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(54) Title: APPARATUS FOR TRANSFERRING SPECIMENS OF BIOLOGICAL MATERIAL BETWEEN LABORATORY AUTOMATION SYSTEMS PLACED AT DIFFERENT HEIGHTS

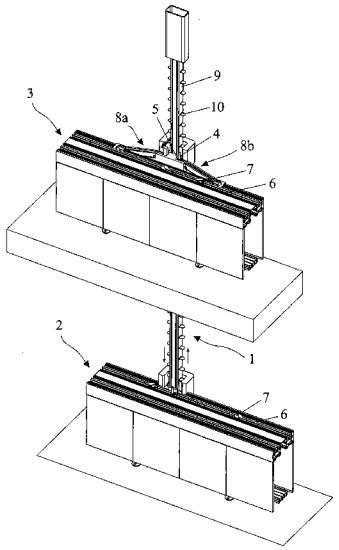

FIG.1

(57) Abstract: There is described an apparatus (1) for the transfer of conveying devices (5) of containers of biological products (4) between laboratory automation systems (2, 3) placed at different heights. Said apparatus (1) comprises a motor-driven belt (9) arranged transversely with respect to said automation systems (2, 3). Shelves (10) are fixed to said motor-driven belt (9) for accommodating said conveying devices (5) during said transfer. Said conveying devices (5) are loaded/unloaded on/from said shelves (10) of said apparatus (1) by the action of pushers (11). Said belt (9) allows, by means of its rotation, a simultaneous bidirectional transfer, both in ascent and descent, of conveying devices (5) from one automation system (2, 3) to the other (3, 2).

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"Apparatus for transferring specimens of biological material between laboratory automation systems placed at different heights".

* * * *

The present invention relates to an apparatus for the transfer of specimens of biological material between laboratory automation systems placed at different heights.

Automation systems for the movement of test tubes in an analysis laboratory have increasingly large dimensions, and now a single laboratory room is often not sufficient to contain the entire system and all analysis modules interfacing therewith.

In most laboratories, multiple automation systems are therefore arranged, separate from one another, in different rooms possibly even located on different floors of the laboratory itself. Each system may be interfaced, according to the space available, with a certain amount of assay modules, also different from one another from system to system.

However, it is frequent the case in which a same specimen is to be taken over and analyzed, in a sequence, by modules that interface with separate automation systems located in different rooms.

The most obvious solution clearly is the pick up of a certain amount of specimens contained in test tubes by an operator and their manual transfer from one room to another, i.e. from one automation system to another. This solution is not very practical, first because it may keep the operator in charge constantly engaged, who could instead carry out other tasks in the laboratory, and it would also be preferable to ensure a supply of specimens to the system where they should be transferred, which occurs immediately when there is a need, regardless of the more or less regular movements, from one room to the other, of the operator as the test tube carrier.

Apparatuses which carry out operations of this kind are already known, for example a transfer of specimens, each contained in a test tube in turn accommodated in a conveying device, from a conveyor of a laboratory

automation system to a second conveyor placed at a different height.

However, in the known solutions, the apparatus in question can only operate in an alternating manner, as an elevator at certain times and as a descender at others, as there is only one path available for both the ascent and the descent of conveying devices. Accordingly, if the path is occupied by a conveying device which is for example going up, one must wait for the completion of that operation before a descent operation of a next conveying device may possibly start along the same path.

US-5672512 describes a vertical chain conveyor for the transfer of biological material. Said conveyor includes shelves adapted to overturn the biological material from one inlet area to an outlet area located at the same height.

EP-0300619 describes a chain conveyor for the transfer of parcels between locations at different heights. Said conveyor includes reclining shelves for loading and unloading the parcels. In order to load the parcels on the shelves and vice versa, means are required to tilt said shelves and thus the parcels to help them rise on the shelves or vice versa descend from the shelves.

It is the object of the present invention to provide an apparatus with a bidirectional mechanism for the simultaneous ascent and descent of conveying devices containing specimens, thus parallelizing the operations and considerably speeding up, compared to the known solutions, the exchange of specimens between one automation system and the other.

This and other objects are achieved by an apparatus as described in claim 1.

These and other features of the present invention will become more apparent from the following detailed description of an embodiment thereof, made by way of a non-limiting example with reference to the accompanying drawings, in which:

figure 1 shows a perspective view of the apparatus according to the

invention, interfaced with two laboratory automation systems placed at different heights;

figure 2 shows a rear view of a further detail of the interfacing between the apparatus and one of the two automation systems;

figure 3 shows a front view of the apparatus only;

figure 4 shows a perspective view of a detail of the step of loading specimens from the automation system, placed at a lower height, to the apparatus;

figure 5 shows a perspective view of a detail of the step of unloading specimens from the apparatus to the automation system placed at a higher height;

figure 6 shows a perspective view of a detail of the step of loading specimens from the automation system, placed at a higher height, to the apparatus;

figure 7 shows a perspective view of a detail of the step of unloading specimens from the apparatus to the automation system placed at a lower height.

An apparatus 1 connects together two different automation systems 2, 3, for example placed in two separate rooms (located one above the other) of an analysis laboratory (figure 1). Apparatus 1 extends through both rooms, through a suitable cavity 50 made in the ceiling of the room on the lower floor, and is used to transfer specimens of biological material, contained in test tubes 4, between systems 2 and 3 in both directions. Cavity 50 may be protected by a layer 51 of insulating and fire-retardant material, such as rock wool (figure 2).

Each test tube 4 is in turn contained in conveying devices 5 for a single test tube 4, and may indifferently be capped or uncapped. According to the specific needs of the analysis modules connected to systems 2 and 3, the possibility to also transfer empty conveying devices 5 along apparatus 1 may also be included.

Each conveying device 5 is adapted to keep the respective test tube 4 in a vertical position, as shown for example in figure 4.

The conveying devices 5 which must be directed towards the apparatus 1 in order to be loaded thereon are diverted along the automation system 2 or 3, from a main lane 6 to a secondary lane 7 directly interfaced with apparatus 1. Likewise, during the step of unloading from apparatus 1, the conveying devices 5 are first released along the secondary lane 7 to then return to the main lane 6 and hence resume their path along system 2 or 3 (figure 1).

The interfacing between the automation system 3 placed in the room on the upper floor and apparatus 1 is actually accomplished by using two peripheral units (spurs) 8a and 8b with a ramp section (figure 1), similar to that described in Italian patent application MI2013A000181 to the Applicant. This is to carry out a fine adjustment and exactly adapt the height of the loading/unloading point of the conveying devices 5 on/from apparatus 1 for every possible height of system 3 relative to the floor of the upper room, and for the extension of every possible height of the ceiling of the lower room; this is required since apparatus 1 moves according to fixed steps, as will be better explained hereafter.

Apparatus 1 comprises a motor-driven belt 9 to which shelves 10 are fixed, at a regular distance from one another and over the entire length thereof, which are intended to receive and transport the conveying devices 5, either empty or with test tube 4, along belt 9 (figure 3).

Said shelves 10 are horizontal along the entire transfer path so that the test tubes 4 remain vertically arranged during the height change.

Belt 9 is vertically arranged and, looking frontally at apparatus 1 from the automation system (either the lower 2 or higher 3 system), this causes the effect to have the upward movement of the conveying devices 5 on one side and the downward movement on the opposite side.

Apparatus 1 further comprises pushers 11 (figures 4-7) adapted to

carry out the horizontal displacement of the conveying devices 5 from one of the two automation systems 2, 3 to the shelves 10 of apparatus 1, as well as carry out, at the other end of apparatus 1, the opposite operation; in other words, pushers 11 carry out both the start and the completion of the operation of transferring specimens from one automation system 2, 3 to the other.

It is worth noting that, in any case, the peripheral units 8a, 8b have a horizontal section at the transfer zone adjacent to belt 9 so that the translation of the conveying devices 5 is horizontal, thus keeping the test tubes 4 vertical.

It is very important that, in the transfer step, the test tube 4 is kept vertical; the tilting of the test tube 4 could in fact cause the displacement thereof with respect to the conveying device 5 or even an uncoupling from the latter.

Moreover, keeping the test tube 4 vertical allows better preserving the biological material contained therein, thus preventing motions that may alter the biological material itself by unintended mixing, or even cause the escape thereof when the test tube 4 is uncapped, which are all very unpleasant situations especially if the biological material has yet to be analyzed.

The operation of the pushers 11 is ensured by a sliding system thereof, comprising a pair of belts 12a and 12b driven by a motor 13, and sensors 14 which start such a sliding movement only if it is actually needed, i.e. if there actually is a conveying device 5 which must be moved from apparatus 1 to the automation system 2, 3, or vice versa.

Apparatus 1 is therefore designed to ensure a continuous exchange of specimens between two (or possibly more than two) automation systems 2, 3 vertically placed on two (or more) distinct levels.

Therefore, assuming that there are conveying devices 5, with or without test tube 4, which are to be transported from system 2 on the lower floor to system 3 on the upper floor, they are suitably diverted (according to

a control from a control unit) from the main lane 6 to the secondary lane 7 of the automation system 2 on the lower floor.

Upon the arrival of the diverted conveying device 5 at the interface with apparatus 1, sensor 14 detects the presence of the conveying device 5 and then actuates pusher 11 which moves the transport conveying device 5 from the secondary lane 7 to the shelf 10 of apparatus 1, suitably stopped at the correct height so that shelf 10 is at the same level with system 2 and therefore ready to accommodate the conveying device 5 (figure 4).

Multiple conveying devices 5 may be diverted along the secondary lane 7, one after the other; in this case, a queue is formed along the same lane and the actuation of pusher 11 to place multiple conveying devices 5 in a sequence on different consecutive shelves 10 of apparatus 1 is almost continuous, the stepping movement of the latter being perfectly coordinated with the thrust of each conveying device 5 by means of pusher 11.

Obviously, nothing changes if the arrival of the conveying devices 5 at the interface with apparatus 1 is irregular; their release and subsequent conveying to a shelf 10 of apparatus 1 is always handled in a suitable manner, possibly by blocking the conveying device 5 for a certain period of time by means of a stop gate 15 placed at the end of the secondary lane 7. This is to ensure that the release is in any case synchronized with the sliding of the belt 9 of apparatus 1, and thus of the shelves 10 thereof.

The operating principle just described, with reference to the loading of the conveying devices 5 from the automation system 2 placed in the room on the lower floor, is also substantially identical in the other three loading/unloading points that interface with apparatus 1.

In particular, the conveying devices 5 loaded on apparatus 1 (as described above), once the top of the apparatus itself has been reached, are detected by a sensor 14, which contributes to the actuation of a new pusher 11; the latter transfers the conveying devices 5 from the shelf 10 of the apparatus to the peripheral unit 8b, from which they are then routed along

the secondary lane 7 and then the main lane 6 of the automation system 3 that is located in the room on the upper floor (figure 5).

At the same time, on the opposite branch of apparatus 1, contrary operations take place for transferring the conveying devices 5 from the automation system 3 on the upper floor to the automation system 2 on the lower floor.

The conveying devices 5 are then appropriately diverted from the main lane 6 to the secondary lane 7 of system 3 and after crossing the peripheral unit 8a are pushed by a new pusher 11 within apparatus 1 (figure 6). Once at the base of apparatus 1, they are again pushed by another pusher 11 and directed along the secondary lane 7, and then along the main lane 6 of the automation system 2 on the lower floor (figure 7).

Therefore, it is the innovative aspect of the invention to ensure a complete automation of the process of transferring specimens between two or more different automation systems located on different floors at different heights, and in particular in separate rooms of a laboratory. Thereby, the laboratory operator is relieved from the manual performance of this task.

Moreover, the complete continuity and bidirectionality of such a transfer is ensured at any time. The apparatus of the invention in fact allows parallelizing the operations along its two distinct branches (an ascent branch and a descent branch), thereby also carrying out the transfer of specimens, from the automation system located at a lower level to that placed at a higher level and vice versa.

Moreover, since such an apparatus is essentially a monolithic block, any maintenance thereof is also quite simple.

Several changes and variations may be made to the invention thus conceived, all falling within the scope of the inventive concept.

In the practice, the materials used as well as the shapes and sizes may be any, according to the requirements.

CLAIMS

1. An apparatus (1) for the transfer of conveying devices (5) for single test tubes (4) containing biological material, at least between a first (2) and a second (3) laboratory automation system, placed at different heights, said conveying devices (5) being adapted to keep the test tube (4) in a vertical position during handling,

characterized in that it comprises

a motor-driven belt (9) arranged vertically with respect to said automation systems (2, 3),

shelves (10) being fixed to said motor-driven belt (9) for accommodating said conveying devices (5), said shelves (10) remaining horizontal during said transfer so that the test tubes (4) remain in vertical position,

said conveying devices (5) being loaded/unloaded on/from said shelves (10) of said belt (9) of said apparatus (1) by the action of pushers (11) adapted to horizontally move the conveying devices (5) so as to keep the test tubes (4) in vertical position during the transfer from each automation system (2, 3) to one of said shelves (10) and vice versa,

said belt (9) allowing, by means of its rotation, the conveying devices (5) to be lifted from the first automation system (2) to the second automation system (3), and the conveying devices (5) to be simultaneously descended from the second automation system (3) to first automation system (2).

2. An apparatus (1) according to claim 1, characterized in that the connection between one of said automation systems (3) and said shelves (10) of said apparatus (1) is made by means of peripheral units (8a, 8b) with a ramp section, said peripheral units (8a, 8b) having a horizontal section at the transfer zone adjacent to the belt (9).

3. An apparatus (1) according to claim 1, characterized in that the actuation of said pusher (11) is ensured by a sliding system, comprising a pair of belts (12a, 12b) and sensors (14) for detecting said conveying devices

(5).

4. An apparatus (1) according to any one of the preceding claims, characterized in that it comprises a cavity (50) in the ceiling which separates the rooms which advantageously accommodate said separate automation systems (2, 3), said cavity being protected by a layer (51) of insulating and fire-retardant material, such as rock wool.

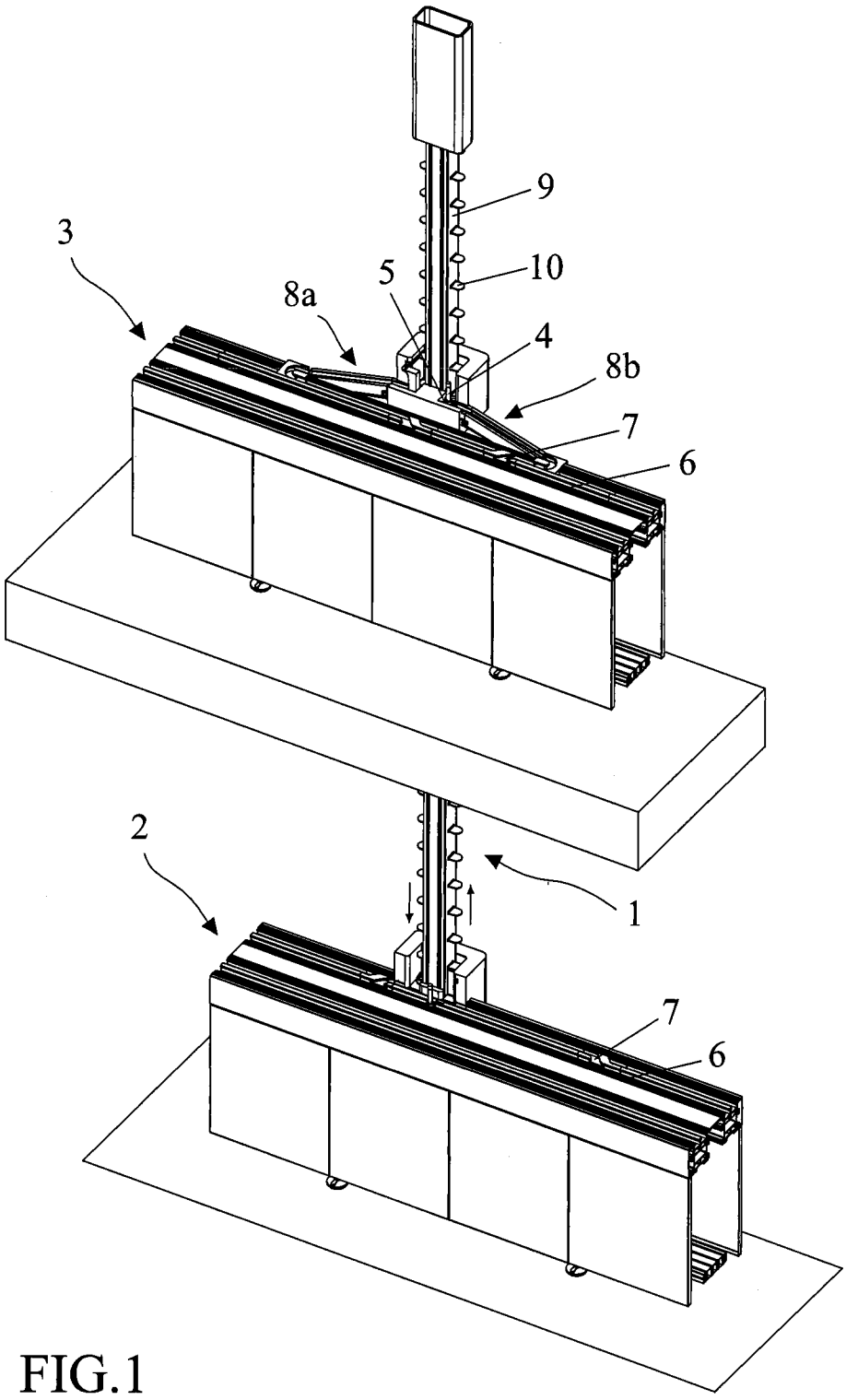

FIG.1

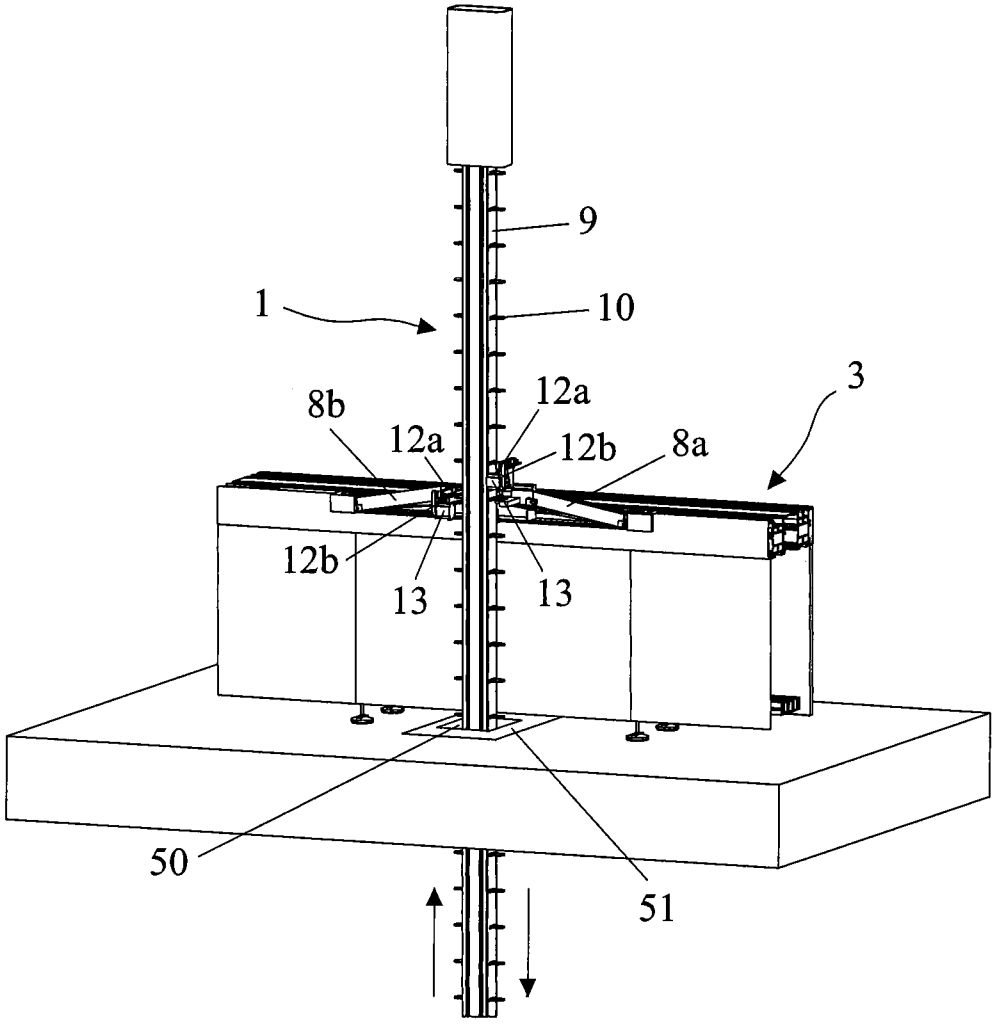

FIG.2

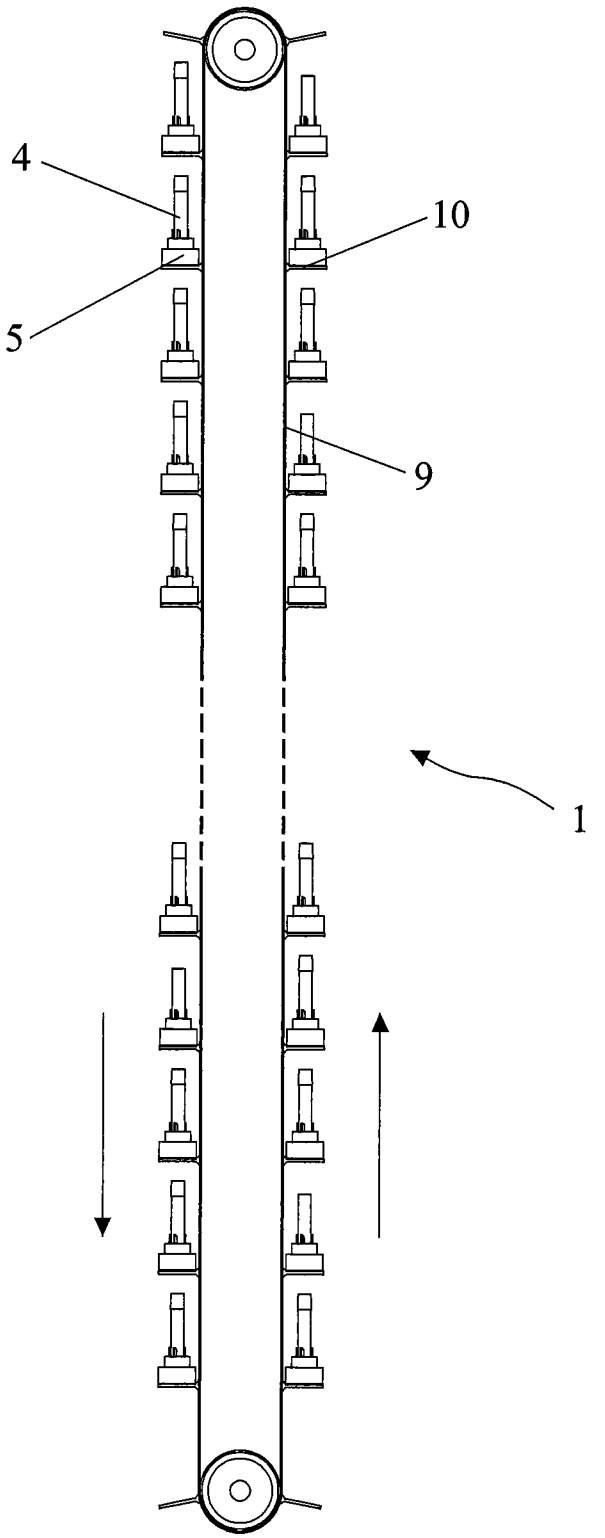

FIG.3

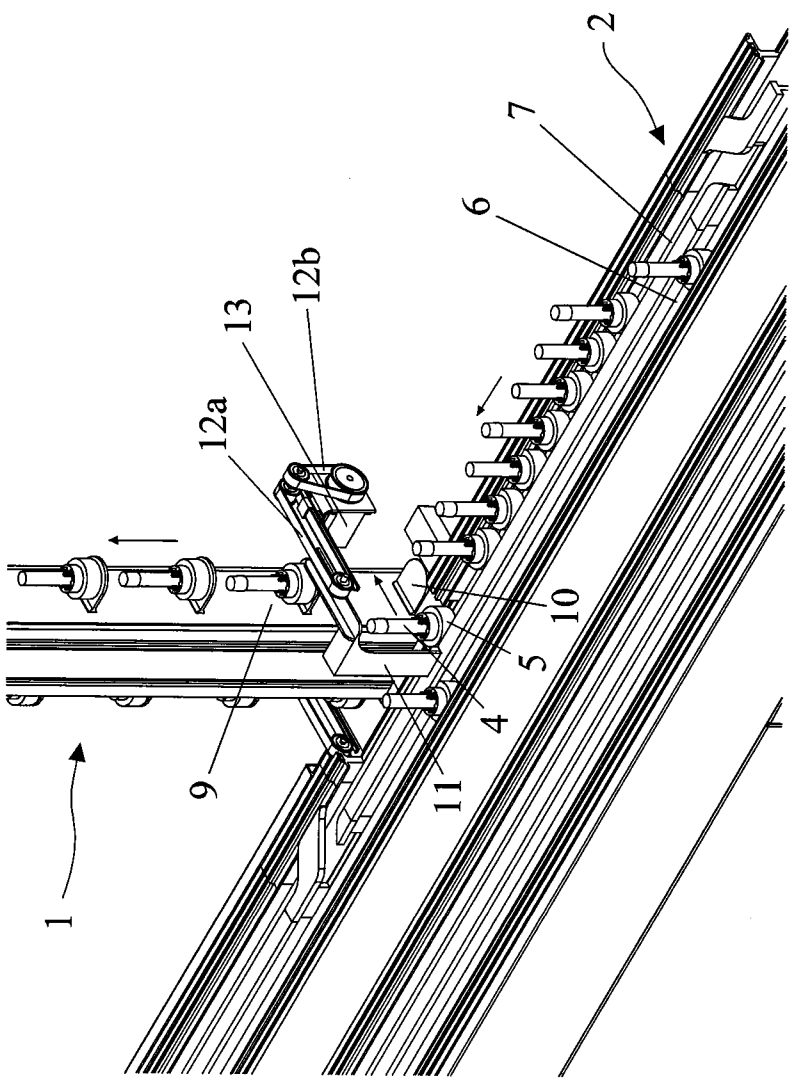

FIG.4

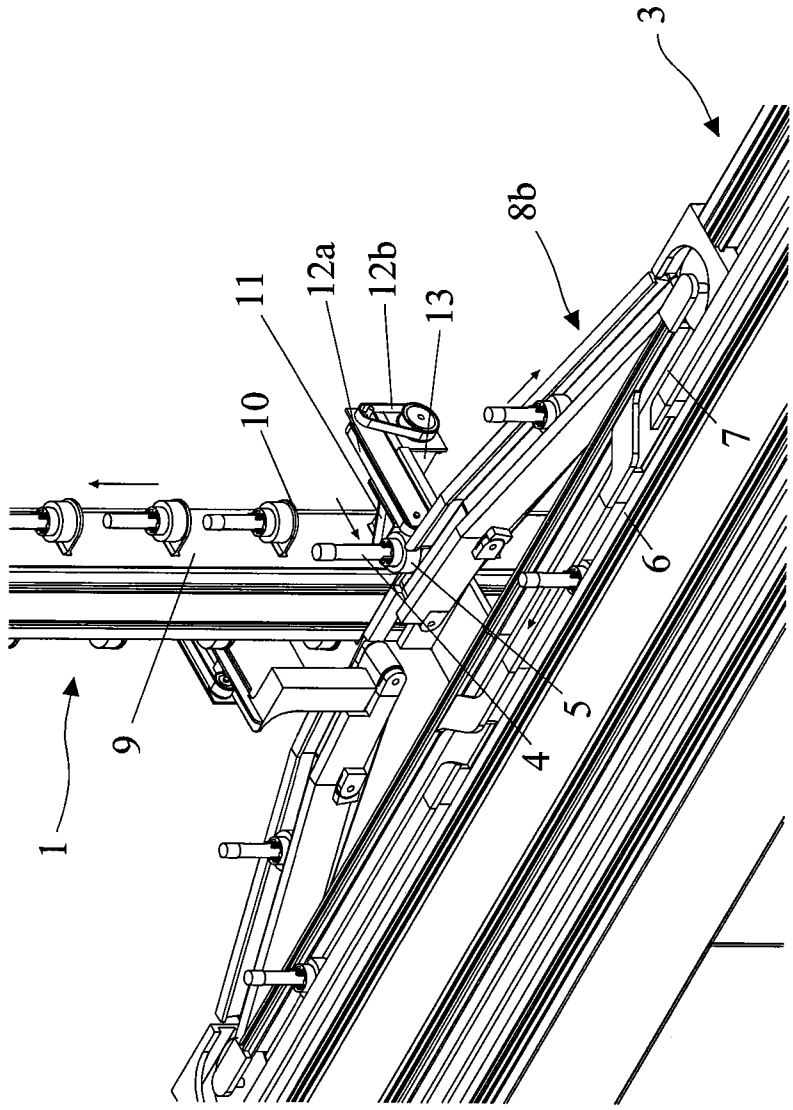

FIG.5

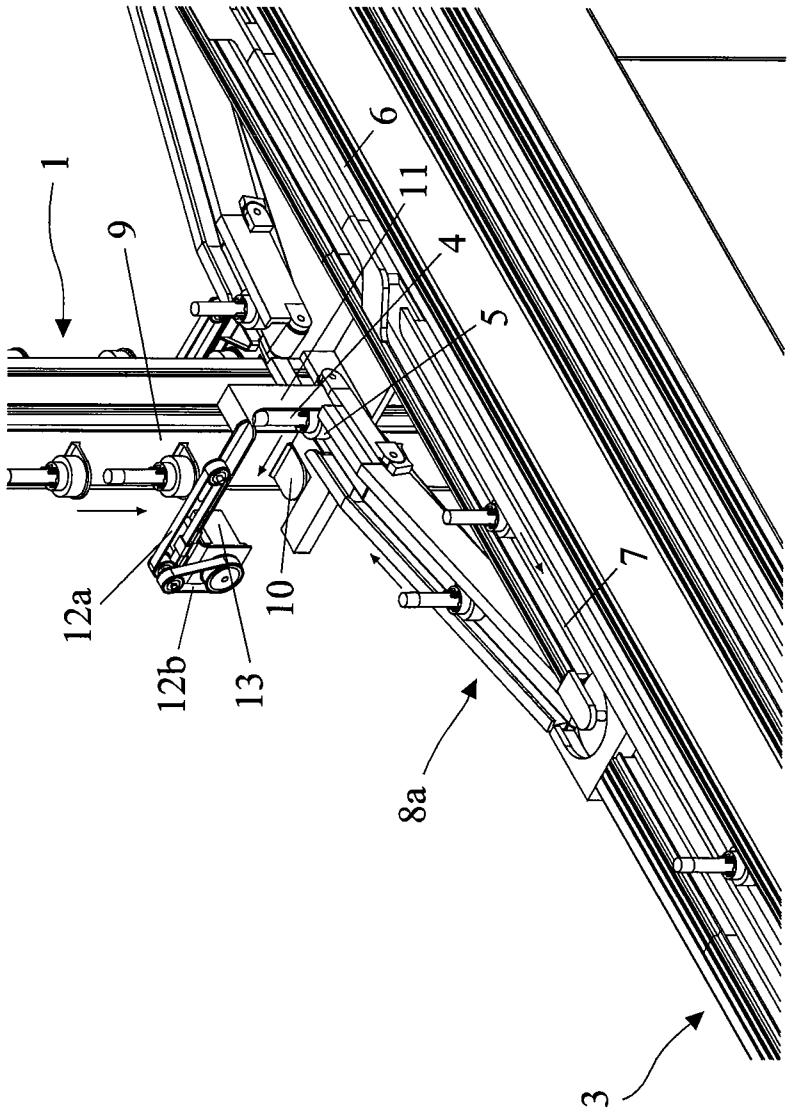

FIG.6

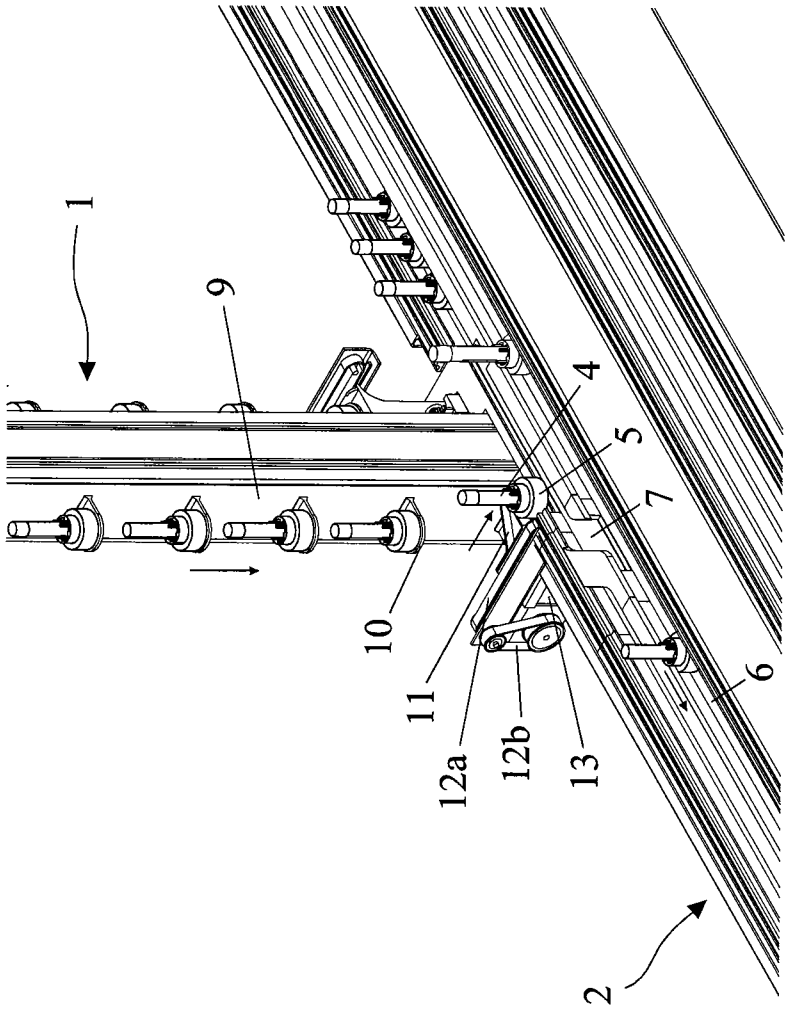

FIG.7

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B65G17/12 B65G47/57 G01N35/04
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)
B65G G01N

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	DE 20 2004 013601 U1 (WITRON LOGISTIK & INF GMBH [DE]) 25 November 2004 (2004-11-25) figures 1,2,3,6 paragraph [0002] - paragraph [0003] paragraph [0005] - paragraph [0006] paragraphs [0012], [0021] -----	1-4
X	EP 0 300 619 A2 (ROBOLIFT LTD [GB]) 25 January 1989 (1989-01-25) cited in the application figures 1-3 column 1, line 1 - line 14 column 1, line 39 - line 45 column 2, line 38 - line 42 column 3, line 9 - line 57 ----- -/--	1-4

[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
20 March 2015	30/03/2015

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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