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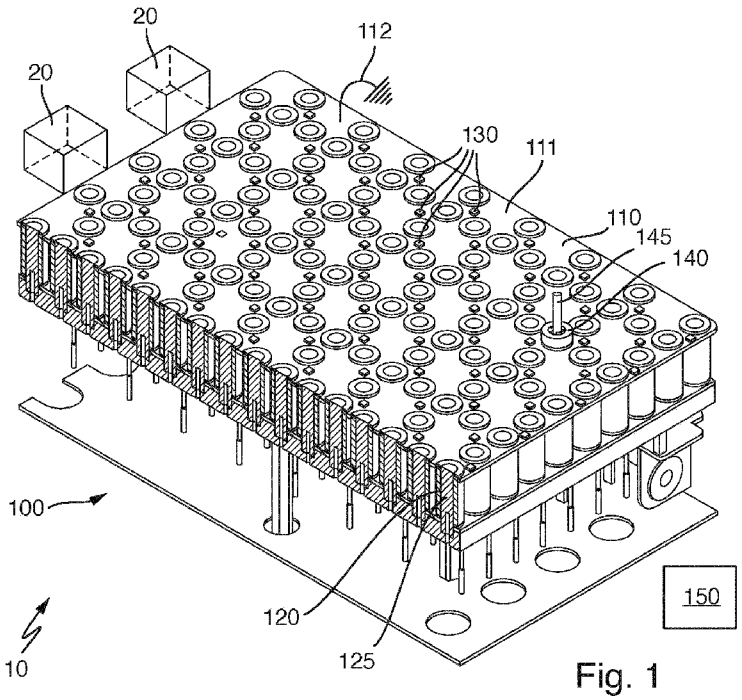


Fig. 1

(57) Abstract: The invention relates to a laboratory sample distribution system comprising a transport plane in which the transport plane is covered by an electrically conductive material. The invention relates further to a laboratory automation system comprising such a laboratory sample distribution system.

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Laboratory sample distribution system and laboratory automation system

Applicable field and prior art

The invention relates to a laboratory sample distribution system comprising a transport plane, a number of sample container carriers, drive means being adapted to move the sample container carriers on the transport plane, and a control device being configured to control the movement of the sample container carriers on top of the transport plane by driving the drive means such that the sample container carriers move along corresponding transport paths. The invention further relates to a laboratory automation system comprising a number of laboratory stations and a laboratory sample distribution system.

Known laboratory sample distribution systems are typically used in laboratory automation systems in order to transport samples contained in sample containers between different laboratory stations.

A typical laboratory sample distribution system is shown in document WO 2013/064656 A1. Such a laboratory sample distribution system provides for a high throughput and for reliable operation.

Object and solution

It is an object of the present invention to further optimize a laboratory sample distribution system and a laboratory automation system comprising a laboratory sample distribution system.

The invention solves this object by a laboratory sample distribution system according to claim 1 and a laboratory automation system according to claim 15.

The laboratory sample distribution system comprises a transport plane.

The laboratory sample distribution system further comprises a number of sample container carriers and drive means being adapted to move the sample container carriers on (over) the transport plane.

The laboratory sample distribution system further comprises a control device, e.g. in the form of a microprocessor or a personal computer, being configured to control the movement of the

sample container carriers on top of the transport plane by driving the drive means such that the sample container carriers move along corresponding transport paths.

The transport plane is covered by (coated with) or is made of a (first) electrically conductive material.

By means of the electrically conductive material covering the transport plane, electric charges arising during movement of the sample container carriers can be distributed over the transport plane and can, if appropriate grounding means are present, be conducted to ground in order to eliminate the electric charges from the transport plane. This reduces electric charges on the transport plane that could disturb operation of the laboratory sample distribution system.

According to an embodiment, the first electrically conductive material is/comprises a copolyester material.

According to an embodiment, the first electrically conductive material is/comprises a polyethylene terephthalate material.

According to an embodiment, the first electrically conductive material is an optically bright material. This has been proven suitable for optically surveilling operation of the laboratory sample distribution system.

According to an embodiment, the first electrically conductive material lacks a carbon-based electrically conducting additive. On other words, the first electrically conductive material is free of a carbon-based electrically conducting additive. This has been proven suitable in order to get an optically bright material being electrically conducting.

According to an embodiment, the transport plane has a grained surface. This can further reduce friction between the transport plane and the sample container carriers.

According to an embodiment, each sample container carrier comprises a flat bottom surface for moving on the transport plane. The bottom surface is covered by or is made of a (second) electrically conductive material. This allows for an easy transport of electric charges being present on the bottom surface to the transport plane, where the electric charges can be distributed or discharged.

According to an embodiment, the second electrically conductive material is/comprises an ultra-high molecular polyethylene.

According to an embodiment, the first electrically conductive material and/or the second electrically conductive material is/are an electrically conductive polymer.

According to an embodiment, the first electrically conductive material and/or the second electrically conductive material comprise(s) an electrically conducting additive. The electrically conducting additive can be used to achieve an electrically conductive material without using dark carbon-based materials.

According to an embodiment, the electrically conducting additive is a polyaniline material or another electrically conductive polymer.

According to an embodiment, the first electrically conductive material and/or the second electrically conductive material is/are low friction and/or low wear materials. This can further reduce friction or wear between the transport plane and the sample container carriers when the sample container carriers move on the transport plane.

According to an embodiment, the first electrically conductive material and/or the second electrically conductive material is/are adapted to at least approximately equate gliding friction and static friction. This has been proven suitable for longtime reliable operation. Especially, spilling can be prevented by this measure. The first electrically conductive material and/or the second electrically conductive material can be adapted to exactly equate gliding friction and static friction.

According to an embodiment, the drive means are formed as electromagnetic actuators being located as a grid having rows and columns below the transport plane and being controllable by the control device, wherein the sample container carriers each comprise a magnetically active device, e.g. in the form of a permanent magnet, for interaction with a magnetic field generated by the electromagnetic actuators such that a magnetic drive force is applied to the sample container carriers. Such an embodiment allows for reliable operation using magnetic drive forces in order to drive the sample container carriers on the transport plane.

The invention further relates to a laboratory automation system comprising a number of laboratory stations, preferably pre-analytical, analytical and/or post-analytical stations, and a

laboratory sample distribution system according to the invention. With regard to the laboratory sample distribution system, all embodiments and variations discussed herein can be applied.

The stations may be arranged adjacent to the laboratory sample distribution system.

Pre-analytical stations may be adapted to perform any kind of pre-processing of samples, sample containers and/or sample container carriers.

Analytical stations may be adapted to use a sample or part of the sample and a reagent to generate a measuring signal, the measuring signal indicating if and in which concentration, if any, an analyte is existing.

Post-analytical stations may be adapted to perform any kind of post-processing of samples, sample containers and/or sample container carriers.

The pre-analytical, analytical and/or post-analytical stations may comprise at least one of a decapping station, a recapping station, an aliquot station, a centrifugation station, an archiving station, a pipetting station, a sorting station, a tube type identification station, a sample quality determining station, an add-on buffer station, a liquid level detection station, and a sealing/desealing station.

It should be noted that for the first electrically conductive material, a material named PET Eastar 6763 (including 12 percent by weight PETG Funaden perm AS (14-05189)) / Funaden el. Cond. (eroding structure K29 VDI 3400), Ra 2.8, has been proven as a suitable material. For the second electrically conductive material, the material PE-UHMW-S-Bright-ESD of Murtfeldt, Ra 3.2, has been proven suitable. The Ra-terms determine the roughness of the respective material.

Short description of the drawings

The invention will be described in detail with respect to the drawings schematically depicting embodiments of the invention. In detail:

Fig. 1 shows a laboratory automation system comprising a laboratory sample distribution system according to the invention, and

Fig. 2 shows a sample container carrier in a perspective bottom side view.

Detailed description of the embodiments

Fig. 1 shows a laboratory automation system 10 comprising a laboratory sample distribution system 100 and a number of pre-analytical, analytical and/or post-analytical stations 20 arranged adjacent to the laboratory sample distribution system 100. Self-evidently, more than the two stations 20 depicted in fig. 1 may be comprised in the laboratory automation system 10.

The laboratory sample distribution system 100 comprises a transport plane 110 below which a plurality of electromagnetic actuators in the form of electromagnets 120 are positioned in rows and columns. The electromagnets 120 are implemented as solenoids having solid ferromagnetic cores 125.

Sample container carriers 140 are positioned on the transport plane 110 and can be moved by means of the electromagnets 120, because each sample container carrier 140 comprises a magnetically active device 141 in the form of a permanent magnet.

While it should be understood that a plurality of sample container carriers 140 can be positioned on the transport plane 110, due to simplicity only a single sample container carrier 140 is depicted in fig. 1. The sample container carrier 140 holds and carries a sample container 145, in which a sample to be analyzed can be contained.

The laboratory sample distribution system 100 is adapted to transport the sample container carriers 140 and/or the sample containers 145 between the laboratory stations 20. The laboratory stations 20 are positioned adjacent to the transport plane 110 such that a sample container carrier 140 can be used to transport a sample contained in the sample container 145 to a respective laboratory station 20.

A plurality of Hall-sensors 130 is arranged such that positions of respective sample container carriers 140 on the transport plane 110 can be detected.

The laboratory sample distribution system 100 further comprises a control device 150. The control device 150 is configured to control movement of the sample container carriers 140 on the transport plane by driving the electromagnets 120 such that the sample container carriers 140 independently and simultaneously move along corresponding transport paths.

The transport plane 110 is covered or coated with a first electrically conductive material 111.

In the present case, the first electrically conductive material 111 comprises a copolyester material and a polyethylene terephthalate material. The first electrically conductive material 111 is optically bright and comprises an electrically conductive additive being a polymer, such that no carbon-based electrically conductive additives have to be used. Furthermore, the first electrically conductive material 111 is connected to a grounding 112, such that electric charges can be discharged to ground.

Fig. 2 shows the sample container carrier 140 with its sample container 145 in a perspective view, such that a bottom surface 142 of the sample container carrier 140 is visible.

The bottom surface 142 is covered or coated by a second electrically conductive material 143, which is, in the present case, comprised of an ultra-high molecular polyethylene comprising an electrically conductive polymer.

The sample container carriers 140 each comprise a magnetically active device 141 in the form of a permanent magnet for interaction with a magnetic field generated by the electromagnetic actuators 120 such that a magnetic drive force can be applied to the sample container carriers 140.

By means of the invention electric charges, generated when operating the sample distribution system 100 by moving the sample container carriers 140 over the transport plane 110, are safely discharged, thus avoiding malfunctions.

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Claims

1. Laboratory sample distribution system (100), comprising
- a transport plane (110),
- a number of sample container carriers (140),
- drive means (120) being adapted to move the sample container carriers (140) on the transport plane (110), and
- a control device (150) being configured to control the movement of the sample container carriers (140) on top of the transport plane (110) by driving the drive means (120) such that the sample container carriers (140) move along corresponding transport paths,
- wherein the transport plane (110) is covered by a first electrically conductive material (111).

2. Laboratory sample distribution system (100) according to claim 1, characterized in that
- the first electrically conductive material (111) comprises a copolyester material.

3. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) comprises a polyethylene terephthalate material.

4. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) is an optically bright material.

5. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) lacks a carbon-based electrically conducting additive.

6. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the transport plane (110) has a grained surface.

7. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- each sample container carrier (140) comprises a flat bottom surface (142) for moving on the transport plane (110), the bottom surface (142) being covered with a second electrically conductive material (143).

8. Laboratory sample distribution system (100) according to claim 7, characterized in that
- the second electrically conductive material (143) comprises an ultrahigh molecular polyethylene.

9. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) and/or the second electrically conductive material (143) is an electrically conductive polymer.

10. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) and/or the second electrically conductive material (143) comprises an electrically conducting additive.

11. Laboratory sample distribution system (100) according to claim 10, characterized in that
- the electrically conducting additive is an electrically conducting polymer.

12. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) and/or the second electrically conductive material (143) is a low friction and/or low wear material.

13. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that
- the first electrically conductive material (111) and/or the second electrically conductive material (143) is adapted to at least approximately equate gliding friction and static friction.

14. Laboratory sample distribution system (100) according to one of the preceding claims, characterized in that

- the drive means (120) are formed as electromagnetic actuators (120) being located below the transport plane (110) and being controllable by the control device (150), and
- the sample container carriers (140) each comprise a magnetically active device (141) for interaction with a magnetic field generated by the electromagnetic actuators such that a magnetic drive force is applied to the sample container carriers (140).

15. Laboratory automation system (10), comprising

- a number of laboratory stations (20), and
- a laboratory sample distribution system (100) according to one of the preceding claims.

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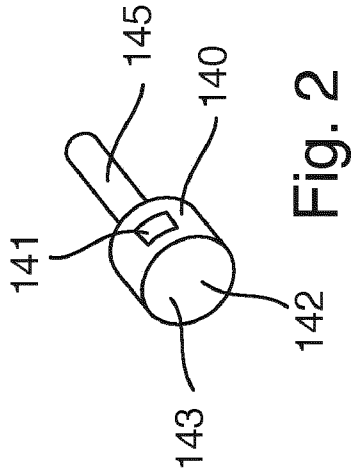

145
140
141
142
143

Fig. 2

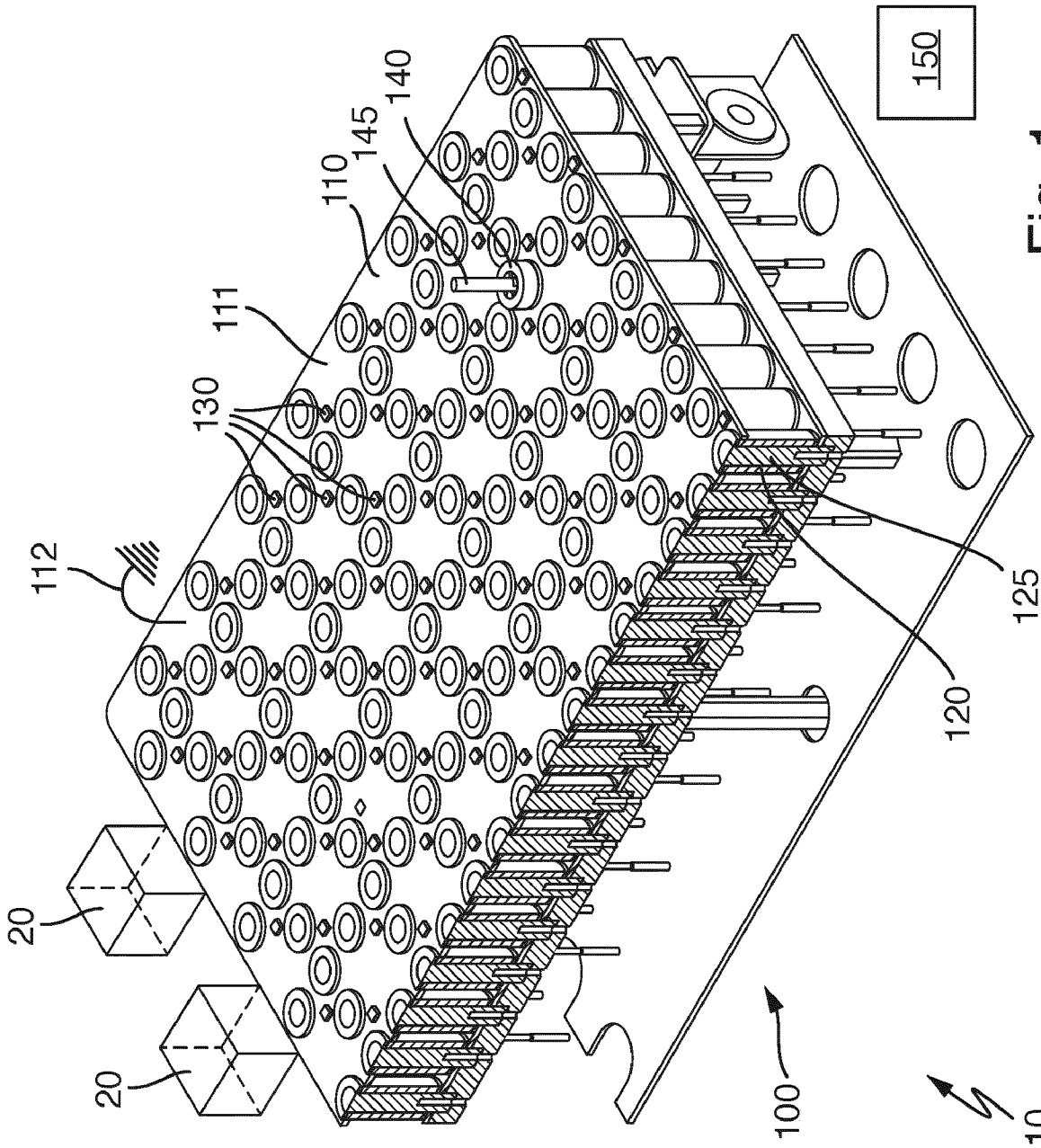

150
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Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/063201

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N35/04 B65G54/02
ADD.

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)
G01N B65G B01L

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)
EPO-Internal, WPI Data

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2017	04/09/2017

Name and mailing address of the ISA/	Authorized officer
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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