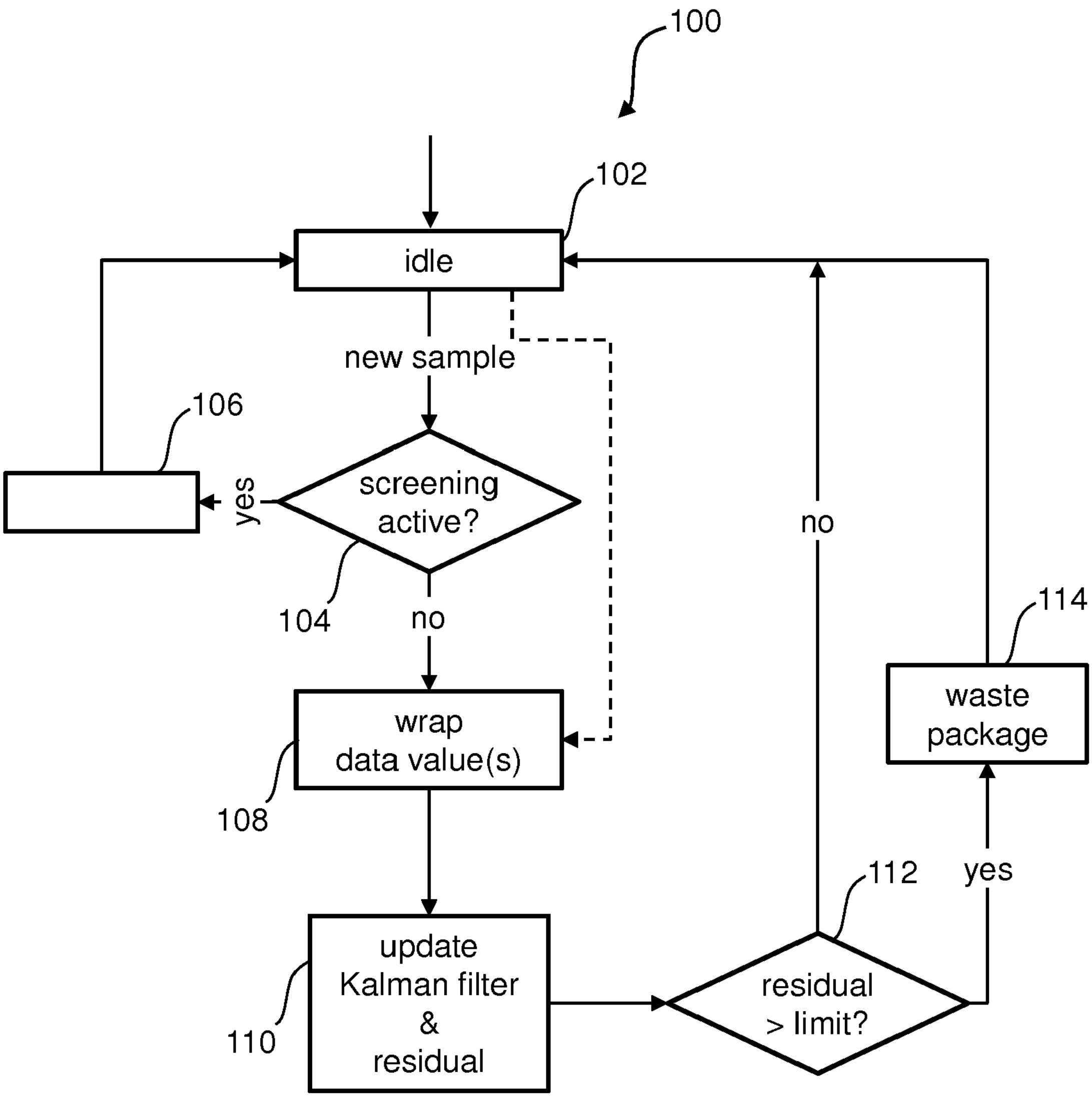
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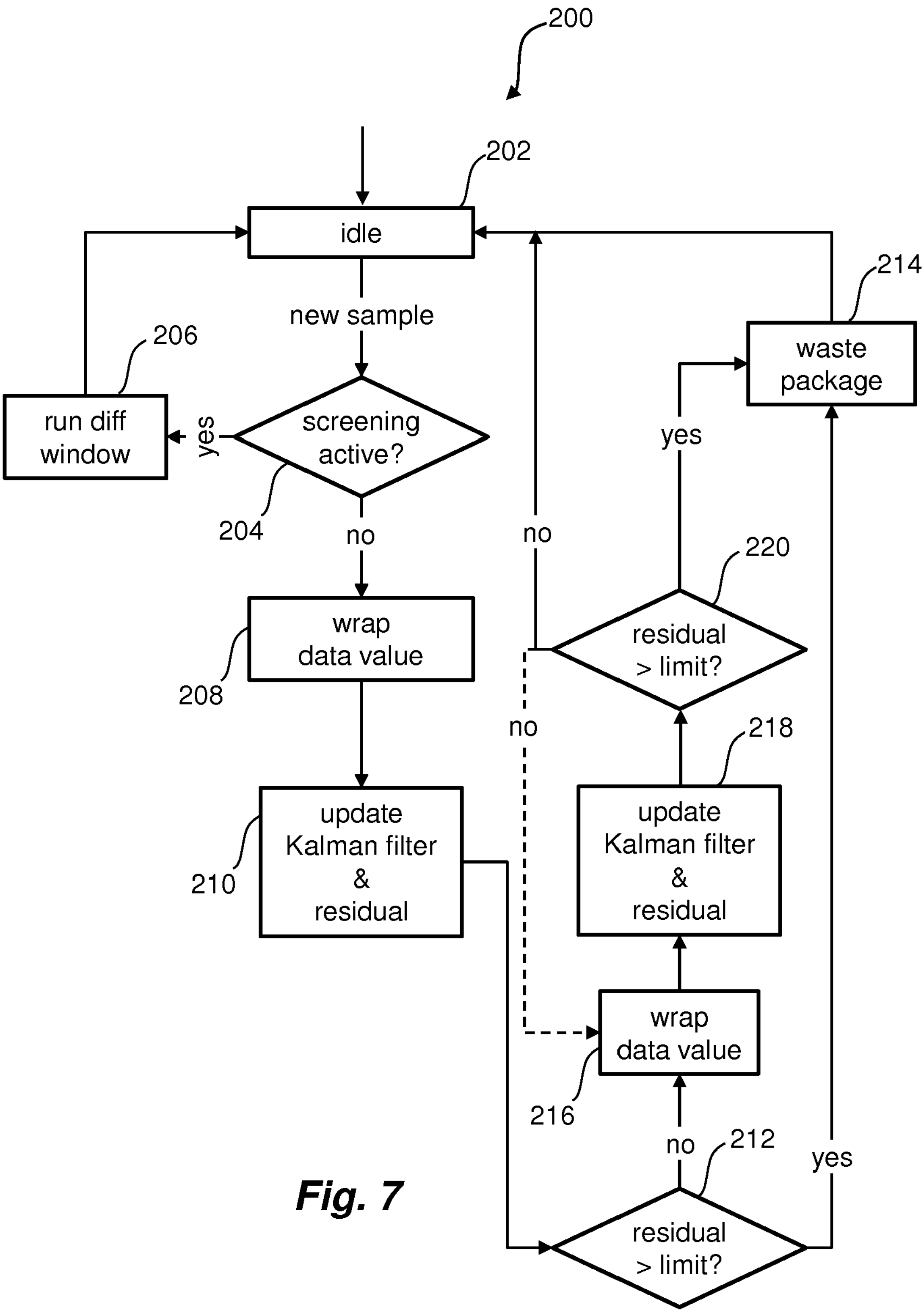
Fig. 6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residual > limit?
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218
update Kalman filter & residual
wrap data value
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no
212
yes
residual > limit?

Fig. 7

Europäisches Patentamt
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Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 21 5179

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 321 935 A (SPATZ GUENTER [DE] ET AL) 21 June 1994 (1994-06-21) * column 3, line 25 - line 52 * * column 4, line 10 - column 6, line 33; figure *	1-16	INV. B67B3/26
X	EP 1 249 426 A1 (SHIBUYA KOGYO CO LTD [JP]) 16 October 2002 (2002-10-16) * paragraphs [0015], [0018], [0027]; figures 1-5 *	1-13,15, 16	
A	WO 2011/029617 A2 (CLOSURE SYSTEMS INTERNAT DEUTSCHLAND GMBH [DE]; SCHWARZ WOLFHARD [DE]) 17 March 2011 (2011-03-17) * page 5, paragraph 3 * * page 12, paragraph 4 - page 13, paragraph 1; figures 1,2 *	1-16	
A	EP 2 311 773 A1 (KRONES AG [DE]) 20 April 2011 (2011-04-20) * paragraphs [0009], [0016], [0030], [0042], [0043]; figures 1-3 *	1-16	TECHNICAL FIELDS SEARCHED (IPC)
A	WO 2016/177750 A1 (TETRA LAVAL HOLDINGS & FINANCE [CH]) 10 November 2016 (2016-11-10) * abstract; figures 1-6 *	1-16	B67B
A	US 3 301 399 A (OCHS CHARLES S) 31 January 1967 (1967-01-31) * line 1, paragraph 5 - paragraph 12; figures 8,12,13 *	1-16	

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 April 2019	Wartenhorst, Frank

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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