Declinations under Rule 4.17:
— of inventorship (Rule 4.17(iv))

[Continued on next page]
Published:

— with international search report (Art. 21(3))
Quality control system for agriculture products

Invention refers to quality control system, especially to quality control systems detecting a presence of insects, pests and the like in such product like cereals, seed, grains and the like.

Early detection and disinfection of supplies eliminates product damage by pests. A product to be controlled is selected from the group of the following products: corn, rice, wheat, barley, sorghum, millet, oats, rye, triticale, buckwheat, white mustard, black mustard, brown mustard, hemp, cumin, poppy, rape, sunflowers, flax, safflower, beans, peas, Turkish peas, lentils, soybeans, peanuts, legume seed flour products.

Quality control of cereals, seed, grains and the like is performed by manually collecting a sample and by visual analysis of collected sample. Control of said products usually is performed during bulk cargo loading, unloading and handling. Said quality control includes detection and identification of live pests, larvae, insects and the like.

In this way, previous quality control systems do not adequately provide an efficient, reliable and fast quality control of tested sample. Such a process always will be influenced by human factor. Therefore, it is necessary to develop a quality control system which is efficient, fast and reliable in detection and identification of live pests, insects in cereals, seed, grains and the like.

The aim of the invention is reached by designing a quality control system for controlling the cereals, seeds, grains and the like. The quality control system comprising a sample collecting device for collecting a sample in pre-determined amount from a product to be tested, a self-cleaning cyclone filter for cleaning the sample, a vibro separator for separation of the sample in pre-determined sizes, a heating chamber for heating the sample separated in the vibro separator. The system further comprises a noise sensor, movement scanner for identifying a presence of life insects, pests and the like in said sample, an infrared spectrometer for detection and identification of life insects, pests and the like in said sample, a thermo visor for detection and identification of life insects, pests and the like in said sample, and an image recognition device for detection and identification of life insects, pests and the like in said sample.
The noise and movement scanner, the infrared spectrometer, the thermo visor and the image recognition device can be incorporated in an identification apparatus.

At the final stage of the system it further comprises a disinfection tank for reception and disinfection of processed samples. If live insects, pests and the like are detected, the sample is moved to the disinfection tank. The same tank can be used to disinfect all cargo, from which the sample were taken.

The identification apparatus further comprises an ultrasound sensor for detection of life insects, pests and the like in said sample. Said ultrasound sensor can be installed in any place in the system according to the needs of system user. Installation of said sensor gives additional security that the insects, pests and the like will be detected.

Another embodiment of the invention is a quality control system comprising a sample collecting device for collecting a sample in pre-determined amount from a product to be tested, a self-cleaning cyclone filter for cleaning the sample, a vibro separator having three stages for separation of the sample in three samples. A first sample separated in the first stage flows back through a discharge opening to the product flow. In the first stage, impurities are separated. In the second stage a second sample is separated, which can comprise live insects, pests and the like. In the third stage a third sample is separated, wherein the third sample has crops or any other agricultural product with smaller grade than in the second sample. The second and the third sample is transported to the heating chamber for heating said samples separately. After the heating, the third sample as well as the second sample are transported to the noise and movement scanner for detection a presence of live insects, pests and the like. For each sample there is separate noise and movement scanner.

The second sample is further transported to the infrared spectrometer, the thermo visor and the image recognition device. If the presence of live insects, pests and the like is detected the second sample is sent to the disinfection tank. If the presence of live insects, pests and the like is not detected the second sample is sent to the outflow from the system or back to the flow of basic product.
If the presence of live insects, pests and the like is detected in the third sample in the noise and movement scanner then the third sample is sent for further investigation to the thermo visor and to the image recognition device and subsequently to the disinfection tank. If the presence was not detected in the noise and the movement scanner, then the third sample is discharged through the discharge opening back to the product conveyor or tank through pneumatic line or transporter.

The collecting device is configured to collect a sample of product, which is transported through pipeline or which is accommodated in a tank. The collecting device can comprise pneumatic system configured to collect a predetermined amount of the product to be tested. The collecting device can be a frame configured to collect the samples while the product flows through the frame. After collecting of the sample it is transported to the self-cleaning cyclone filter that is configured to clean the sample from dusts and other impurities.

After the cleaning the sample is conveyed to the vibro separator, that is configured to separate the samples of different nature, grades and sizes, wherein said product passes through a series of screen, preferable at least three screens. The vibro separator to be used can be three-level, three-dimensional motion vibro separator with interchangeable separators with self-cleaning and unloading functions. The vibro separator can be in at least two stages, preferably in three stages. The system can comprise more than one vibro separator to increase an overall efficiency. For example, the system can comprise two separators connected parallel, doubling the efficiency.

Said sensor units are interchangeable and can be arranged in different manner from previous mentioned. For example, the first identification unit can be the infrared spectrometer instead of the noise and movement scanner. Position of said sensor units depend on configuration of the system according to the needs of a user.

A rotor conveyor can be installed in the identification apparatus for transportation of sample from one control unit to another one. Accordingly, a sample is loaded in a rotor conveyor and then is transported from the noise and movement scanner to the infrared spectrometer and later on to the thermo visor and the image recognition device for detection and identification of life insects, pests and the like in said sample. The
movement of samples can be accomplished by belt conveyor and by any other transportation means configured to convey a sample to be tested from one to another unit of the system.

The present invention further comprises a method for detection and identification of live insects, pests and the like using said quality control system. The method includes the following steps: collecting a sample of a product using a collecting device, cleaning the sample in a self-cleaning cyclone filter, separation of the sample in pre-determined sizes or grades using a vibro separator, heating of each separated sample in a heating chamber, detecting a presence of live insects, pests and the like in said sample by a noise and movement scanner, detecting and identifying of live insects, pests and the like in said sample using infrared spectrometer, a thermo visor and an image recognition device.

After detection and identification of live insects, pests and the like the second and the third samples are sent to disinfection tank or discharged through a discharge opening.

Detection and identification of a live insects, pests and the like in said sample is performed by using a noise sensor, a movement scanner, a noise or movement scanner, an infrared spectrometer, a thermo visor, an image recognition device or an ultrasound sensor.

After detection and identification of live insects, pests and the like each sample is sent to disinfection tank or discharged through a discharge opening. Usually, when live insects, pests and the like are detected the sample is sent to the disinfection tank. In result all cargo can be sent to the disinfection tank. The disinfection tank is configured to keep a constant disinfection environment. When there is no detection, the sample is sent to the discharge opening to return it into a product tank.

At least one sample, where the presence of insects were detected, can be discharged through a discharge opening to a compartment configured to store a collected sample. This feature is very useful to preserve the tested sample for further quality control or for documentation of test results.
The aspects of the present invention will become apparent and more readily appreciated from the following description of embodiments, taken in conjunction with the accompanying drawings in which:

Fig. 1 is a block diagram illustrating a quality control system; Fig. 2 is a block diagram illustrating an embodiment of a quality control system; Fig. 3 is a block diagram illustrating another embodiment of a quality control system.

A quality control system (Fig. 1) for controlling of cereals, seeds, grains and the like, comprises a sample collecting device 1 for collecting a sample in pre-determined amount from a product P to be tested, a self-cleaning cyclone filter 2 for cleaning the sample and a vibro separator 3 for separation of the sample in pre-determined sizes or grades. The following example in Fig. 1 illustrates the three stage vibro separator 3. The samples separated at a first stage are discharged to a discharge opening 10. The samples in the first stage are impurities that cannot be used for testing. The samples separated in the second stage and in the third stage are the samples to be tested. Said samples differ in the grain size.

After separation the second and the third sample are transported to a heating chamber 4 for heating the sample separated in the vibro separator. Each heated sample is then sent to an identification apparatus 5 for detection and identification of live insects, pests and the like in said sample.

Said identification apparatus 5 comprises a noise and movement scanner 6 for detection a presence of live insects, pests and the like in said sample, an infrared spectrometer 7, a thermo visor 8 for detection and identification of live insects, pests and the like in said sample, and an image recognition device 9 for identification of live insects, pests and the like in said sample. Accordingly, a user of the system will be able to recognize the detected insect, pest or the like. Afterwards said tested samples are transported to a disinfection tank 11 for disinfection.

Another embodiment of a quality control system (Fig. 2) comprises a sample collecting device 1 for collecting a sample in pre-determined amount from a product P to be tested, a self-cleaning cyclone filter 2 for cleaning the sample and a vibro separator 3 for
separation of the sample in pre-determined sizes or grades. The vibro separator 3 comprises three stages 3a, 3b and 3c. The samples separated at a first stage 3a are discharged to a discharge opening 10. The samples in the first stage are different impurities that cannot be used for testing. The samples separated in the second stage 3b and in the third stage 3c are the samples to be tested. Said samples differ in the grain sizes. After separation, the second and the third sample are transported to a heating chamber 4 for heating the sample.

The third samples are sent to the noise and movement scanner 6 for detection a presence of live insects, pests and the like in said sample. If the presence is detected the sample is sent to the thermo visor 8 and the image recognition device 9 for further investigation and afterwards to the disinfection tank 11 for disinfection. If in the noise and movement scanner 6 the presence of live insects, pest or the like is not detected, then the sample is sent to the discharge opening 10.

The second samples are sent to an identification apparatus 5 for detection and identification of live insects, pests and the like in said sample.

Said identification apparatus 5 comprises a noise and movement scanner 6 for detection a presence of live insects, pests and the like in said sample, an infrared spectrometer 7, a thermo visor 8 for detection and identification of live insects, pests and the like in said sample, and an image recognition device 9 for identification of live insects, pests and the like in said sample. If the presence of live insects, pest or the like is detected and identified the sample is sent to the disinfection tank 11 for disinfection. If the presence is not detected, then the sample is sent to the discharge opening 10. At least one sample, where the presence of insects were detected, can be discharged through a discharge opening 10 to a compartment (not shown in figure) configured to store a collected sample. At least one sample, where the presence of insects were detected, can be discharged through a discharge opening 10 to a compartment (not shown in figure) configured to store a collected sample.

Another embodiment of a quality control system (Fig. 3) comprises a sample collecting device 1 for collecting a sample in pre-determined amount from a product P to be tested, a self-cleaning cyclone filter 2 for cleaning the sample and a vibro separator 3 for
separation of the sample in pre-determined sizes or grades. The vibro separator 3 comprises three stages 3a, 3b and 3c. The samples separated at a first stage 3a are discharged to a discharge opening 10. The samples in the first stage are impurities that cannot be used for testing. The samples separated in the second stage 3b and in the third stage 3c are the samples to be tested. Said samples differ in the grain sizes. After separation the second and the third sample are transported to a heating chamber 4 for heating the sample.

Each third sample is sent to identification apparatus 5. The identification apparatus 5 comprises a noise sensor 6A and a movement scanner 6B, the thermo visor 8, the infrared spectrometer 7 and the image recognition device 9. If the presence of live insects, pest or the like is detected and identified the sample is sent to the disinfection tank 11 for disinfection. If the presence is not detected, then the sample is sent to the discharge opening 10.

Each second sample is sent to identification apparatus 5. Said identification apparatus 5 comprises a noise sensor 6A and a movement scanner 6B, the thermo visor 8, the infrared spectrometer 7, an ultrasound sensor 12 and the image recognition device 9. If the presence of live insects, pest or the like is detected and identified the sample is sent to the disinfection tank 11 for disinfection. If the presence is not detected, then the sample is sent to the discharge opening 10. At least one sample, where the presence of insects were detected, can be discharged through a discharge opening 10 to a compartment (not shown in figure) configured to store a collected sample.

The present invention is not limited to the above-described embodiments. It is apparent to one who has an ordinary skill in the art that there may be many modifications and variations within the scope of the invention as defined by the appended claims.

Explanation of main parts of the drawings:

1 - a sample collecting device;  
2 - a self-cleaning cyclone filter;  
3 - a vibro separator;  
3a - a first stage of the vibro separator;
3b - a second stage of the vibro separator;
3c - a third stage of the vibro separator;
4 - a heating chamber;
5 - an identification apparatus;
6 - a noise and movement scanner;
6A - a noise sensor;
6B - a movement scanner;
7 - infrared spectrometer;
8 - thermo visor;
9 - an image recognition device;
10 - discharge opening;
11 - disinfection tank;
12 - ultrasound sensor;
P - product to be controlled.
CLAIMS

1. A Quality control system for controlling of cereals, seeds, grains and the like, comprising
a sample collecting device (1) for collecting a sample in pre-determined amount from a product (P) to be tested,
a self-cleaning cyclone filter (2) for cleaning the sample,
a vibro separator (3) for separation of the sample in pre-determined sizes or grades,
a heating chamber (4) for heating the sample separated in the vibro separator,
wherein said system further comprises a movement scanner (6B) for detection a presence of live insects, pests and the like in said sample,
an infrared spectrometer (7) for detection and identification of live insects, pests and the like in said sample,
a thermo visor (8) for detection and identification of live insects, pests and the like in said sample,
an image recognition device (9) for identification of live insects, pests and the like in said sample.

2. The quality control system according to Claim 1, wherein the system further comprises a noise sensor (6A) for detection a presence of live insects, pests and the like in said sample.

3. The quality control system according to Claim 1 or 2, wherein the noise sensor (6A) and the movement scanner (6B) are combined as a noise and movement scanner (6).

4. The quality control system according to Claims 1 to 3 wherein the identification apparatus (5) further comprises an ultrasound sensor (12) for detection of live insects, pests and the like in said sample.

5. The quality control system according to Claims 1 to 4, wherein the noise sensor (6A), the movement scanner (6B), the infrared spectrometer (7), the thermo visor
(8), the image recognition device (9) and ultrasound sensor (12) are incorporated in an identification apparatus (5).

6. The quality control system according to Claims 1 to 5, wherein it further comprises disinfection tank (11) connected to the final stage of the system for disinfection of processed samples.

7. The quality control system according to Claims 1 to 6, wherein the vibro separator (3) comprises at least three stages (3a, 3b, 3c) for separation of a sample in three samples,

wherein a first sample separated in the first stage (3a) flows to the outflow (10) of the system, a second sample separated in the second stage (3b) and a third sample separated in the third stage (3c) flow to a heating chamber (4) configured to heat said samples.

8. Method for detection and identification of live insects, pests and the like using said quality control system, wherein the method includes the following steps:

- collecting a sample of a product (P) using a collecting device (1),
- cleaning the sample in a self-cleaning cyclone filter (2),
- separation of the sample in pre-determined sizes or grades using a vibro separator (3),
- heating of each separated sample in a heating chamber (4),
- detecting and identifying of live insects, pests and the like in said sample.

9. Method according to Claim 8, wherein the step for detecting and identifying of a live insects, pests and the like in said sample is performed by using a noise sensor (6A), a movement scanner (6B), a noise or movement scanner (6), an infrared spectrometer (7), a thermo visor (8), an image recognition device (9) or an ultrasound sensor (12).

10. Method according to the Claims 8 or 9, wherein after detection and identification of live insects, pests and the like each sample is sent to disinfection tank (11) or discharged through a discharge opening (10).
Fig. 2
### INTERNATIONAL SEARCH REPORT

**International application No.**

PCT/IB 2014/064850

**A. CLASSIFICATION OF SUBJECT MATTER**

**G01N 33/02 (2006.01)**

**B02B 5/00 (2006.01)**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

G01J 5/00, 5/02, G01N 21/00, 33/00, 33/02, B02B 5/00-5/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO, PatSearch, RUPTO, WIPO, Espacenet

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 3036707 A (W J WALDEN SEED COMPANY INC) 29.05. 1962, col. 1 lines 10-15, col. 2 lines 1-5, 70 - col. 3 line 7, fig. 1</td>
<td>1-3, 8-10</td>
</tr>
<tr>
<td>Y</td>
<td>US 2515725 A (DELinted SEED COMPANY) 18.07.1950, col.6 lines 59-65, fig. 1</td>
<td>1-3, 8-10</td>
</tr>
<tr>
<td>Y</td>
<td>CN 101701906 A (UNIV JIANGSU) 05.05.2010, abstract, par. [0001], [0003]</td>
<td>1-3, 8-10</td>
</tr>
<tr>
<td>Y</td>
<td>US 8047129 B2 (JUNG JI HYUN) 01.11.2011, claims 1-2</td>
<td>1-3, 8-10</td>
</tr>
</tbody>
</table>

- **Special documents are listed in the continuation of Box C.**
- **See patent family annex.**

- **“A”** document defining the general state of the art which is not considered to be of particular relevance
- **“E”** earlier document but published on or after the international filing date cited to establish the publication date of another citation or other special reason (as specified)
- **“O”** document referring to an oral disclosure, use, exhibition or other means
- **“P”** document published prior to the international filing date but later than the priority date claimed
- **“T”** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- **“X”** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- **“Y”** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- **“&”** document member of the same patent family

**Date of the actual completion of the international search**

09 July 2015 (09.07.2015)

**Date of mailing of the international search report**

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**Name and mailing address of the ISA/RU:**

Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993

Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37

**Authorized officer**

I. Ivkina

**Telephone No. (495) 531-64-8**

Form PCT/ISA/210 (second sheet) (January 2015)
**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-7
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.