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(54) **Title:** ELECTRIC ACTUATOR SYSTEM

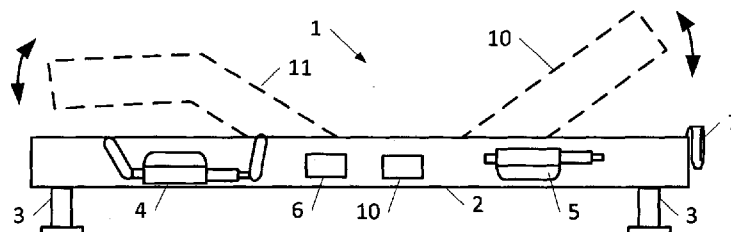


Fig. 1

(57) **Abstract:** The invention relates to a hospital or care bed (1) with an electric actuator system comprising at least one linear actuator (4,5), a control (8), a power supply (9), and at least one operating panel (7). The linear actuator (4,5) comprises means for registering the force on the linear actuator (4,5) and the relative changes therein. The actuator system comprises a network driven as a serial data stream to which data of a force registered by the linear actuator can be converted. Further, the actuator system comprises means for monitoring the serial data stream and means for registering the time. The means for registering the time starts or restarts a time reading each time the means for monitoring the serial data stream registers data of a force on the linear actuator on the serial data stream of the network.



Electric actuator system

The invention relates to a hospital or care bed equipped with an electric actuator system comprising at least one linear actuator, a control, a power supply and at least one operating panel, and where the linear actuator comprises means for registering the force on the linear actuator and the relative changes therein, and where the actuator system comprises a network driven as a serial data stream to which data of a force registered by the linear actuator may be converted.

The actuator system is according to the invention of the type which can be used for adjusting a hospital or care bed. In this type of bed the mattress is carried by a support surface which may be raised and lowered by means of electromechanical linear actuators (hereafter mentioned as linear actuators) which are comprised by the actuator system. Further, the backrest and the legrest sections of the bed may be adjusted by means of linear actuators. Normally, linear actuators comprising a thrust rod, e.g. of the type as described in WO 02/29284 A1 LINAK A/S are used.

For certain patients in the hospital and care sector it is necessary for the nursing staff to know whether the patient is in the process of leaving his bed or has left his bed. Such a bed is described e.g. in US 4,934,468 Hill Rom Co. Inc., US 5,276,432 Stryker Corp and EP 1 974 708 A1 Paramount. These beds are provided with a weighing system for weighing and/or monitoring the patient's weight. The weighing system can also be configured to monitor the patient's position in the bed. The weighing

system can however also be connected to an alarm which can provide a signal in case the patient assumes a position where it is conceivable that the patient may leave the bed (pre-egress) or the patient has already
5 left the bed (egress). The beds register changes in the patient's center of gravity by means of a number of interconnected weight sensors located at each corner of the lying surface of the bed frame. By comparing the readings from each weight sensor, it can be detected
10 whether a patient is sitting up and is thus potentially in the process of leaving the hospital bed, but also whether the patient has left the bed.

Common for these types of bed structures is that they are
15 intended for weighing and for accurate supervision of the patient's weight and weight distribution. In order to be able to do this with sufficient accuracy, sensors with high resolution are used. This fact is thus also reflected in the price of these bed constructions, which
20 are very expensive. The use of these beds is thus also limited to a select few patients requiring special treatment and intensive care.

A far simpler and cheaper construction is described in WO
25 2009/021513 A1 Linak A/S. In this construction each of the linear actuators of the actuator system used for adjusting the bed comprises means for registering the force on the actuator. Means for registering these forces may be a load cell, such as a strain gauge or a piezo
30 element. By registering the relative changes of the force on each actuator, it can be determined whether a person is in the process of leaving a bed or has left the bed by comparing the registered changes to a threshold value.

Based on this an alarm can be provided e.g. on the bed, to an operating panel on the bed or to the staff's room at a hospital ward. However, manufacturing, implementing and maintenance of such systems are very comprehensive and complex. Therefore these systems are subject to high investment and operating expenses. When it comes to persons who require relatively little care, such as elderly people living in their own homes, in a cohousing community or in a nursing home, the above solution is not attractive at all. Instead a solution which can give information to the nursing staff or to the other residents in order to determine whether the resident requires attention is required.

Therefore, the purpose of the invention is to provide a simpler and cheaper actuator system which can register a person's activity level and communicate this to the nursing staff or to the other residents.

According to the invention this is provided by a hospital or care bed equipped with an electric actuator system comprising at least one linear actuator, a control, a power supply, and at least one operating panel, and where the linear actuator comprises means for registering the force on the linear actuator and the relative changes therein, and where the actuator system comprises a network, driven as a serial data stream, to which data of a force registered by the linear actuator can be converted. Further, the actuator system comprises means for monitoring the serial data stream and means for registering the time, and where the means for registering the time starts or restarts a time reading each time the means for monitoring the serial data stream registers

data of a force on the linear actuator on the serial data stream of the network. The above hospital or care bed can alert the staff or other residents in case a patient or a resident requires attention due to inactivity in a given
5 period of time. Due to the simplicity of the hospital or care bed it can be manufactured with low production costs. This hospital or care bed is thus an inexpensive alternative to the existing comprehensive and complex hospital or care beds.

10

In an embodiment of the hospital or care bed, the network is driven as a wireless network. In this way the cabled connections can be minimized.

15 In an embodiment the actuator system on a hospital or care bed has a junction box, comprising the means for monitoring the serial data stream and the means for registering the time. Hereby, the functions of these means can be offered as an option for a hospital or care
20 bed, which will lower the production costs further. Furthermore, it is possibly to customize the junction box to fit the individual user and/or customer.

In an embodiment the actuator system can comprise a
25 gateway module which can communicate on the gateway in a protected housing, nursing home or hospital. In an embodiment the gateway module can be located in the junction box. By this integration the functionality of the hospital or care bed can be utilized to a great
30 extent.

In a further embodiment the actuator system on a hospital or care bed can comprise a module for communication on

the internet and/or on the mobile telephone network. Hereby, data on the serial data stream can be transmitted to receivers, present on these networks.

5 In an embodiment of the hospital or care bed, the means for registering the force on the linear actuator is a load cell. The load cell can be a strain gauge or a piezo element.

10 In another embodiment the hospital or care bed comprises a backrest section, where the linear actuator is connected to the backrest section.

An embodiment of the actuator system according to the
15 invention will in the following be described more detailed with reference to the accompanying drawing, in which

Fig. 1 shows a schematic view of a care bed
20 comprising an actuator system,

Fig. 2 shows a schematic view of the actuator system on the care bed shown in Fig. 1,

25 Fig. 3 shows a block diagram of the registered forces on the bed seen over time, and

Fig. 4 shows a hospital or care bed comprising an actuator system.

30

The schematically shown care bed in Fig. 1 comprises a mattress (not shown), supported by an under frame 2. The under frame is carried by a pair of legs 3. The care bed

is equipped with an actuator system (schematically shown in Fig. 2) comprising two linear actuators 4,5 connected to a control box 6 and an operating panel 7. The control box 6 comprises a control 8 and a power supply 9. The backrest section 10 and the legrest section 11 can be adjusted by the actuators 4,5. The actuator system has a network, driven as a serial data stream, to which data from the units of the actuator system can be converted and communicated. The network is driven by a microprocessor (positioned) in the control box 6. The serial data stream is timed by a clock signal and the data stream is transmitting data packages comprising an identification section and a data section. The actuator system comprises means for registering whether a person is occupying the bed 1, or whether a person occupying the bed 1 is moving in the bed. When this means registers that a person is occupying the bed 1 or the person is moving in the bed 1, the signal S1 (see Fig. 3) is converted to one or more data packages on the network.

20

A means for detecting whether a person is occupying the bed or whether a person occupying the bed is moving in the bed can be provided in that at least one of the actuators 4,5 comprises a load cell which can register the force and the changes in this as a result of the load the user exerts on the bed. Further, the actuator system comprises a junction box 12 (also known commercially as: a junction box or multi junction box) which is connected between the control box 6 and the operating panel 7. The junction box 10 comprises means for monitoring the serial data stream of the network and means for registering the time. Further the junction box 12 comprises a gateway module which can communicate on the gateway 13 in a

protected housing, nursing home or a hospital. The communication can be cabled or wireless. In another embodiment the actuator system including the junction box 12 can comprise a module for communication on the internet, the mobile telephone network or another wireless network.

When the signal S1 in the form of one or more data packages is present on the serial data stream of the network, this will be registered by the means for monitoring the network. The means for registering the time is designed to start or restart a vitality time reading T_{vit} at the time T_1 . As the vitality time reading T_{vit} starts or restarts each time the signal S1 in the form of one or more data packages is present on the serial data stream (the network), the vitality time reading T_{vit} indirectly expresses the period of time where the load cell generates no signal S0. The means for registering the time compares the vitality time reading T_{vit} to a predefined reference time T_{set} . When the vitality time reading T_{vit} is equivalent to or greater than the reference time T_{set} , an alarm is generated via the gateway module, which can be auditory, visual or tactile. The alarm could be provided to the staff in a nursing home or in a hospital and to the other residents or to the nursing staff in a protected housing (e.g. a sheltered housing) via the gateway in the nursing home, hospital or common house.

The load cells or other sensors which register whether a person is occupying the bed or the person occupying the bed is moving in the bed are almost always exposed to a force even though no person is occupying the bed. In

order to avoid that these sensors generate signal S1 continuously, the signal S1 will not be generated until an average value calculated continuously by the sensor itself or by the control 8 in the control box 6 is exceeded. The average value may for example depend on the position of the person in the bed and further the angle of the adjustable sections of the bed 10,11.

With reference to Figs. 2 and 3 the operation of the actuator system will be outlined for 3 typical user situations e.g. in a nursing home or in a common house.

Situation 1: A resident leaves the bed, hereby the bed generates signal S1. The vitality time reading T_{vit} starts at t_1 . The resident returns to the bed and generates the signal S1 again. This happens before T_{vit} has exceeded the reference time T_{set} by which the vitality time reading T_{vit} is reset or restarted.

Situation 2: A resident leaves the bed, hereby the bed generates signal S1. The vitality time reading T_{vit} starts at the time t_1 . The resident does not return to the bed. The vitality time reading T_{vit} thus exceeds the reference time T_{set} which generates an alarm to the staff via the gateway module in the junction box 12.

Situation 3: The resident is lying in the bed but is not moving. The signal S1 is therefore not generated. The vitality time reading T_{vit} exceeds the reference time T_{set} which generates an alarm to the staff via the gateway module in the junction box 12.

Further the actuator system is capable of generating an alarm to the staff if a failure has occurred in the actuator system. A failure could e.g. be that the actuator system is not connected to mains, that the junction box 12 fails or the load cell in the linear actuator 4,5 is defect.

The hospital bed 14 shown in Fig. 4 comprises an under frame 15 and an upper frame 16, where the under frame 15 has drive wheels 17. On the upper frame 16 an adjustable support surface for the mattress is mounted. The support surface comprises a backrest section 18, an articulated legrest section 19 and a fixed middle section 20 there between. The backrest and legrest section 18,19 can be raised and lowered by means of each of its actuators 21,22 such that the support surface may assume different contours. The upper frame 16 is connected to the under frame 15 with two linear actuators designed as lifting columns 23,24. The actuators 21,22,23,24 are connected to a control box 25 comprising a power supply for connection to mains, a rechargeable battery pack and a control.

A junction box 26 for connection of control units such as operating panels 27, fixed control units in side rails 28 and possibly other kind of equipment are connected to the control box 25. One or more of the actuators 21,22,23,24 comprise means for registering the forces, to which the actuator is exposed. This is described more detailed in connection to Figs. 1-3. The units of the actuator system that is control units 27,28, actuators 21,22,23,24, control box 25, junction box 26 and other connected equipment communicate in a network, driven as a serial data stream to which all of the units can convert data.

The actuator system on the hospital bed 14 functions as described in connection with the care bed 1 (see Figs. 1-3).

Claims:

1. Hospital or care bed with an electric actuator system comprising at least one linear actuator (4,5), a control (8), a power supply (9), and at least one operating panel (7) and where the linear actuator (4,5) comprises means for registering the force on the linear actuator (4,5) and the relative changes therein, and where the actuator system comprises a network driven as a serial data stream to which data of a force registered by the linear actuator can be converted, characterized in that the actuator system comprises means for monitoring the serial data stream and means for registering the time, and where the means for registering the time is designed to start or restart a time reading each time the means for monitoring the serial data stream registers data of a force on the linear actuator (4,5) on the serial data stream of the network.
2. Hospital or care bed according to claim 1, characterized in that the network is a wireless network.
3. Hospital or care bed according to one or more of the claims 1-2, characterized in that the actuator system has a junction box (12) comprising means for monitoring the serial data stream and the means for time registering.
4. Hospital or care bed according to one or more of the claims 1-3, characterized in that the actuator system comprises a gateway module (13) which is

able to communicate on the gateway in a protected housing or nursing home, or at a hospital.

5 5. Hospital or care bed according to claim 4, c h a r a c t e r i z e d in that the gateway module (13) is arranged in the junction box (12).

10 6. Hospital or care bed according to one or more of the claims 1-3, c h a r a c t e r i z e d in that the actuator system comprises a module which can communicate on the internet and/or on the mobile telephone network.

15 7. Hospital or care bed according to one or more of the claims 1-6, c h a r a c t e r i z e d in that the means for registering the force on the linear actuator (4,5) is a load cell.

20 8. Hospital or care bed according to one or more of the claims 1-7, c h a r a c t e r i z e d in that it comprises a backrest section (10) and where the linear actuator (4,5) is connected to the backrest section.

25 9. Hospital or care bed according claims 7, c h a r a c t e r i z e d in that the load cell is a strain gauge or a piezo element.

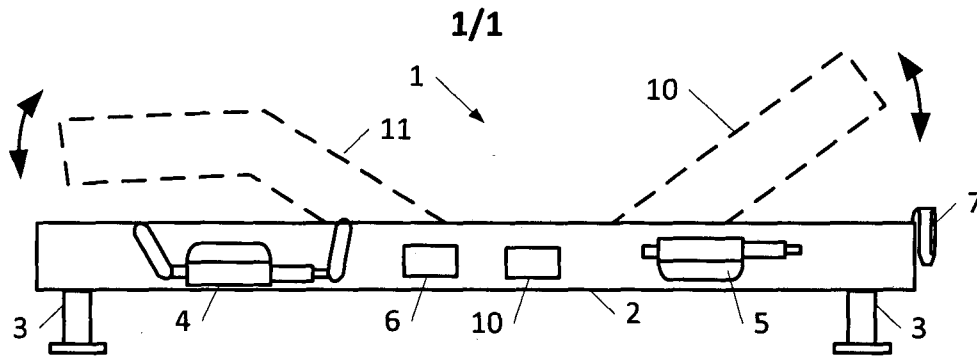


Fig. 1

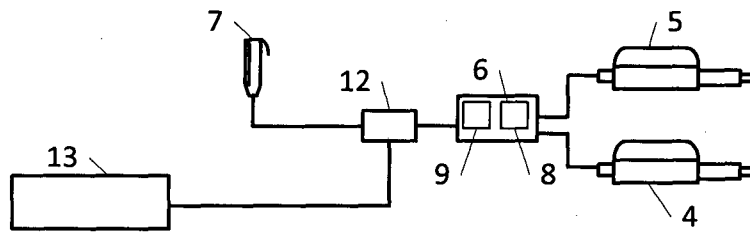


Fig. 2

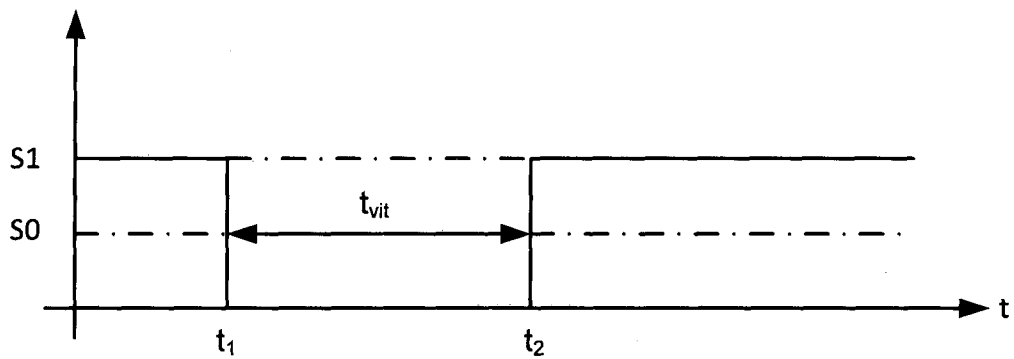


Fig. 3

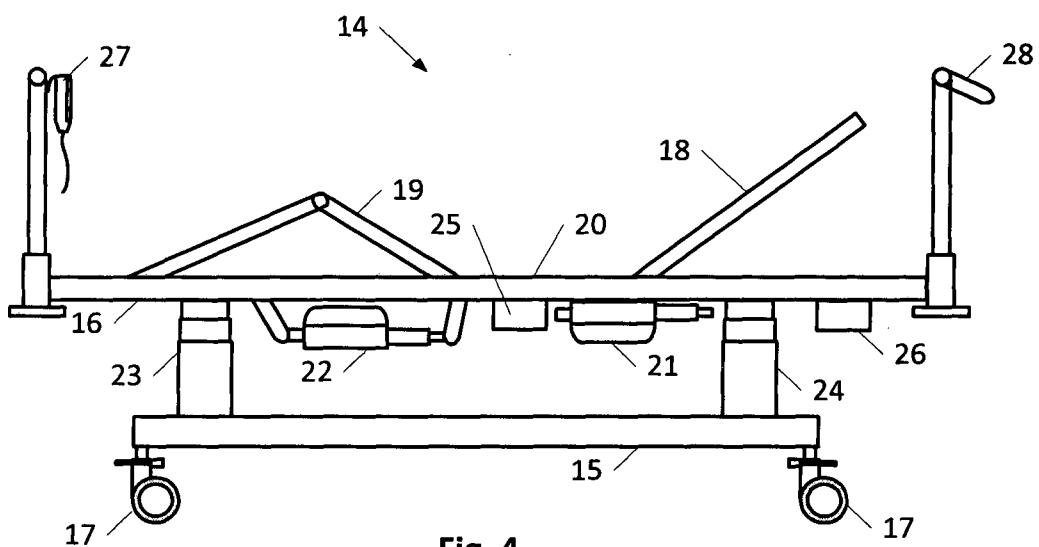


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2013/000067

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61G7/018 A61B5/11
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)
A61G A61B

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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A	----- US 2008/201847 A1 (MENKEDICK DOUGLAS J [US] ET AL WILKER JR JACK [US] ET AL) 28 August 2008 (2008-08-28) paragraphs [0203], [0252] figure 35C ----- -/-	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No

PCT/DK2013/000067

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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