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Product Inspection Apparatus

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[0001] This invention relates to a product inspection apparatus for detecting a contaminated product.

BACKGROUND

[0002] The presence of foreign bodies such as metal in a product may be an undesirable consequence of manufacturing. For the manufacturing of foodstuffs, unwanted inclusion of metal items is particularly problematic due to product safety and health concerns. Legislation has demanded that food manufacturing industry should provide effective measures to prevent the presence of foreign bodies such as metal in the product.

[0003] Compliance may be implemented by the use of metal detectors to detect a product contaminated with a metal object. The metal detector may be implemented on a production line or product inspection line, through which the product travels on a conveyor system. The product may not be easily removed whilst it is in the metal detector, due to being surrounded by the metal detector housing. It is therefore desired to provide a reject mechanism to remove the product at a later point on the conveyor system. The contaminated product must then be accurately identified, amongst other uncontaminated products, by the reject mechanism at the later point. However, if the conveyor speed fluctuates it may be difficult to accurately identify the contaminated product at the later point. An accurate indication of conveyor speed over time is required. The indication may be obtained using a rotary belt speed encoder, requiring the provision of extra equipment with associated cost.

[0004] It is an aim of the present invention to mitigate one or more of the problems with the prior art.

BRIEF SUMMARY OF THE DISCLOSURE

[0005] In accordance with the present invention there is provided a product inspection apparatus and a method for operation thereof. The product inspection apparatus may be for detecting metal contamination in foodstuffs. The product inspection apparatus comprises a conveyor system for transporting products between a first location and a second location. The conveyor system may be a belt conveyor system, for example. There is provided a drive motor configured to drive the conveyor system.

[0006] The product inspection apparatus comprises a detector such as a metal detector for detecting a contaminated product at the first location. The product inspection apparatus

comprises a reject mechanism for removing the contaminated product at the second location.

[0007] The product inspection apparatus comprises an inverter configured to receive an AC power supply of less than 150V and control a rotation speed of the drive motor.

[0008] The product inspection apparatus comprises a reject mechanism control system configured to: receive, from the metal detector, an indication that the contaminated product has been detected at the first location; receive, from the inverter, a pulse train output indicative of the rotation speed of the drive motor; and identify the contaminated product at the second location in dependence on the indication of the contaminated product and the pulse train output. In dependence on the identification, the reject mechanism control system may output a control signal to actuate the reject mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Embodiments of the invention are further described hereinafter with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a product inspection apparatus according to the present invention;

Figure 2 is an illustration of elements of a product inspection apparatus according to an embodiment of the invention;

Figure 3 is an illustration of a reject mechanism control system according to an embodiment of the invention;

Figure 4 is a flow chart of a method according to an embodiment of the invention; and

Figure 5 is an illustration of an example pulse train output.

DETAILED DESCRIPTION

[0010] Figure 1 illustrates a product inspection apparatus 100 according to an embodiment of the invention. The product inspection apparatus 100 is configured to identify and remove a contaminated product from a sequential arrangement of products. The product inspection apparatus 100 may be implemented in isolation or may form part of a larger production line or product inspection line.

[0011] The product inspection apparatus 100 comprises a conveyor system 110, a metal detector 120, a reject mechanism 130, an inverter 140 and a reject mechanism control system 150. The metal detector 120 is configured to detect a contaminated product, and the reject mechanism 130 is configured to remove the contaminated product from the

conveyor system 110, as will be explained. Aspects of the present invention provide a mechanism by which the contaminated product may be accurately removed by the reject mechanism 130.

[0012] The conveyor system 110 comprises a conveyor 111 for transporting the product and a drive motor 112 configured to drive the conveyor 111. The inverter 140 is configured to receive an AC power supply and control a rotation speed of the drive motor 112. The inverter is configured to receive an AC power supply of less than 150V. Preferably, the inverter is configured to receive an AC power supply of between 110V and 130V. In an illustrated embodiment the AC power supply is around 120V.

[0013] The conveyor system 110 is arranged to transport the product along a path through the product inspection apparatus 100. The speed at which the product is transported along the conveyor system is determined by the rotation speed of the drive motor 112 controlled by the inverter 140 and may fluctuate over time. The conveyor system transports the product between at least a first location and a second location in the product inspection apparatus 100.

[0014] The conveyor system 110 may be a belt conveyor system 110. However, it will be appreciated that alternative conveyor systems 110 may also be envisaged, such as for example a roller conveyor system 110.

[0015] Figure 2 illustrates an exemplary view of the product inspection apparatus 100 according to an embodiment of the invention. Figure 2 illustrates a belt conveyor system 110. Figure 2 illustrates superimposed on the product inspection apparatus 100 an indication of the first location 210 and the second location 220 between which the conveyor 111 is configured to transport the product. The conveyor 111 in the form of a conveyor belt 111 may be looped around one or more rollers driven by the drive motor 112, so that the conveyor belt 111 slides across a conveyor bed as the conveyor belt 111 transports the product along the conveyor system 110 from the first location 210 to the second location 220.

[0016] The product inspection apparatus 110 comprises a metal detector 120 for detecting a contaminated product at the first location 210. The metal detector 120 may comprise a search head 122 with an aperture 121 through which the product on the conveyor belt 111 passes to be checked by the metal detector 120. When a product is at the first location 210 the metal detector 120 is configured to check the product for the presence of foreign objects or contaminants such as pieces of metal or other foreign bodies. The metal detector 120 may be configured to identify the product as contaminated if any contaminant is detected, or if a contaminant is detected in the product at a quantity above a predetermined threshold.

[0017] If a contaminated product is detected by the metal detector 120, it is rejected. The product inspection apparatus comprises a reject mechanism 130 for removing the contaminated product from the conveyor 111 at the second location. The reject mechanism 130 may comprise a pusher assembly 130, however it will be appreciated that any other removal mechanism may be utilised. The reject mechanism 130 may be tailored for suitability depending on the shape, size and constitution of the product. The pusher assembly 130 may comprise a pusher arm, as illustrated in Figure 2, which when actuated by the reject mechanism control system 150 pushes the contaminated product from the conveyor 111. Optionally, the product inspection apparatus 110 comprises one or more reject bins 131 into which the contaminated product is placed by the reject mechanism 130 when actuated.

[0018] If a contaminated product is identified by the metal detector 120, the metal detector 120 is configured to output a reject signal to the reject mechanism control system 150. The reject mechanism control system 150 is then configured to determine when the identified contaminated product reaches the second location 220, and to output a control signal to actuate the reject mechanism 130 when the contaminated product reaches the second location 220. It will be appreciated that accurately determining when to actuate the reject mechanism is important, in order that the correct contaminated product in the sequence of products is removed. Errors in actuating the reject mechanism at the incorrect time may cause contaminated products to remain on the conveyor system 110 and continue to market.

[0019] Figure 3 illustrates a reject mechanism control system 150 according to an embodiment of the invention. The reject mechanism control system 150, referred to hereinafter as the controller 150 comprises at least one processor 151 and memory 152. The memory 152 may store computer readable instructions which may be executed by the one or more processors 151 to perform a method for identifying the contaminated product at the second location 220. Although illustrated schematically in Figure 3 as a single controller 150, it will be appreciated that in some embodiments the functionality of the controller 150 may be implemented across a plurality of controllers, communicably coupled via a communication means. The controller 150 is configured to receive input signals from the metal detector 120 and the inverter 140. The controller 150 is configured to output a control signal to actuate the reject mechanism 130.

[0020] Figure 4 illustrates a method 400 for identifying the contaminated product at the second location 220. The method 400 is performed by the controller 150 according to an embodiment of the invention.

[0021] The method 400 comprises a step 410 of receiving a reject signal from the metal detector 120. As discussed, the reject signal comprises an indication that a contaminated product has been detected at the first location 210. The reject signal may comprise an indication of the time at which the contaminated product was detected by the metal detector 120. Alternatively, the time at which the contaminated product was detected may be inferred by the controller 150 in dependence on the time at which the reject signal is received in step 410.

[0022] The method 400 comprises a step 420 of receiving a pulse train output signal from the inverter 140 indicative of the rotation speed of the drive motor 112.

[0023] The inverter 140 is configured to output a pulse train output signal indicative of its current output frequency. Figure 5 illustrates an example pulse train output signal 500, comprising a sequence of pulses 510 over time. The frequency of the pulse train signal may be quantified by one or both of the length of each pulse 512 or the time between each pulse 511. The inverter 140 may be configured such that the frequency of the pulse train output signal is indicative of the frequency of rotation of the drive motor. Given a calibration between the drive motor frequency and the speed of the conveyor 111, the distance moved by the conveyor 111 in a given time period may be extracted from the pulse train output signal.

[0024] The method 400 comprises a step 430 of identifying the contaminated product at the second location in dependence on the reject signal and the pulse train output. As discussed, the time at which the contaminated product was detected at the first location 210 may be received or inferred by the controller 150 from the received reject signal. The distance between the first location 210 and the second location 220 may be preconfigured and stored accessible to the controller 150, for example on the memory 152. The controller 150 may infer from the pulse train output the time taken for the conveyor 111 to travel the distance between the first location 210 and the second location 220. Thus, the time at which the contaminated product reaches the second location 220 may be determined.

[0025] The method 400 comprises a step 440 of outputting a control signal to actuate the reject mechanism 130 at the time inferred in step 430. That is, the reject mechanism 130 may be actuated when the contaminated product reaches the second location 220.

[0026] By inferring the conveyor distance travelled directly from the pulse train output of the inverter 140, fluctuations in conveyor speed may be accounted for and thus the contaminated object may be robustly and accurately identified and removed at the second location 220. Furthermore, no additional belt speed encoder need be utilised, thus minimising the complexity and cost of the product inspection apparatus 100.

[0027] It will be appreciated that embodiments of the present invention can be realised in the form of hardware, software or a combination of hardware and software. Any such software may be stored in the form of volatile or non-volatile storage such as, for example, a storage device like a ROM, whether erasable or rewritable or not, or in the form of memory such as, for example, RAM, memory chips, device or integrated circuits or on an optically or magnetically readable medium such as, for example, a CD, DVD, magnetic disk or magnetic tape. It will be appreciated that the storage devices and storage media are embodiments of machine-readable storage that are suitable for storing a program or programs that, when executed, implement embodiments of the present invention. Accordingly, embodiments provide a program comprising code for implementing a system or method as claimed in any preceding claim and a machine readable storage storing such a program. Still further, embodiments of the present invention may be conveyed electronically via any medium such as a communication signal carried over a wired or wireless connection and embodiments suitably encompass the same.

[0028] Throughout the description and claims of this specification, the words “comprise” and “contain” and variations of them mean “including but not limited to”, and they are not intended to (and do not) exclude other moieties, additives, components, integers or steps. Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0029] Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

[0030] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and

which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

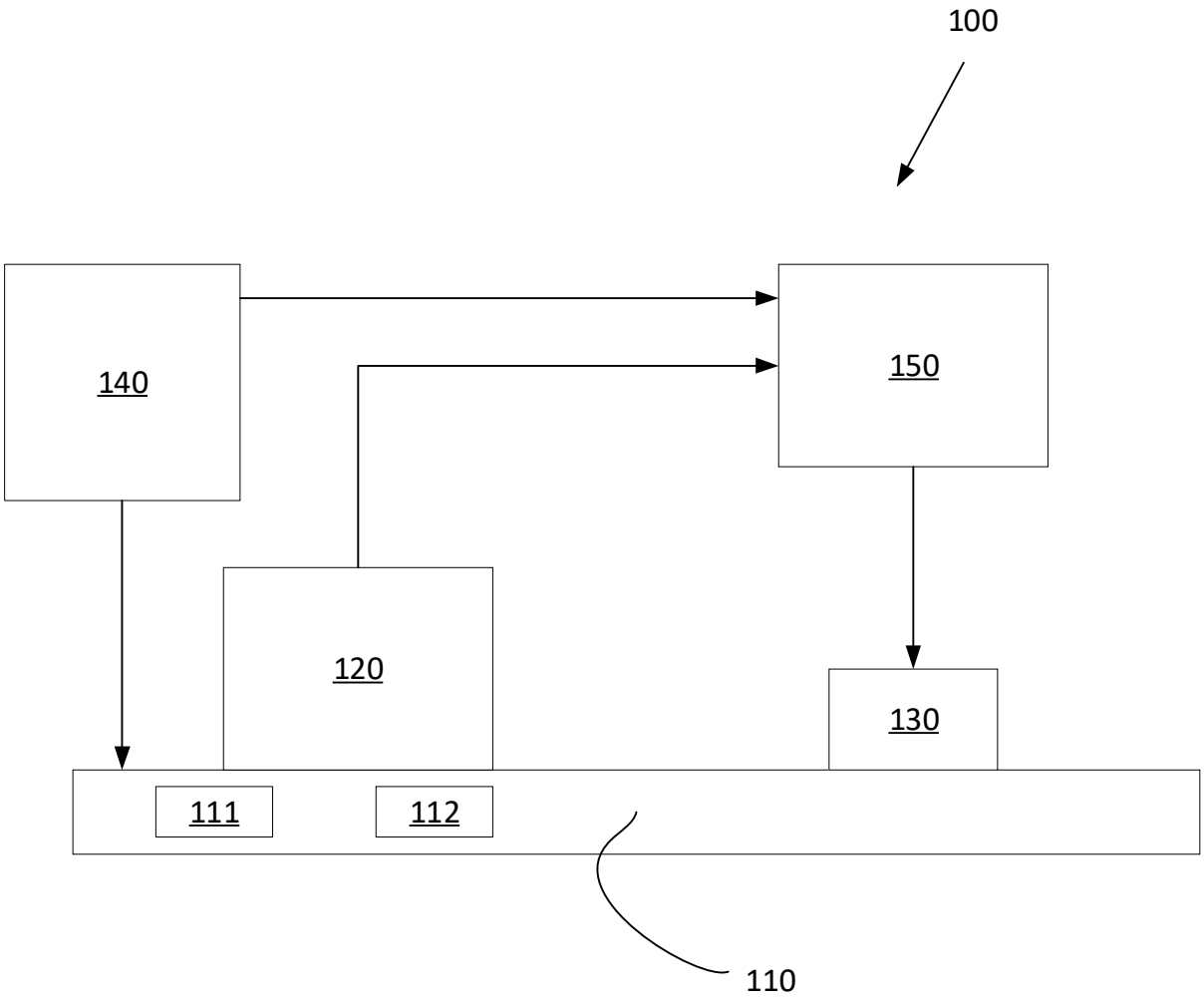

Fig. 1

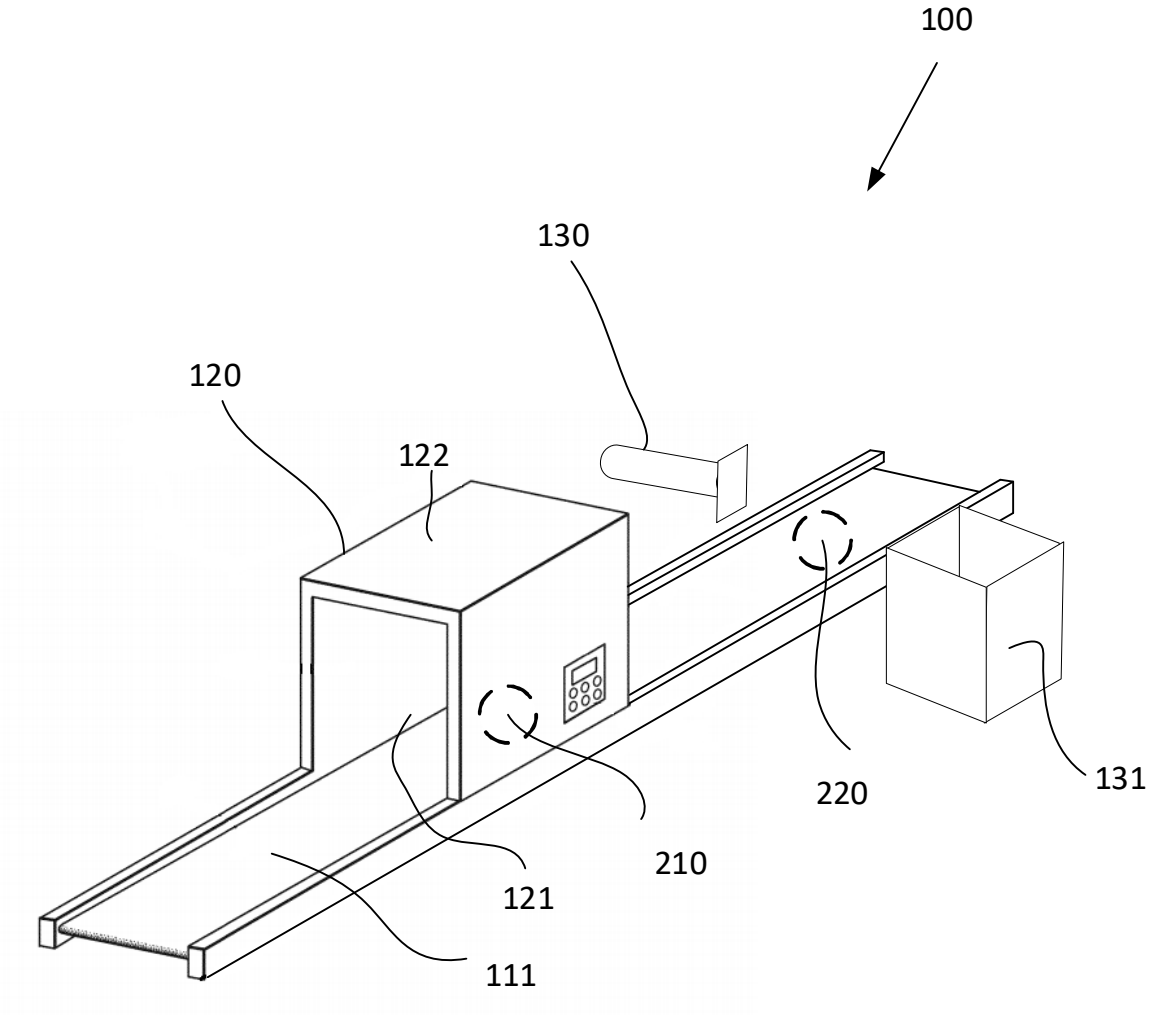

Fig. 2

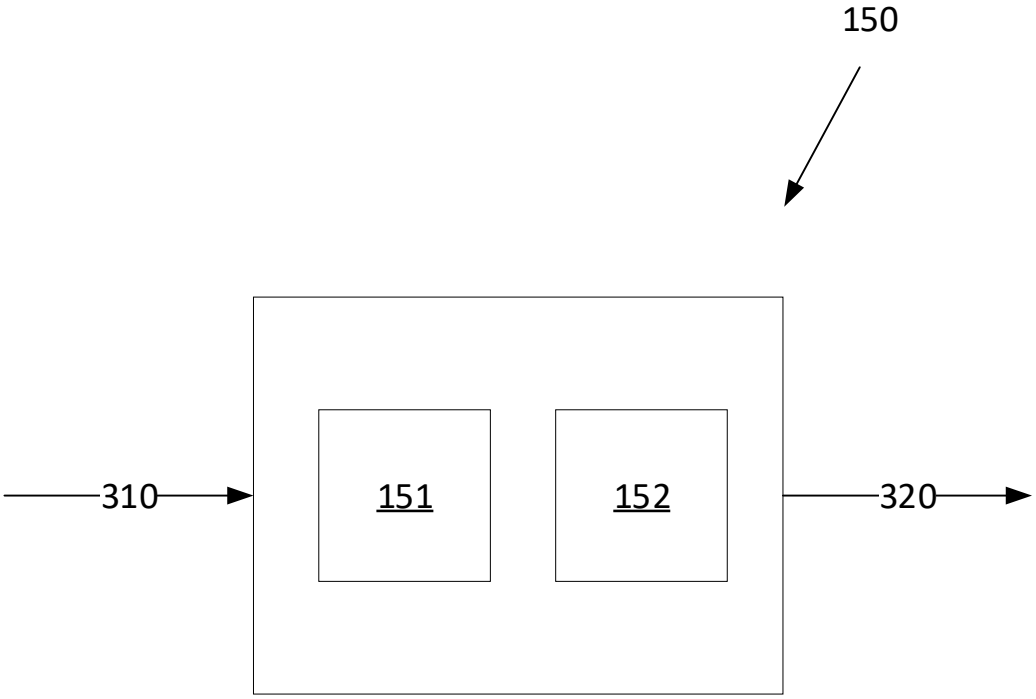

Fig. 3

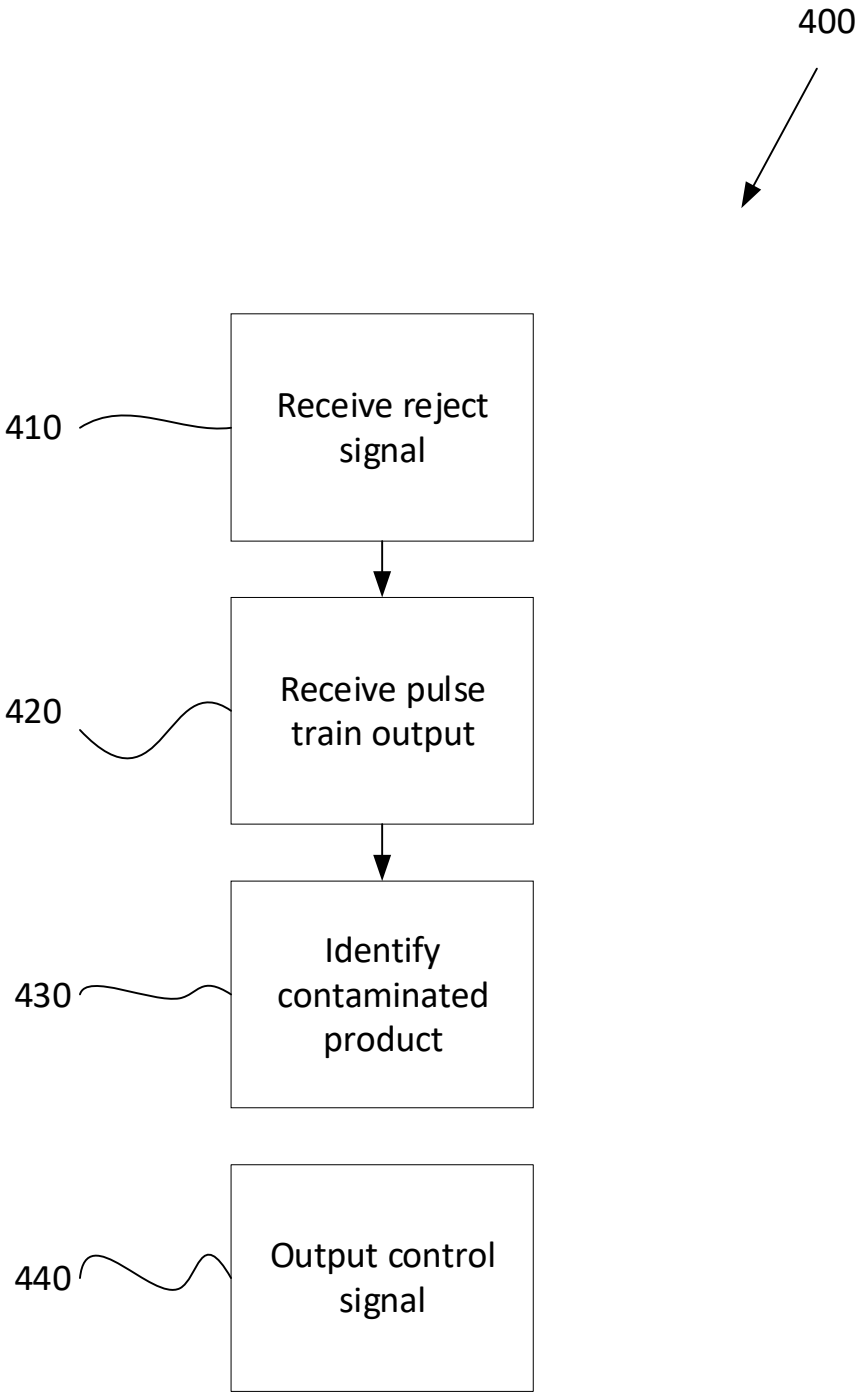
400
410
Receive reject signal
420
Receive pulse train output
430
Identify contaminated product
440
Output control signal

Fig. 4

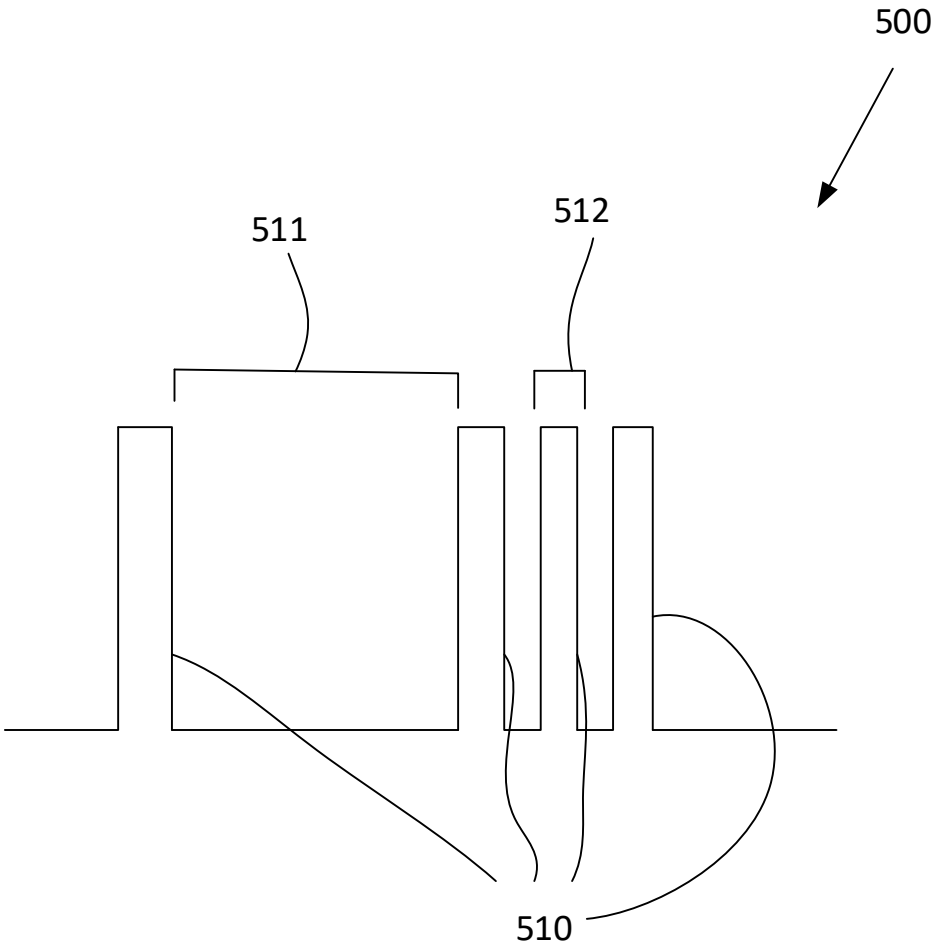

Fig. 5