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(54) **DEVICE FOR THE AUTOMATION OF SLIDING DOORS**

(57) Device (1) for the movement of a sliding door, of the type comprising a base structure (4) and at least one sliding closing element (5). The device comprises at least one fixed portion (2) constrainable to the base structure (4) and guiding means (15) to guide a movable portion (3) which is constrainable to the closing element (5). The device comprises at least one linear electric motor (M, 8), wherein the active portion (M) of the linear electric motor (M, 8) is integral with the movable portion (3). The fixed portion (2) comprises converting means (12) for the conversion of electric power in order to output a direct current having low or extra-low voltage, whereas the movable portion comprises additional converting means (14) for the conversion of electric power, which receive the input direct current having low or extra-low voltage, and output a three-phase current to supply the active portion (M).

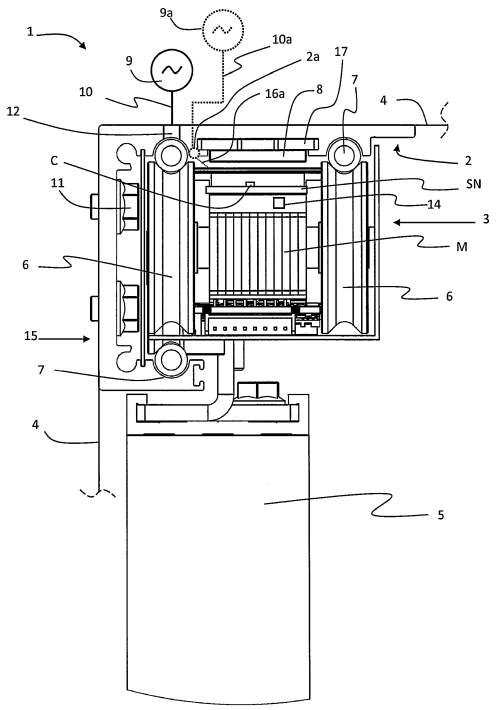

FIG. 1

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Description

[0001] The present invention concerns the field of sliding doors, and in particular devices controlling their movement. The present invention particularly relates to the field of so-called pedestrian sliding doors.

[0002] Systems providing for a ferromagnetic bar wrapped up by an electric winding and fastened to the door structure are known in the art, where the bar, when current-supplied, acts as a linear electric motor thereby actuating a rotor integral with a closing element, typically in the form of a leaf door, usually obtained thanks to magnetic elements.

[0003] These very popular systems have proven to be reliable, although they suffer from certain lack of flexibility. In fact, in order to achieve fine adjustments of door movement, very complex and therefore expensive devices are needed.

[0004] It is an object of the present invention to provide a device for the movement of sliding doors which is simple, reliable and at the same time provided with certain versatility.

[0005] A further object of the present invention is to provide a device for the movement of sliding doors, wherein a single fixed portion can be used together with various types of closing elements therefore having different size. The present invention achieves these and other objects by means of a device according to claim 1. Preferred aspects are set forth in dependent claims.

[0006] According to the invention, a device for the movement of sliding doors, of the type comprising a base structure and at least one closing element sliding relative to the base structure, comprises at least one fixed portion and at least one movable portion. The fixed portion is constrainable to the base structure of the door, whereas the movable portion is constrainable to the closing element. More in detail, the fixed portion comprises guiding means to guide the movable portion. Furthermore, the device is provided with movement means comprising at least one linear electric motor, which has the active portion integral with the movable portion of the device and, preferably, also at least one sliding element to slide on the guide means.

[0007] "Active portion" means the portion of the motor provided with windings causing the motion of the linear motor, i.e. the driving portion. In fact, as known, a linear motor comprises an element provided with active windings (the "active portion"), that can be likened to the rotor of a rotary motor, and an element provided with a passive magnet, that can be likened to the stator of a rotary motor.

[0008] Therefore, according to the invention there is at least one electric winding arranged so as to be integral with the movable portion.

[0009] The fixed portion, typically the guiding means, comprises converting means for the conversion of electric power. In particular, the guiding means are electrically connected to a source, typically the 220V national electric network. Converting means output direct current having low or extra-low voltage, preferably comprised between 12V and 48V.

[0010] This direct current is preferably transmitted to one or more elongated elements, or "tracks", arranged so as to face the movable portion, thereby transmitting electric power from the guiding means to the electric motor.

[0011] According to an aspect of the present invention, the energy transmission between the fixed portion and the movable portion takes places through mobile contact means, typically brushes, so as to allow the electrical continuity between the two components moving with respect to each other.

[0012] The movable portion comprises additional converting means for the conversion of the electric power, which receive the input electric current having low or extra-low voltage and output three-phase current to supply the electric motor (or the electric motors).

[0013] Preferably, this operation is carried out by means of a vector inverter.

[0014] By providing continuous electrical power to the mobile portion, the converting means, and in particular the vector inverter, can easily provide the correct power supply to the active part, typically a specially modulated three-phase electric current. Furthermore, according to a preferred aspect of the present invention, the device comprises controlling means to control the active portion, which are arranged so as to be integral with the movable portion. These controlling means generally require direct current supply. Such a power supply is directly provided to the movable portion from the fixed portion.

[0015] Thanks to the particular power supply described, the active part of the linear motor, and preferably also of the controlling means, can therefore be easily positioned on the movable portion of the device, i.e. on the closing element of the door. Therefore, the movable portion itself actuates, and preferably also manages, the movement of the movable portion independently of the fixed portion of the device.

[0016] Thanks to this, different types of closing elements of a door can operate on the same base structure.

[0017] Moreover, in the case of controlling means integral with the movable portion, the fixed portion is a completely passive element, since the movement is managed only by the movable portion of the device.

[0018] It is also preferable to avoid elongated elements (i.e. the guiding means) powered by 220V alternating current, or any other high-voltage alternating current, potentially exposed to the outside and therefore dangerous to humans.

[0019] According to an aspect of the present invention, the controlling means comprise position sensors.

[0020] Hereinafter, referring to the appended figures, an exemplary and non-limiting embodiment of the present invention will be disclosed, wherein:

- figure 1 is a sectional view of a device according to the present invention;

- figure 2 is a side view of the device of figure 1, coupled to a sliding door leaf;
- figure 3 is an enlarged view of a detail of figure 2.

[0021] Referring to figures, a device 1 for the movement of sliding doors comprises a fixed portion 2 and at least one movable portion 3. The figures show a preferred embodiment, in which the sliding door is a pedestrian sliding door.

[0022] The fixed portion 2 is constrainable, by means of constraints 11 known in the art, to the base structure 4 of the door.

[0023] Typically, the base structure 4 is part of one or more walls of the building or the room where the door is integrated in, whereas the movable portion 3 is integrally constrainable to a closing element 5 of the door, typically in the form of door leaf. Obviously, if there is a greater number of closing elements 5, the device 1 will be provided with a suitable number of movable portions 3. The movable portion 3 can translate, usually in a linear way, relative to the fixed portion 2.

[0024] The fixed portion 2 comprises guiding means 15 to guide to movable portion 3. In particular, in the embodiment shown in figures, the guiding means 15 comprise supports 7 allowing the movable portion 3 to slide thereon.

[0025] The supports 7 can be of different kinds and they are generally shaped as tracks. However, the use of supports operating without direct contact with the movable portion 3, for example magnetic levitation systems, is contemplated.

[0026] In the present embodiment, such supports are at least partially made of electrically conductive material, for example by means of bars of metal material. In particular, these metal materials can include copper or steel. An electrical connection 10 known in the art can connect the supports 7 to a power source 9, typically the national electric network. The power source 9 and the connection 10 are schematically shown in figures. The power source 9 is depicted as an alternating current power source, although a direct current power source is also possible.

[0027] The supports 7, later described in more detail, directly or indirectly supply electric power the active portion M of a linear motor 8, M.

[0028] In particular, mobile contact elements are arranged between the supports 7 and the movable portion 3. The mobile contact elements, not shown in detail in figures, guarantee electrical continuity between the movable portion 3 and the supports 7. It should be noted that the adjective "mobile" does not refer to the "elements" of contact, but to the "contact" itself. In fact, these contact elements are generally integral with the movable portion 3 or the fixed portion 2, and are able to guarantee the electrical continuity between the two portions even if they are moving relative to one another. For this purpose, brush contact elements can be used.

[0029] As afore mentioned, typically the source 9 is the national electric network, which supplies 220V alternating current.

[0030] In alternative embodiments, it is possible that the electrical continuity between the fixed portion 2 and the movable portion 3 is not given through the supports 7, or in general, through the guiding means. For example, figure 1 shows in dotted line an alternative embodiment wherein a part 2a of the fixed portion 2 is made of an electrically conductive material and is connected to a source 9a by means of an electrical connection 10a. Mobile contact elements 16a, schematically shown, electrically connect the fixed portion 2 to the movable portion 3.

[0031] In general, generic means adapted to guarantee the electrical continuity between the fixed portion and movable portion of the device, comprising at least one element at least partially made of conductive material, integral with or integrated into the fixed portion and electrically connected to a power source, and mobile contact means between this element and the movable portion, are within the object of the present invention. For ease of description, reference will be made hereinafter only to the supports 7 as power transmission means for transmitting electric power between the fixed portion 2 and the movable portion 3, but it is clear that the following description identically applies also to other possible power transmission means, including for example the alternative solution shown in dotted lines in figure 1.

[0032] A direct current having low or extra-low voltage, preferably comprised between 12V and 48V, is supplied to the supports 7.

[0033] For this purpose a transformer 12, schematically shown in figures, is interposed between the power source 9 and the supports 7 in order to supply them with the aforementioned direct current, having low or extra-low voltage.

[0034] Furthermore, the fixed portion 2 is provided with the passive portion of a linear electric motor, i.e. the above described passive magnets. In the embodiment shown in figures, in particular, the fixed portion is provided with one or more magnetic elements 8, preferably permanent magnets, or anyway elements adapted to generate a magnetic field along at least part of the length of the device 1, i.e. the sliding direction of the closing element 5.

[0035] Preferably, the magnetic elements comprise rare earths and, in particular in the embodiment shown in the figures, the magnetic elements 8 comprise neodymium. Additionally, the magnetic elements 8 can be coupled to elements 17 made of ferromagnetic material in order to help generate and stabilize a magnetic field.

[0036] The device 1 further comprises movement means M, 8, 6 adapted to allow the fixed portion 2 and the movable portion 3 to translate relative to one another.

[0037] In particular, the movable portion 3 is provided with the active portion M of the linear electric motor M, 8. In particular, the active portion M comprises at least one element provided with electric windings, acting as an active portion M of a linear motor.

[0038] Preferably, the linear electric motor M, 8 is a

three-phase synchronous linear motor. A particular type of such engines, known in the art as "ironcore", proved to be particularly suitable for the invention.

[0039] Therefore, the magnetic elements 8 and the active portion M form a linear motor 8, M. As previously described, in particular the magnetic elements 8 can be likened to the stator of a rotary motor, whereas the active portion M can be likened to the rotor of a rotary motor.

[0040] Thus, according to a preferred embodiment, the linear electric motor M, 8 is a three-phase motor, whereas the active portion M is supplied by means of the supports 7, or similar elements, powered by direct current.

[0041] Converting means 14 are interposed between and electrically connected to the supports 7, or anyway the fixed portion 2, and the electric motor M.

[0042] In the embodiment shown, the converting means comprise a vector inverter 14 schematically shown in figures. Although the shown embodiment has proven to be particularly suitable for the invention, other types of inverters or converting means can be used.

[0043] In particular, the use of a vector inverter simplifies the delivery of power that becomes direct current, thus avoiding complex systems of mobile conduits to carry signals and power supplies.

[0044] In a known way, the interaction between the magnetic field created by the active portion M and the magnetic elements 8 induces a force on the movable portion 3, thereby causing the latter to translate relative to the fixed portion 2.

[0045] The movement of the movable portion 3 relative to the fixed portion 2 can take place in many ways.

[0046] In the shown embodiment sliding elements 6, here in the form of wheels, rotates on, and relative to, the previously described supports 7. As previously mentioned, different mechanisms can cause the relative movement of the two portions 2, 3, possibly even if no contact is provided between them, as in the previously mentioned case of magnetic levitation systems. In such embodiments it is evident that the active portion M is not supplied with electric power through these guide means but, for example, by using a solution similar to that shown in dotted lines in Figure 1. According to an aspect of the present invention, the device 1 comprises controlling means 13 to control the active portion M. Preferably, these controlling means are arranged on the movable portion 3. The controlling means comprise at least one programmable control unit C.

[0047] The programmable control unit C is provided with functions for controlling the active portion M of the linear motor M, 8.

[0048] Preferably, the controlling means 13 further comprise sensors SN, schematically shown in figures, arranged on the movable portion 3 of the device 1 so as to detect the position of the movable portion 3 relative to the fixed portion 2.

[0049] In the shown embodiment, the sensors SN are linear encoders. In addition to linear encoders, or as an alternative thereof, different types of sensors could be used, such as Hall effect sensors, non-linear encoders, etc.

[0050] In general, the described system allows the use of the overall width of the sliding closing element, so as to be able to house the active portion M of the linear motor M, 8 and possibly the sliding elements 6, thereby preventing the need of overlaps, used by similar systems provided with mobile magnets and fixed motor, and allowing the customization of the travel length of the closing element.

[0051] As anticipated, the device 1 further allows to use the same guiding means 15 to simultaneously operate multiple active portions M and therefore multiple closing elements 5 of the door, with synchronized movements in the same direction or in the opposite direction, as normal double doors, also independently from one another.

[0052] In use, the source 9 supplies electric power to the supports 7, or similar elements, of the fixed portion 2 of the device 1. A transformer 12 converts the current supplied by the source 9 into direct current having low or extra-low voltage, in particular preferably comprised between 12V and 48V. Through the mobile contact elements, this current is transmitted from the fixed portion 2 to the mobile portion 3 of the device 1.

[0053] An inverter 14 further converts the electric current in order to supply the active portion M with a three-phase, suitably modulated, alternating current, for example a 30V current. Once the active portion M has been powered, it generates a magnetic field that, due to the interaction with the magnetic elements 8, induces a driving force obliging the movable portion 3, and the closing element 5 integral therewith, to translate relative to the fixed portion 2.

[0054] Preferably, the controlling means govern the operations of the active portion M so as to control the movement of the respective closing element 5.

Claims

1. Device (1) for the movement of a sliding door, of the type comprising a base structure (4) and at least one closing element (5) sliding relative to said base structure, said device comprising at least one fixed portion (2) and at least one movable portion (3), said fixed portion (2) being constrainable to said base structure (4) of said door and said movable portion (3) being constrainable to said closing element (5), wherein said fixed portion (2) comprises guiding means (15) to guide said movable portion (3), said device comprising movement means (M, 8, 6) comprising at least one linear electric motor (M, 8), wherein the active portion (M) of said linear electric motor (M, 8) is integral with said movable portion (3) of said device, said fixed portion (2) comprising converting means (12) for the conversion of electric power, which receive the input electric current supplied by a source (9) of electric power, and output a direct

current having low or extra-low voltage, said low or extra-low voltage being comprised between 12 and 48V, said movable portion comprising converting means (14) for the conversion of electric power, which receive said input direct current having low or extra-low voltage, and output a three-phase current to supply said active portion (M).

2. Device according to claim 1, wherein mobile contact means are arranged between said movable portion (3) and said fixed portion (2) in order to guarantee the electrical connection between said active portion (M) and said fixed portion (2).

3. Device according to one of the preceding claims, comprising controlling means (13) to control said active portion, said controlling means comprising at least one programmable control unit (C).

4. Device according to claim 3, wherein said controlling means comprise sensors (SN) of the position of said at least one closing element relative to said guiding means.

5. Device according to claim 3 or 4, wherein said controlling means are arranged on said movable portion (3).

6. Device according to one of the preceding claims, wherein said fixed portion (2) comprises at least one magnetic element (8).

7. Device according to claim 6, wherein said magnetic element comprises rare earth elements, preferably neodymium.

8. Pedestrian sliding door comprising at least one movable closing element, and a device according to one of the preceding claims, which is operatively constrained to said movable closing element.

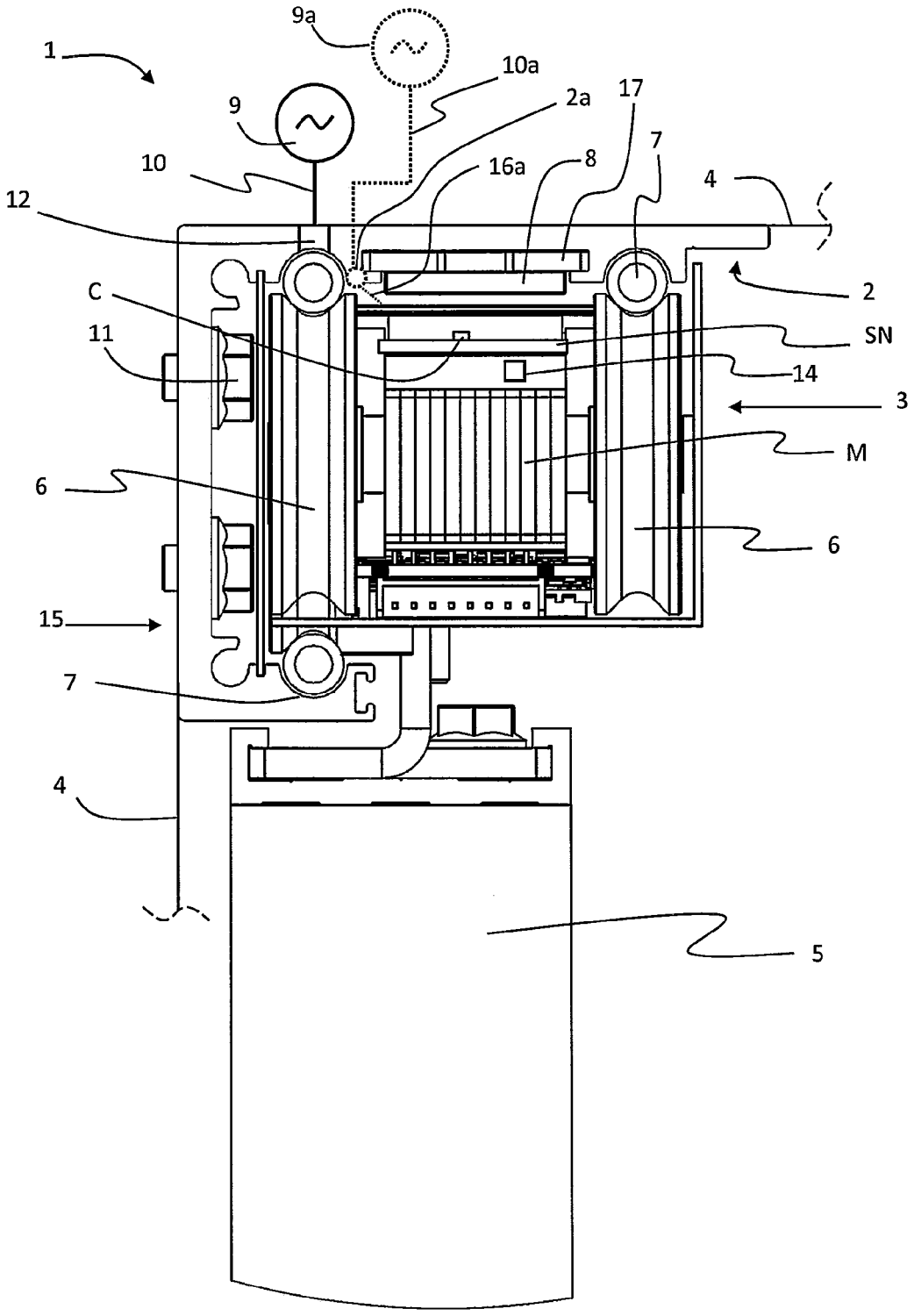

FIG. 1

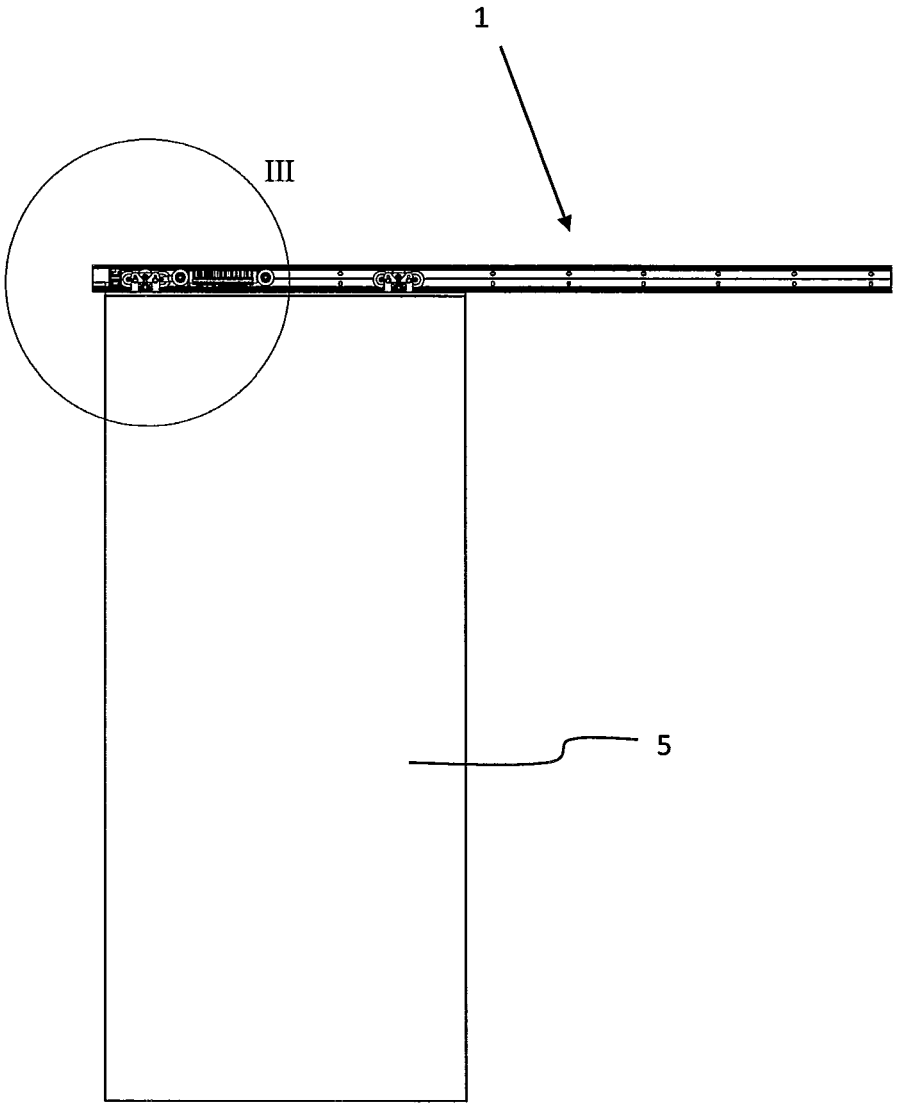

FIG. 2

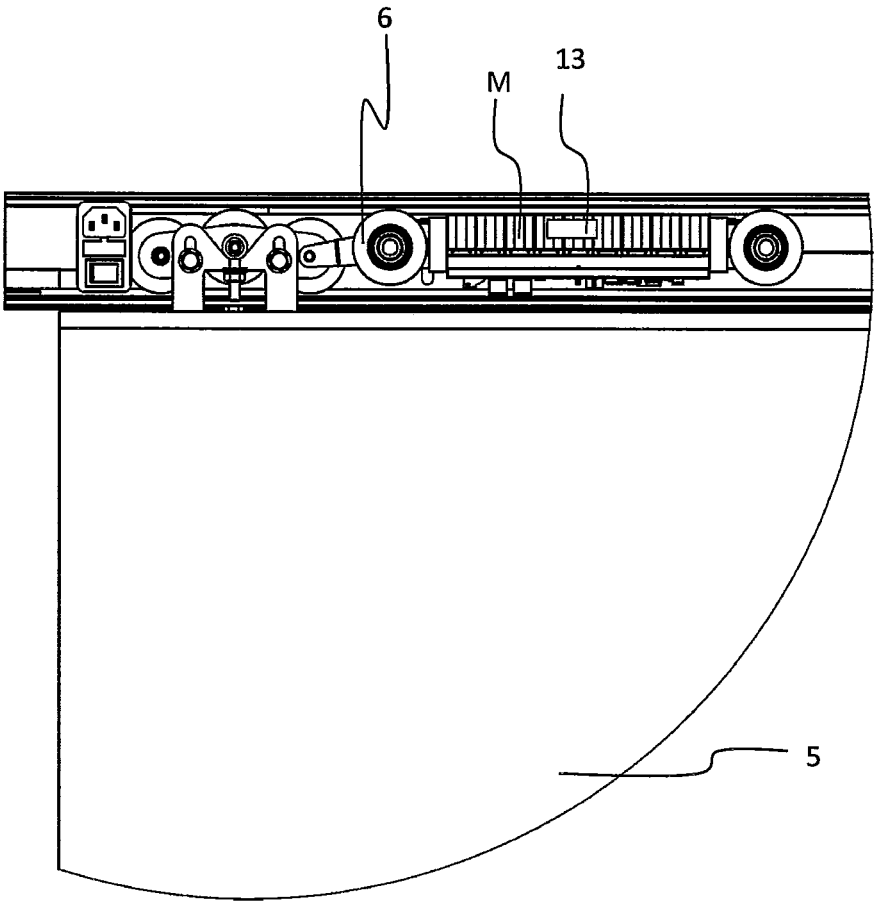

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 4118

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 3 852 626 A (DAVIS M) 3 December 1974 (1974-12-03) * column 1, line 20 * * column 3, line 5 - column 4, line 55; figures 1-5 * -----	1-6,8	INV. E05F15/18
A	US 5 661 350 A (LUCIDARME JEAN [FR] ET AL) 26 August 1997 (1997-08-26) * column 1, line 45 - line 48 * * column 2, line 57 - column 3, line 31 * * page 4, line 54 - page 5, line 55; figures 1,8-10 * -----	1-6,8	
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			TECHNICAL FIELDS SEARCHED (IPC) E05F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 August 2015	Guillaume, Geert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 16 4118

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20-08-2015

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82