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(54) **Sliding plug door mechanism**

(57) Sliding plug door mechanism, comprising guide means (1) having a first guide means section (2a) and a second guide means section (2b). The mechanism includes a lever element (3) arranged to move with a door panel (10, 10a, 10b), the lever element (3) comprising a first and a second joint (4, 5). The first joint (4) is arranged to couple an actuator of the mechanism to the lever element (3) and the second joint (5) is arranged to move in/on the guide means. The second joint (5) is a turning joint connected to a door panel carriage (13, 13a, 13b) fixed non-rotatably to the door panel (10, 10a, 10b). The lever element (3) is arranged to rotate relative to said door panel carriage (13, 13a, 13b) as a result of the movement of the lever element (3) from the first guide means section (2a) to the second guide means section (2b).

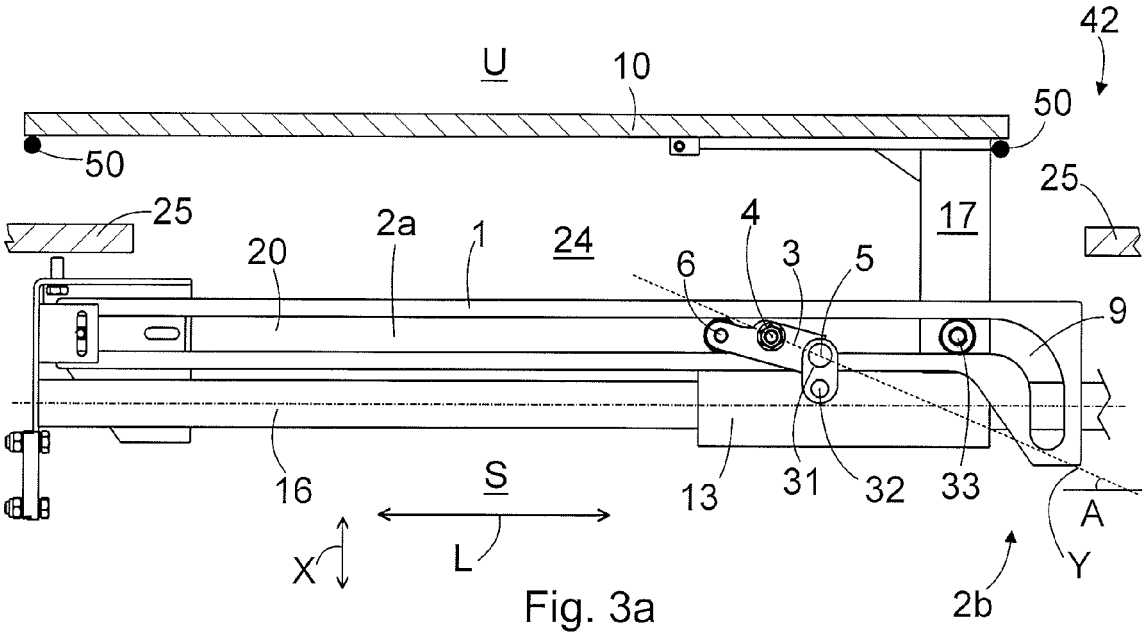

Fig. 3a

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a sliding plug door mechanism, the mechanism comprising guide means, the guide means having a first guide means section and a second guide means section, the first guide means section extending parallel with a doorway and associating with the second guide means section.

BACKGROUND OF THE INVENTION

[0002] Some vehicles, especially vehicles for public transport, such as buses, trolley-buses, or railbound vehicles such as trams, railway wagons etc. possess one or more sliding plug doors. The sliding plug door is an advantageous concept for a vehicle of public transport because its opening and closing movement takes place in a minor space. A sliding plug door may comprise one or two door panel(s). The door panel is seated in a doorway so as to be flush with the vehicle body in the closed state. While in the open state the door panel is located on the outer side of the vehicle body, clearing the door opening in this state. The movement of the door panel from the closed state towards the open state begins with a rather short movement outwards from the door opening, which is called a "plugging movement". The opening movement continues then sidewards, i.e. in a direction parallel with the outer skin of the vehicle.

[0003] Closing movement takes place in reverse, i.e. the door panel is first moved parallel with the outer skin of the vehicle on the door opening and then plugged against the door opening by an inward movement.

[0004] The path of the door panel from the closed state to the open state and vice versa is determined by a door mechanism. The door mechanism is typically arranged above the top edge and/or lower edge of the door opening.

[0005] A problem with known sliding plug door mechanisms is that an opening force of the door panel created by an actuator of the door mechanism may be limited to the extent that the opening of the door is unsure due to freezing of the seals and the mechanisms of the door during cold seasons.

BRIEF DESCRIPTION OF THE INVENTION

[0006] An object of the present invention is to provide a sliding plug door mechanism so as to alleviate the above disadvantages. The objects of the invention are achieved by a mechanism which is characterized by what is stated in the independent claim. The preferred embodiments of the invention are disclosed in the dependent claims.

[0007] The invention is based on the idea that the second guide means section is arranged to extend perpendicular to the first guide means section, that the mechanism further includes a lever element arranged to move with a door panel, the lever element comprising a first joint and a second joint located at a constant distance from the first joint, the first joint being arranged to couple an actuator of the mechanism to the lever element, the second joint being arranged to move in/on the guide means, and that the second joint is a turning joint connected to a door panel carriage fixed non-rotatable in relation to the door panel, the lever element being arranged to rotate relative to said door panel carriage as a result of the movement of the lever element from the first guide means section to the second guide means section, whereupon the door panel is arranged to plug the doorway. An advantage of the sliding plug door mechanism of the invention is that a high opening force may be generated.

[0008] According to an embodiment of the invention, the lever element is arranged to turn more than 90° while the second joint is arranged in the second guide means section and, as a result, a straight line intersecting the stabilizing body or the first joint and the second joint constitutes an obtuse angle A or B, respectively, with the longitudinal direction of the frame structure. An advantage of this embodiment is that the mechanism is locked such that the door cannot be opened by pushing or pulling the door panel(s). This feature is especially advantageous, because according to the national law of certain countries and states the door(s) of a moving vehicle shall be automatically locked by mechanical means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the following the invention will be described in greater detail by means of preferred embodiments with reference to the attached drawings, in which

Figure 1a is a schematic perspective view of an embodiment of the invention, and Figure 1b is a schematic view of a detail of the embodiment shown in Figure 1 a from above;

Figures 2a - 2e illustrate schematically the door mechanism shown in Figure 1 a in action and seen from below;

Figure 2f illustrates schematically the door mechanism shown in Figure 1a from below;

Figures 3a - 3d illustrate schematically a second door mechanism according to the invention in action and seen from above;

Figures 4a - 4e illustrate schematically a third door mechanism according to the invention; and

Figures 5a - 5e illustrate schematically a fourth door mechanism according to the invention.

[0010] For the sake of clarity, the invention is shown simplified in the figures. Similar parts are marked with the same reference numbers.

DETAILED DESCRIPTION OF THE INVENTION

[0011] The sliding plug door mechanism shown in the Figures is construed in a bus. It is clear that the sliding plug door mechanism of the invention may also be construed in another type of vehicles, especially but not solely vehicles for public transport, such as trolleybuses, railbound vehicles such as trams, railway wagons etc.

[0012] It is to be noted that the sliding plug door mechanism is referred as "door mechanism" in the following part of the description.

[0013] Figure 1 a is a schematic perspective view of an embodiment of the invention, and Figure 1b is a schematic view of a detail of the embodiment shown in Figure 1 a from above. The door mechanism is arranged horizontally above a doorway. In some embodiments of the invention the door mechanism is situated underside of the doorway 24 shown in Figures 2a - 2f which are schematic views of the functioning of the embodiment shown in Figure 1 a.

[0014] The main elements of the door mechanism are a guide means 1 and a frame structure 26. The guide means 1 is attached stationary to the bodywork of the vehicle by first fixation elements, here first flanges 21 a. The frame structure 26 is mounted by a linearly adjustable mounting on two support arms 14 that are attached horizontally to the bodywork of the vehicle by second fixation elements, here second flanges 21 b.

[0015] The linearly adjustable mounting is implemented through guide bars 15 which are arranged perpendicular to the longitudinal axis L of the frame structure 26. Thus the frame structure 26 is able to move in relation to the bodywork in direction perpendicular to the axis L as well in relation to the guide means 1.

[0016] The guide means 1 contains a slot guide 20 having an elongated shape. The slot guide 20 comprises a first guide means section 2a and a second guide means section 2b. The second guide means section 2b extends perpendicularly to the first guide means section 2a. The first end of the second guide means section 2b is connected to the second end of the first guide means section 2a by a curved section 9 so that a single continuous guide means 1 is realized.

[0017] There are guide surfaces 7a, 7b arranged underside of the guide means such that they border the first guide means section 2a and extend downwardly on both sides thereof. The guide surfaces 7a, 7b are best seen in Figures 2a - 2e.

[0018] The first guide surface 7a extends from the first end 40a of the first guide means section 2a to the second end 40b of the first guide means section 2a. The second guide surface 7b also extends from the first end 40a of the first guide means section 2a but it extends rectilinearly by the curved section 9 and over a middle axis of the second guide means section 2b.

[0019] The guide means 1 is arranged horizontally or at least substantially horizontally on the doorway 24 such that the first guide means section 2a is extending parallel with the doorway 24 and the second guide means section 2b is extending inwards, i.e. towards the inside S of the vehicle. It is to be noted that reference symbol S stands for inside of the vehicle and U outside of the vehicle.

[0020] The longitudinal axis L of the frame structure 26 is parallel with the lateral direction of the doorway 24. Furthermore, the first guide means section 2a is parallel with the axis L.

[0021] The lever element 3 is a plate-like element arranged on a horizontal plane. The lever element 3 is adapted to move to and fro beneath the guide means 1 in guidance of the slot guide 20. The lever element 3 comprises a first joint 4, a second joint 5 and a stabilizing body 6 which are arranged in a fixed triangular order in the lever element 3.

[0022] The first joint 4 is coupled to an actuator of the door mechanism. In the embodiment shown in Figures 1a, 1 b the first joint 4 is coupled to a driver 11. The first joint 4 allows the lever element 3 to rotate with respect to the driver 11 around a rotation axis that is perpendicular to the plane of the lever element 3.

[0023] The driver 11 is attached to a cogged belt 12. The cogged belt 12 is adapted to move to and fro on a horizontal plane in parallel with the first guide means section 2a. Instead of the cogged belt 12 a drive belt, a chain, a wire, a mechanism based on a lead screw and nut, or any other type of linear motion actuator may be used. A hydraulic cylinder or pneumatic cylinder may also be used. Said cylinders may be coupled, for instance, directly to the first joint 4.

[0024] The actuator of the mechanism shown in Figures 1a, 1 b comprises not only the cogged belt 12 but also an electrical motor that is arranged to run the cogged belt 12. It is to be noted that the electrical motor is not shown in the Figures. The electrical motor may be replaced by another type of drive unit, such as a pneumatic or a hydraulic drive unit.

[0025] As the cogged belt 12 is run by the motor the lever element 3 attached to the driver 11 is moving in the guide means 1 in the running direction of the driver 11.

[0026] The door mechanism shown in Figure 1a has been adapted to operate two door panels 10a, 10b. The second joint 5 is coupled to a first door panel 10a. More precisely, the second joint 5 is connected to a first door panel carriage 13a that is slidably arranged in the frame structure 26. The first door panel carriage 13a is able to move with respect to the frame structure 26 in longitudinal direction L of the frame structure 26. Similarly, the second door panel carriage 13b is slidably arranged in the frame structure 26.

[0027] The first door panel carriage 13a is connected to the door panel 10 through a first arm 17a. Said arm 17a extends under the frame structure 26 transverse to the longitudinal direction L thereof and is attached immovably to the first door panel 10a and the first door panel carriage 13a. The second door panel 10b is attached to the second arm 17b. In another embodiment the arms 17a, 17b extend over the frame structure 26.

[0028] The second joint 5 is a turning joint, the rotational axis of which is perpendicular to the plane of the lever element 3. The lever element 3 may thus rotate relative to the first door panel carriage 13a and the first door panel 10a. The first door panel 10a moves together with the lever element 3.

[0029] The length of the second joint 5 on the upper side of the lever element 3 is dimensioned so that it stays all the time in the slot guide 20, i.e. in the first or second guide means section 2a, 2b or in the curved section 9. The length of the second joint 5 can be seen in Figure 1 a.

[0030] The stabilizing body 6 is arranged to move in the first guide means section 2a. Its length on the upper side of the lever element 3 is substantially smaller than that of the second joint 5 in the extent that the stabilizing body 6 does not protrude in the slot guide 20. Instead, the stabilizing body 6 rests against the guide surfaces 7a, 7b when moving in the first guide means section 2a. The second guide means section 2b does not have such guide surfaces. This feature enables the stabilizing body 6 to exit the guide means 1, i.e. the guide surfaces 7a, 7b at the curved section 9. The stabilizing body 6 may thus move another path than the second joint 5.

[0031] The door panels 10a, 10b are reverse-coupled so that the first door panel 10a opens left side and the second door panel 10b right side of the doorway 24. This kind of coupling may be realized in various ways which are known *per se.*

[0032] The lever element 3 is directly connected to a first arm 17a through the second joint 5. The first arm 17a comprises a first fastening element 27a that is fastened to two connecting wires 28. The two connecting wires 28 are arranged in parallel and they are supported by pulleys 19 attached to the ends of the frame structure 26. The rotational axis of the pulleys 19 are arranged horizontally and perpendicular to the longitudinal axis L of the frame structure.

[0033] The wires 18 are divided by the pulleys 19 into two wire sections, i.e. an upper section and a lower section. The first fastening element 27a is fastened to the upper section that is travelling between the upper sides of the pulleys 19. The second arm 17b has been fastened to the lower section of wires 28 that is travelling between the lower sides of the pulleys 19. Thus the second arm 17b travels always in opposite direction to the first arm 17a. Instead of open loop configuration of the wires, a closed loop may also be used. Therein the wires make a closed loop around pulleys. The wires may also be replaced by a belt, chain etc.

[0034] Figure 2a illustrates schematically a door mechanism according to the invention in a state where the lever element 3 is at the first end 40a of the first guide means section 2a and seen from below.

[0035] The door is fully open, i.e. the door panels 10a, 10b are positioned next to the doorway 24 outside of the vehicle and on the exterior of the bodywork 25 of the vehicle. The door panels 10a, 10b are at least substantially parallel with said exterior of the bodywork 25.

[0036] The lever element 3 is connected to the first door panel 10a that has been opened on the right side of the doorway 24. The lever element 3 is moved at the first end 40a of the first guide means section 2a and the first door panel carriage 13a attached therein has moved to the right, away from the doorway 24. This movement is accomplished by the motor which is connected to the first joint 4 of the lever element 3 through the cogged belt 12 and the driver 11.

[0037] The movement of the first door panel carriage 13a is supplied and reversed by the wires 18 to the second door panel carriage 13b and the second door panel 10b on the left side. Thus the second door panel 10b has moved to the left, away from the doorway 24. The second door panel 10b is out of sight in Figure 2a.

[0038] Figure 2b illustrates schematically the door mechanism shown in Figure 2a in a state where the lever element 3 has moved left at the second end 40b of the first guide means section 2a. The door panels 10a, 10b has moved in front of the doorway 24. There is still a small gap 41 between the door panels 10a, 10b.

[0039] The door panels 10a, 10b have not changed their position in the lateral direction X of the door panels 10a, 10b. In other words the door panels 10a, 10b are still in the same position in direction X as in Figure 2a.

[0040] So there is also a gap 42 between the edges of the door panels 10a, 10b and the edges of the doorway 24.

[0041] Figure 2c illustrates schematically the door mechanism shown in Figure 2a in a state where the actuator of the mechanism has moved the lever element 3 further left to the extent that the lever element 3 has reached the curved section 9 of the guide means 1. The guide means 1 has compelled the second joint 5 to move via the curved section 9 in the second guide means section 2b. This means that the second joint 5 has moved inwards in relation to the bodywork of the vehicle, i.e. towards the doorway 24.

[0042] Also the first door panel carriage 13a attached to the second joint 5 and the frame structure 26 attached to the first door panel carriage 13a have moved inwards to the same extent of movement. It is to be noted that the door panel carriages 13a, 13b and the frame structure 26 are not shown in Figures 2a - 2f.

[0043] Due to the movement of the frame structure 26 also the second door panel carriage 13b, the second arm 17b and the second door panel 10b have moved inwards, i.e. towards the doorway 24. The door panels 10a, 10b are not yet in contact with the edges of the doorway 24 but there is still a gap 42 between the door panels 10a, 10b and said edges.

[0044] In this position the door panels 10a, 10b substantially completely cover the doorway 24 such that the small gap 41 between the door panels 10a, 10b is closed.

[0045] While the second joint 5 is moving in the second guide means section 2b the lever element 3 continues its movement in the longitudinal direction L of the frame structure 26. The door panels 10a, 10b does not move

further in the longitudinal direction of the frame structure 26 because the second joint 5 is not moving in that direction. The second joint 5 is moving in the direction of the second guide means section 2b only.

[0046] While the second joint is travelling through the curved section 9, the speed of movement of the door panels 10a, 10b in the longitudinal direction L of the frame structure 26 is being slowed down steplessly to zero. This means that the transmission ratio between the motor and the door panels 10a, 10b increases steplessly. While the transmission ratio is increasing, the torque affecting in the movement of the door panels 10a, 10b increases, too.

[0047] Figure 2d illustrates schematically the door mechanism shown in Figure 2a in a state where the lever element is in the second guide means section 2b and seen from below.

[0048] The stabilizing body 6 has released from between the guide surfaces 7a, 7b and the lever element 3 has turned 90° compared to its position in the first guide means section 2a shown in Figure 2a. The second joint 5 has reached its extreme position in the second guide means section 2b.

[0049] The door is fully closed, i.e. the door panels 10a, 10b are pressed against the edges of the doorway 24. Usually there are resilient seals arranged in the edges of the doorway 24 and/or in the edges of the door panels 10a, 10b. As the door is closed, these seals are sealing the door panels 10a, 10b to the edges of the doorway 24. The seals are known *per se* and are not shown in Figures 2a - 2f for the sake of clarity.

[0050] Figure 2e illustrates schematically the door mechanism shown in Figure 2a in a locked state and seen from below. The stabilizing body 6 has moved even farther from the guide surfaces 7a, 7b. The lever element 3 has turned over 90° so that a straight line intersecting the stabilizing body 6 and the second joint 5 makes an obtuse angle A with the longitudinal direction L of the frame structure 26.

[0051] The second joint 5 has withdrawn slightly back from its extreme position in the second guide means section 2b. Also the distance between the door panels 10a, 10b has moved equally. Even so, the door is completely closed.

[0052] The lever element 3 has made contact with a stopper 29. The stopper 29 comprises a touch sensor or proximity sensor known *per se.* The stopper 29 is connected to a controlling means of the actuator of the mechanism. As the lever element 3 makes the contact with the stopper 29, a control impulse is generated and transmitted to the controlling means for stopping the movement of the lever element 3, i.e. the movement of the driver 11 is stopped. Also an indication signal that informs the operator, e.g. driver of the vehicle, that the door is locked may be generated.

[0053] The door mechanism has accomplished a locking state in Figure 2e. This means that the door may not be opened by pushing or pulling the door panels 10a, 10b, because the lever element 3 tends to turn away from the first guide means section 2a in the case the door panels are tried to force outwards from the doorway 24. This way the locking of the door is achieved without any extra locking mechanisms or locking means.

[0054] If a failure occurs in the motor or in other parts of the actuator mechanism running the door mechanism, the door may be opened by using a pusher 30 which is arranged in the stopper 29. The pusher 30 pushes the stabilizing body 6 back between the guide surfaces 7a, 7b, after which the opening of the door may take place. The pusher 30 may also be activated in case of emergency. The pusher 30 may be, for instance, a pneumatically or mechanically operated piston or just a manually operated pusher, rocker etc.

[0055] The stopper 29 may be implemented without the pusher 30. The task of the stopper 29 is to limit the motion of the lever element 3 especially during the closing movement of the door. In the Figures the stopper 29 is adjusted to allow the stabilizing body 6 to exit the slot guide 20. The stopper 29 may also be adjusted so that the stabilizing body 6 cannot move in the above-mentioned locked state, i.e. the door may not lock.

[0056] It is to be noted, however, that the stopper 29 and/or the pusher 30 are not essential components of the mechanism.

[0057] Generally speaking, the opening procedure takes place in reverse order as the closing procedure described in connection with Figures 2a - 2e. The only major difference is that the drive belt 12 and the driver 11 attached thereto run in opposite direction. While the second joint 5 is moved back from the second guide means section 2b to the first guide means section 2a, the door panel carriage 13 and the door panels 10 move outwards, i.e. a movement reversed to the plugging movement takes place. An advantage of the mechanism is a uniform movement and a perfect control of the door panels in the opening procedure, too.

[0058] At the beginning of the opening procedure a high torque is acting on the door panel carriage 13. This is created by the motor and a high transmission ratio between the motor and the door panel carriage 13. Due to this high torque at the initiation of the door opening procedure the door opens safely and surely also during cold weather seasons.

[0059] As soon as the door panels 10 are moved outwards they can be moved back in the position shown in Figure 2a via positions shown in Figures 2d, 2c and 2b.

[0060] Figure 3a illustrates schematically a second door mechanism according to the invention seen from above in a state where the lever element 3 is in the first guide means section 2a.

[0061] A guide means 1 is attached stationary to the bodywork 25 of the vehicle. A frame structure 26 comprising a linear guide 16 is arranged movably in relation to the bodywork 25 and the guide means 1 so that it can move in direction perpendicular, i.e. in directions X, to the longitudinal axis L of the frame structure 26. The mountings of the guide means 1 and the frame structure

26 may be realized in the same way as described above. Similarly, the guide means 1 comprises a first guide means section 2a and a second guide means section 2b and a curved section 9 there between. These establish a slot guide 20. The second guide means section 2b extends perpendicularly to the first guide means section 2a.

[0062] A lever element 3 is arranged to move to and fro in guidance of the slot guide 20. The lever element 3 comprises a first joint 4, a second joint 5 and a stabilizing body 6 which are arranged in a fixed triangular order in the lever element 3. The joints 4, 5 and the stabilizing body 6 may also be situated linearly, i.e. consecutively on the same straight line.

[0063] The first joint 4 is arranged to move in the slot guide 20 and is coupled to an actuator of the door mechanism. The actuator comprises a pressure driven cylinder that is connected rotationally to the first joint 4. The cylinder is not shown in Figures 3a - 3d for clarity reasons. The cylinder is arranged substantially parallel with the longitudinal direction L of the frame structure 26. The cylinder may be a hydraulic cylinder or pneumatic cylinder known *per se.*

[0064] Contrary to the previous embodiment of the invention shown in Fig-ures 1 to 2f, the second joint 5 has not been arranged in the slot guide 20 but above the guide means 1. The stabilizing body 6 is arranged to move in the guidance of the slot guide 20. In another embodiment of the invention the second joint 5 is arranged below the slot guide 20.

[0065] The second joint 5 is connected to a door panel carriage 13 through a link 31, relative to which the lever 3 may rotate around a rotational axis arranged perpendicularly to the longitudinal direction L of the frame structure 26. The link 31 is attached stationary to the door panel carriage 13 by a mounting means, e.g. bolt 32.

[0066] The door panel carriage 13 is arranged slidably on the linear guide 16. The door panel carriage 13 comprises guide means, e.g. dummy 33 that is arranged in the slot guide 20 and moving therein. Furthermore, the door panel carriage 13 is attached to a door panel 10 through an arm 17. The arm is fixedly attached to the door panel 10. The door panel 10 is thus rigidly attached to the door panel carriage 13.

[0067] The cylinder moves the lever element 3 in relation to the slot guide 20. The movement of the lever element 3 is transmitted to the door panel carriage 13 and the dummy 33.

[0068] It is to be noted that the actuator of the door mechanism described in connection with Figures 1a - 2f may be applied instead of the cylinder. It is also possible to replace the actuator of the door mechanism with the cylinder in the embodiments of the invention described herein. Furthermore, it is clear that the embodiment shown in Figure 3a may be applied to a door having two door panels.

[0069] Figure 3a is showing a situation where not only the lever element 3 but also the dummy 33 is in the first guide means section 2a. The door panel 10 is moving from its open state to its closed state, i.e. from left to right in the figure. The door panel 10 situates partly on the exterior of the bodywork 25, partly in front of the doorway 24. There is a gap 42 between the door panel 10 and the edges of the doorway 24.

[0070] The lever element 3 is arranged to move in the first guide means section 2a in a position where an axis Y crossing the second joint 5 and the stabilizing body 6 establishes an acute first angle A with the longitudinal axis of the first guide means section 2a.

[0071] Figure 3b is showing a situation where the lever element 3 together with the door panel carriage 13 and the dummy 33 are moved further right. The door mechanism is making its plugging movement inwards, i.e. in closing direction.

[0072] The dummy 33 has proceeded from the first guide means section 2a through the curved section 9 to the second guide means section 2b. The dummy 33 has thus undergone a lateral movement, i.e. in direction X, away from the longitudinal centre line of the first guide means section 2a. The door panel carriage 13 and the door panel 10 have undergone equal movements. Due to the lateral movement the door panel carriage 13 and the door panel 10 are moved inwards.

[0073] The lever element 3 has rotated clockwise and the second joint 5 has also undergone the same lateral movement as the dummy 33 and the door panel carriage 13. Thus the door panel 10 has maintained its orientation, i.e. it lies at least substantially parallel with the longitudinal axis L of the frame structure 26. It is to be noted here that in all the embodiments of the invention the door panel 10 maintains its orientation in all stages of opening and closing movements. The door panel 10 stands on the doorway 24 but there is still a small gap 42 between the door panel 10 and the edges of the doorway 24.

[0074] Figure 3c illustrates schematically the door mechanism shown in Figure 3a in a state where the door panel 10 closes the doorway 24. Seals 50 arranged in the edges of the door panel 10 are in contact with corresponding edges of the doorway 24. It is to be noted that seals may also be arranged in the edges of the doorway, or both in the door panel and the edges of the doorway. An advantage of the mechanism of the invention is that conventional door seals may be used instead of special seals required by known sliding plug door mechanisms.

[0075] The lever element is at an angle of 90° to the longitudinal centre line of the first guide means section 2a. At the same time the distance between the stabilizing body 6 and the door panel carriage 13 reaches its maximum value. In other words the plugging movement of the door panel 10 is arranged to realize by increasing the first angle A.

[0076] Figure 3d illustrates schematically the door mechanism shown in Figure 3a in a state where the door panel 10 is in the locked state. The actuator has moved the lever element 3 still further right beyond the second joint 5 when considering it in the direction of the longitudinal centre line of the first guide means section 2a. The

first angle A is over 90°. The door panel 10 has moved slightly back, but still the seals 50 are in contact with the edges of the doorway 24.

[0077] The distance between the stabilizing body 6 and the door panel carriage 13 is slightly shorter than in Figure 3c, but the door is in contact with the edges of the doorway 24 through seals 50.

[0078] When the door mechanism is in the locking state the door panel 10 cannot be moved away from the doorway 24 as described already in the description of Figure 2e.

[0079] Instead of the slot guide 20 a guide rail etc. may be applied. The guide rail includes sections corresponding to the first and second guide means sections 2a, 2b and the curved section 9 of the slot guide. Accordingly, the stabilizing body 6 and the dummy 33 are provided to slide and/or rotate on the guide rail.

[0080] Figure 4a illustrates schematically the third door mechanism from below in a state where a lever element 3 is in a first guide means section 2a of a guide means 1, Figure 4b illustrates schematically the door mechanism in a state where the lever element 3 has moved left at the second end of the first guide means section 2a, Figure 4c illustrates schematically the door mechanism in a state where the lever element 3 has reached the curved section 9 of the guide means 1, Figure 4d illustrates schematically the door mechanism in a state where the lever element is in the second guide means section, and Figure 4e illustrates the door mechanism in a locked state.

[0081] The door mechanism is construed on a frame structure 26. The lever element 3 is a straight bar at the first end of which there is arranged a first joint 4. A second joint 5 is arranged at the second end of the lever element 3.

[0082] The first joint 4 is coupled to an actuator of the mechanism. The actuator of the mechanism comprises a driver 11 that is connected rotatable in the first joint 4, and a drive belt 12.

[0083] The drive belt 12 and its arrangement in the mechanism may be similar to the belts and arrangements discussed earlier in parts of this description relating to Figures 1 a and 1 b, and it may be replaced by similar structures as described in said parts of this description.

[0084] The drive belt 12 is run by a motor that is not shown in Figures 4a-4e for the sake of clarity. The motor may be similar to the motors discussed earlier.

[0085] The second joint 5 is coupled to a door panel. There may be a similar door panel carriage fixed non-rotatably to the door panel as discussed earlier in this description. It is to be noted that the door panel and the door panel carriage are not shown in Figures 4a - 4e.

[0086] The guide means 1 comprises a slot guide 20 which is here a groove that consists of said first guide means section 2a, a second guide means section 2b and a curved section 9. The groove may be construed from a metal profile, for instance.

[0087] The longitudinal direction L of the frame structure 26 is arranged at least substantially horizontally, i.e. parallel with the lateral dimension of a doorway of the door. It is to be noted that the doorway is not shown in Figures 4a - 4e.

[0088] The main difference between the construction of the mechanism shown in Figures 4a - 4e and the mechanism shown in previous Figures is that the first and second joints 4, 5 proceed successively in the first guide means section 2a, i.e. an imaginary line Z intersecting middle axis of said joints 4, 5 is parallel with the longitudinal axis of the first guide means section 2a.

[0089] Figure 4e illustrates the door mechanism in a locked state. The second joint 5 is capable of moving out from the guide means 1, whereas the first joint 4 follows the guide means 1 all through the opening or closing process. This feature may be accomplished as described earlier in the description. The imaginary line Z makes an obtuse angle B, i.e. more than 90° with the longitudinal direction L of the frame structure 26.

[0090] Figures 5a - 5e illustrate schematically a fourth door mechanism according to the invention and seen from below: Figure 5a shows a state where the lever element 3 is in the first guide means section 2a, Figure 5b shows a state where the lever element 3 has moved left at the second end of the first guide means section 2a, Figure 5c shows a state where the lever element 3 has reached the curved section 9 of the guide means 1, Figure 5d shows a state where the lever element is in the second guide means section and, finally, Figure in a locked state.

[0091] The fourth door mechanism is, in principle, identical to the third door mechanism shown in Figures 4a - 4e above. The major difference is that the driver 11 connected to the first joint 4 as well as the drive belt 12 is arranged on another side of the first guide means section 2a. The first joint 4 is connected through a connecting arm 43 to the driver 11. The connecting arm 43 may be an integral part of the driver 11 or it may be a separate component attached to the driver 11.

[0092] The function of the fourth door mechanism is similar to the third door mechanism.

[0093] It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

[0094] For example, it is not necessary to realize the mechanism of the invention such that it is capable of realizing the locking state described above. Therefore, according to an embodiment of the invention the first joint 4 or the stabilizing body 6 need not exit the slot guide 20, contrary to the embodiments shown, e.g., in Figures 2a - 2f or 4a - 4e, respectively. Thus an embodiment of the invention comprises guide surfaces 7 all the length of the guide means 1. The distance between the door panel 10 of an opened door and the exterior side of the bodywork 25 is easy to adjust by modifying the dimensions of the

lever element 3 and displacing the guide means 1 farther from or closer to the exterior side of the bodywork 25.

[0095] It is to be noted here that all embodiments of the door mechanism described above may be adapted to operate a single door panel or two door panels.

Claims

1. Sliding plug door mechanism, comprising
guide means (1),
the guide means having a first guide means section (2a) and a second guide means section (2b),
the first guide means section (2a) extending parallel with a doorway (24) and associating with the second guide means section (2b), **characterized in that**
the second guide means section (2b) is arranged to extend perpendicular to the first guide means section (2a), that the mechanism further includes
a lever element (3) arranged to move with a door panel (10, 10a, 10b), the lever element (3) comprising
a first joint (4) and
a second joint (5) located at a constant distance from the first joint (4),
the first joint (4) being arranged to couple an actuator of the mechanism to the lever element (3),
the second joint (5) being arranged to move in/on the guide means (1), and that
the second joint (5) is a turning joint connected to a door panel carriage (13, 13a, 13b) fixed non-rotatable in relation to the door panel (10, 10a, 10b),
the lever element (3) being arranged to rotate relative to said door panel carriage (13, 13a, 13b) as a result of the movement of the lever element (3) from the first guide means section (2a) to the second guide means section (2b), whereupon the door panel (10) is arranged to plug the doorway (24).

2. Sliding plug door mechanism as claimed in claim 1, **characterized in that** it further comprises
a stabilizing body (6) arranged in the lever element (3), the stabilizing body (6) being located at a constant distances from the first and second joints (4, 5), the stabilizing body (6) being arranged to move in the guide means (1), and that the first joint (4), the second joint (5) and the stabilizing body (6) are arranged in a triangular order in the lever element (3).

3. Sliding plug door mechanism as claimed in claim 2, **characterized in that** the second joint (5) and the stabilizing body (6) are arranged to move successively in the first guide means section (2a) and the first joint (4) next to the guide means (1), and that the second joint (5) is arranged to move into the second guide means section (2b) without the stabilizing body (6).

4. Sliding plug door mechanism as claimed in any one of claims 1 to 3, **characterized in that** the second joint (5) being at the extreme end of the second guide means section (2b), the stabilizing body (6) is arranged to situate outside the guide means (1).

5. Sliding plug door mechanism as claimed in claim 4, **characterized in that**
while the second joint (5) is arranged in the second guide means section (2b),
the lever element (3) is arranged to turn over 90° so that a straight line (Y) intersecting the stabilizing body (6) and the second joint (5) is adapted to make an obtuse angle (A) with the longitudinal direction (L) of the frame structure (26).

6. Sliding plug door mechanism as claimed in claim 1, **characterized in that** it further comprises a stabilizing body (6) arranged in the lever element (3),
the first joint (4), the second joint (5) and the stabilizing body (6) being arranged in at least substantially linear order in the lever element (3),
the first joint (4) being arranged between the second joint (5) and the stabilizing body (6),
the stabilizing body (6) being arranged to move in the first guide means section (2a) in a position where an axis (Y) crossing the second joint (5) and the stabilizing body (6) constitutes an acute first angle (A) with the longitudinal axis of the first guide means section (2a), and that the plugging movement of the door panel (10) is arranged to take place by increasing the first angle (A).

7. Sliding plug door mechanism as claimed in claim 6, **characterized in that** the mechanism comprises a guide element (33) fixedly fastened in relation to the door panel (10) and arranged movably in/to the guide means (1), the guide element (33) being capable of moving from the first guide means section (2a) to the second guide means section (2b), and that the first angle (A) is forced to increase by movement of the guide element (33) into the second guide means section (2b).

8. Sliding plug door mechanism as claimed in claim 6 or 7, **characterized in that** the mechanism is dimensioned such that when the guide element (33) is at the end of the guide means (1) in the second guide means section (2b), the first angle (A) is over 90°.

9. Sliding plug door mechanism as claimed in claim 1, **characterized in that** the first joint (4) is arranged to follow the second joint (5) in/on the first guide means section (2a) during the closing movement of the door.

10. Sliding plug door mechanism as claimed in claim 9, **characterized in that** the first joint (4) is arranged

to leave the first guide means section (2a) at the end thereof and adapted to continue its movement by the second guide means section (2b) during the closing movement of the door.

11. Sliding plug door mechanism as claimed in any one of the preceding claim, **characterized in that** guide means (1) comprises a slot guide (20).

12. Sliding plug door mechanism as claimed in any one of claims 1 to 10, **characterized in that** guide means (1) comprises a guide rail.

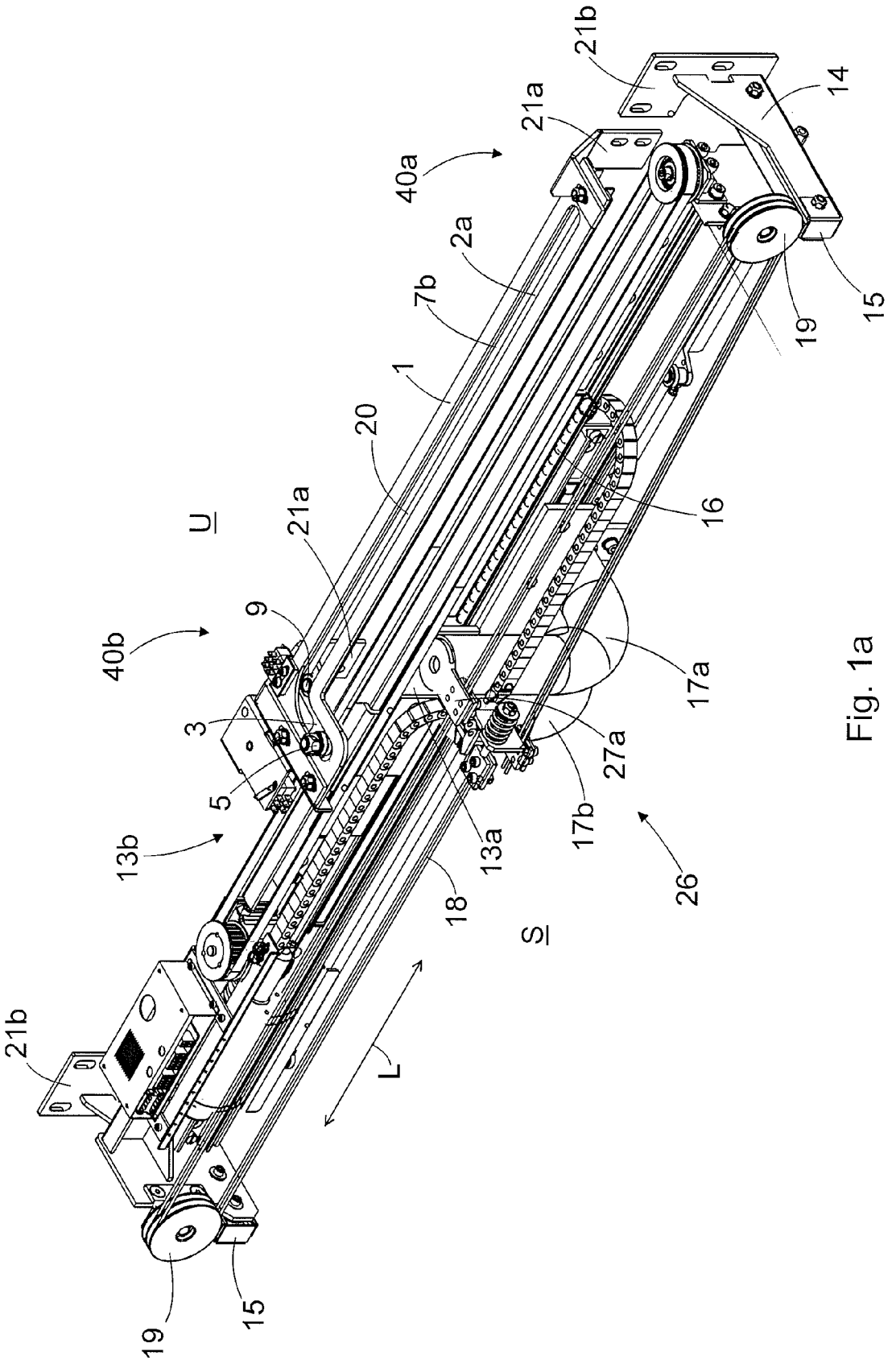
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Fig. 1a

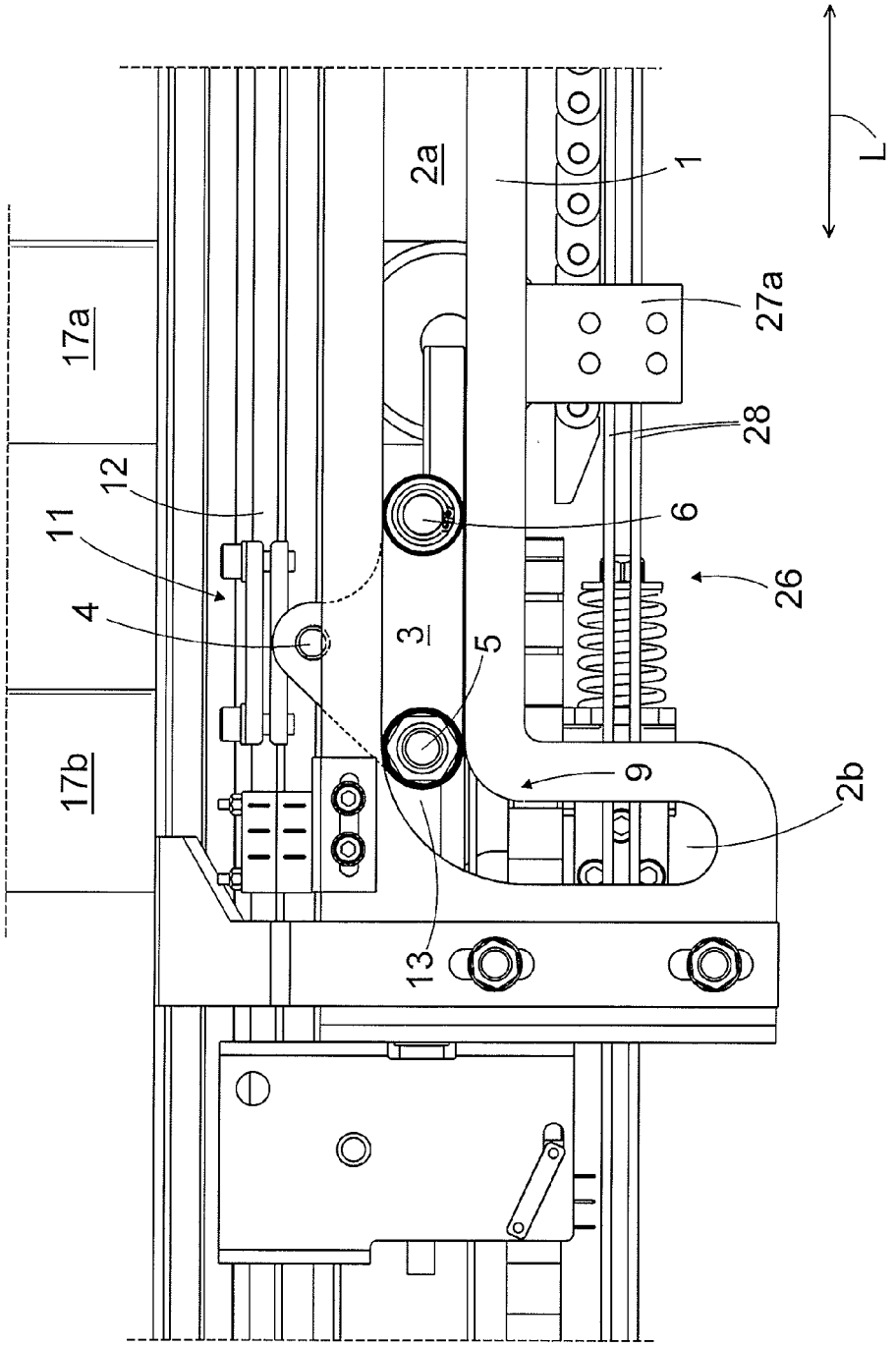

Fig. 1b

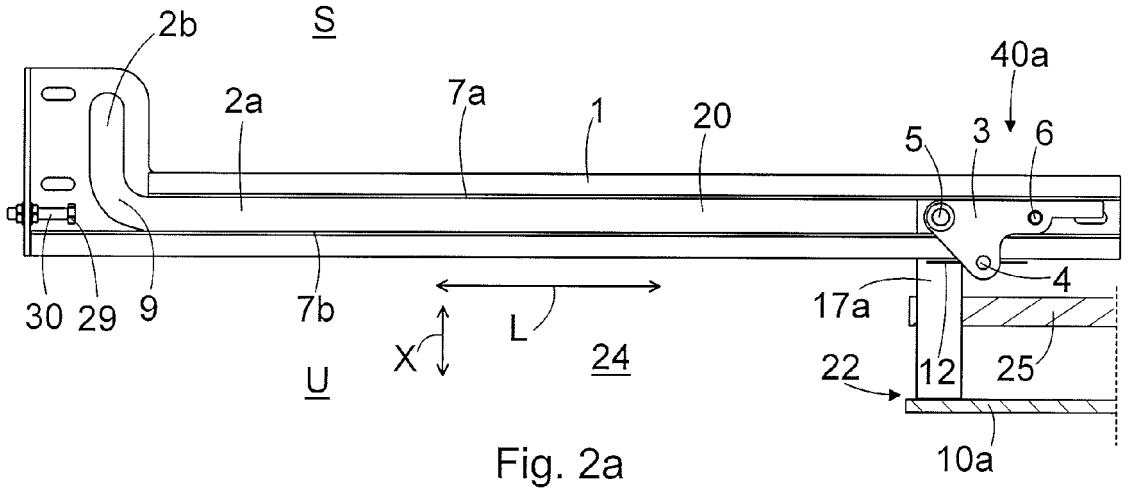

Fig. 2a

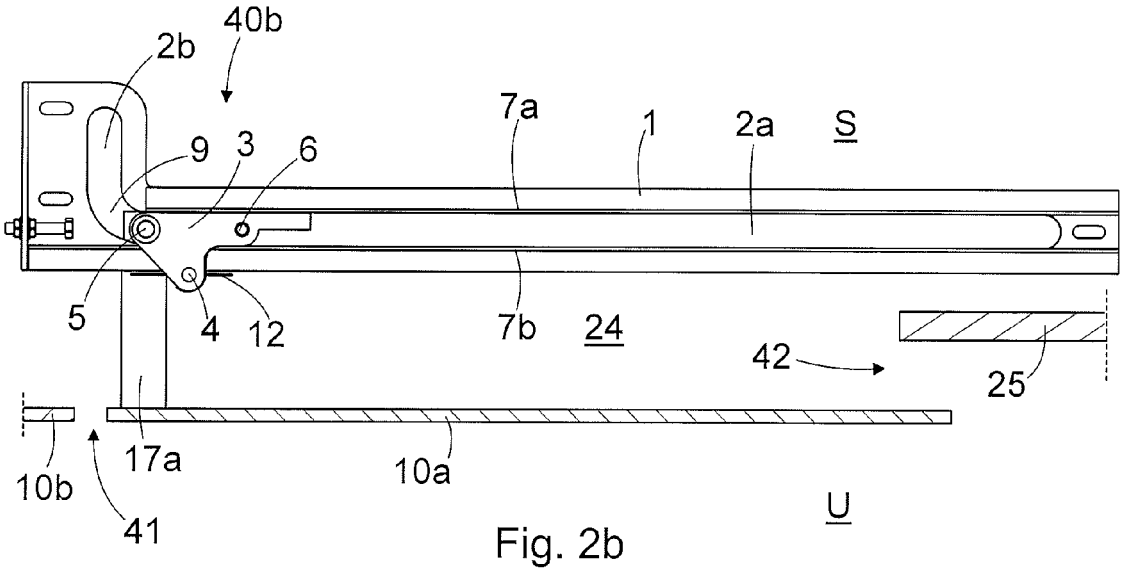

Fig. 2b

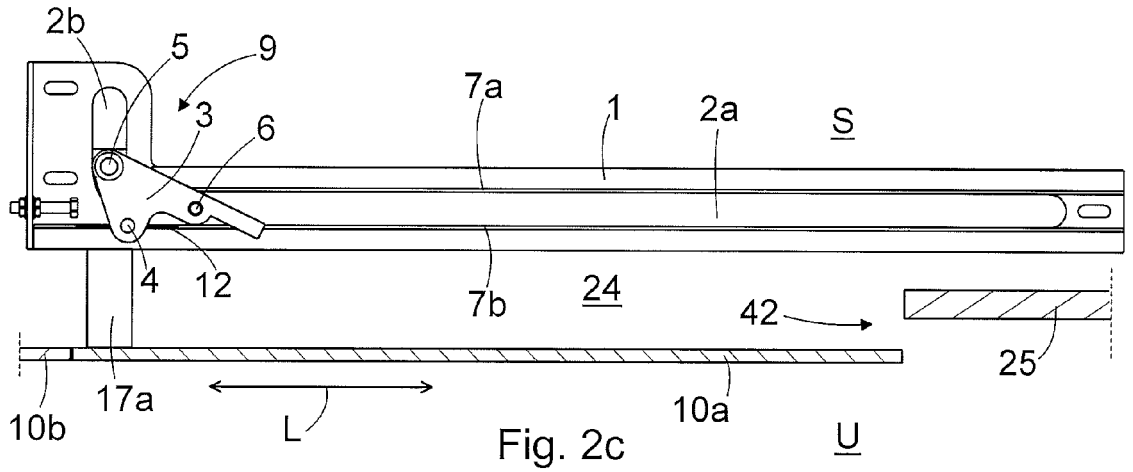

Fig. 2c

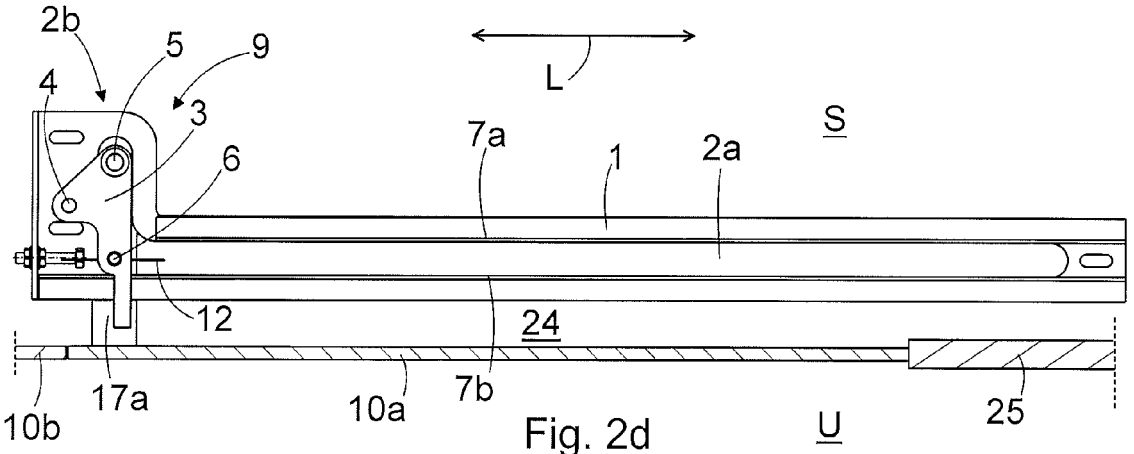

Fig. 2d

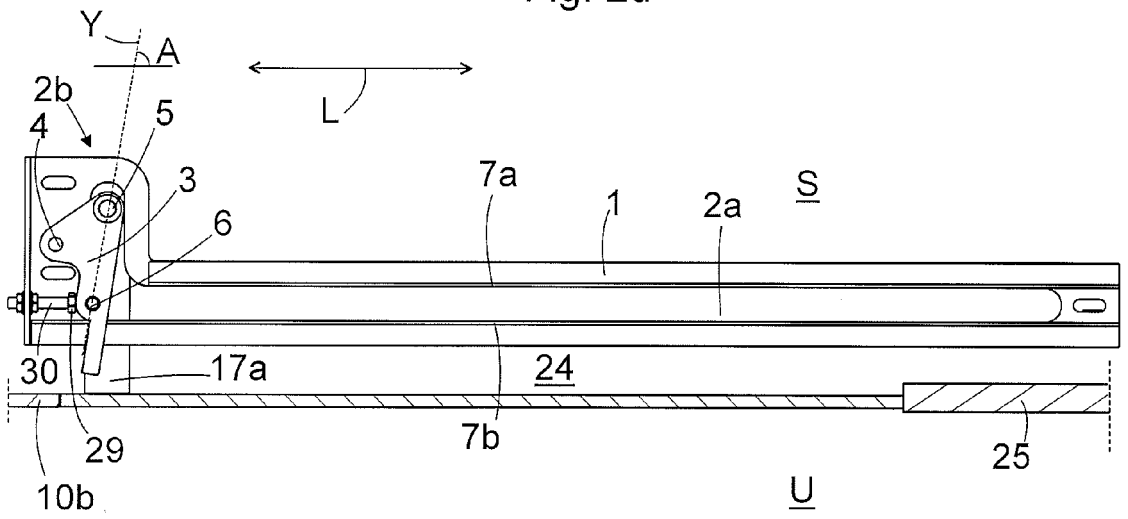

Fig. 2e

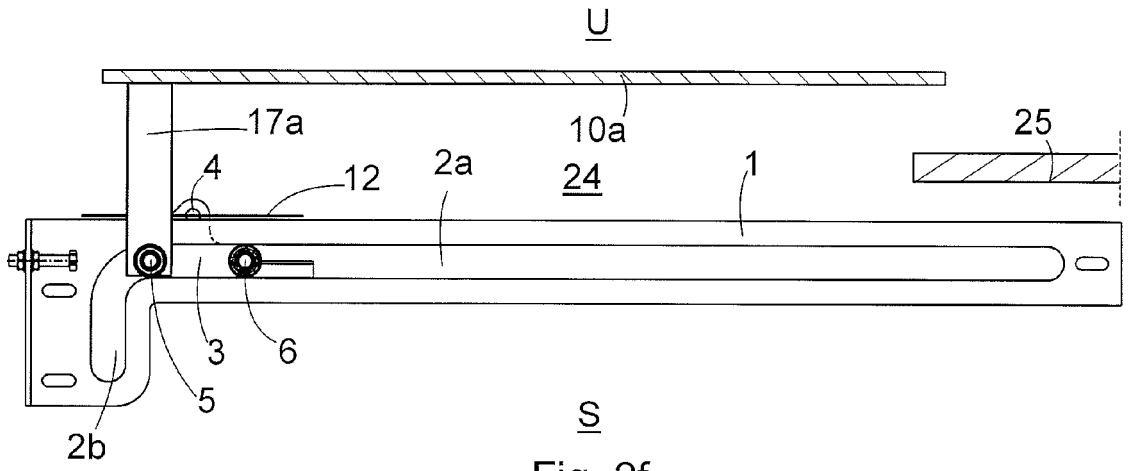

Fig. 2f

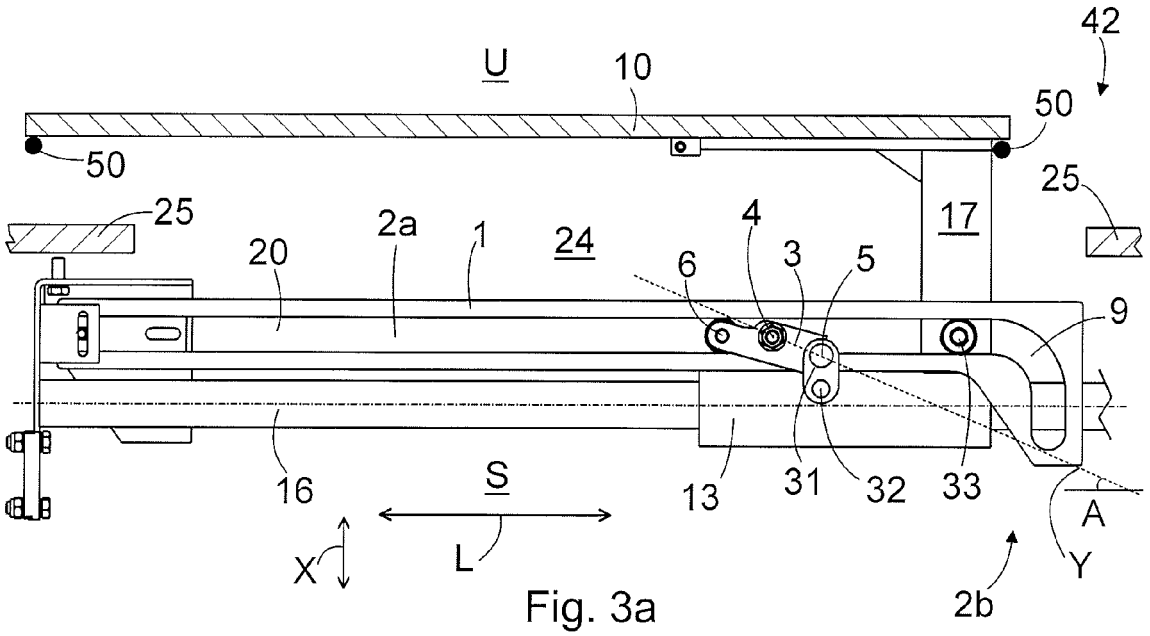
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Fig. 3a

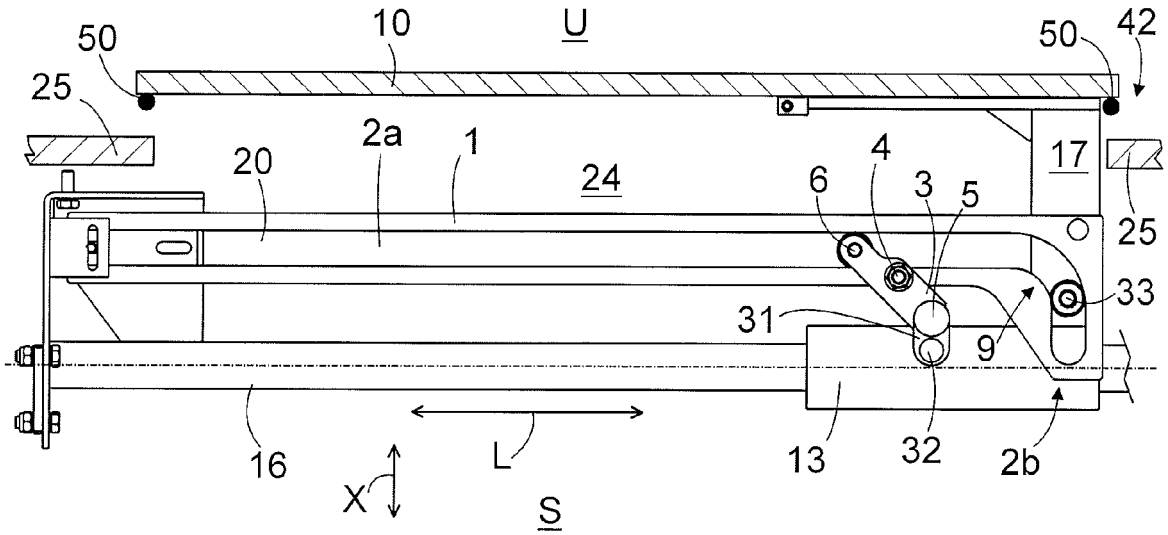
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Fig. 3b

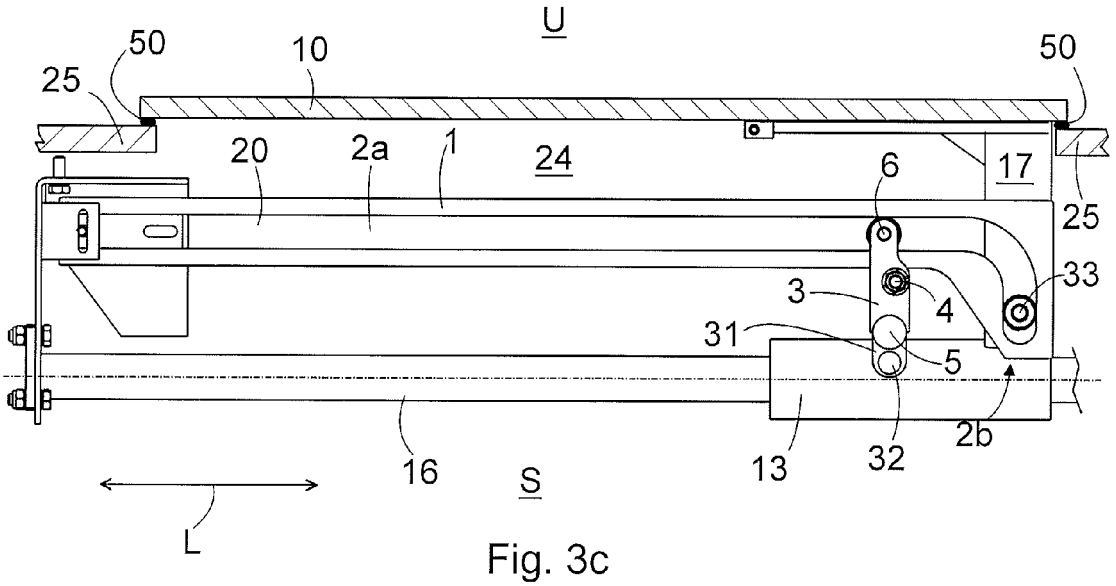
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Fig. 3c

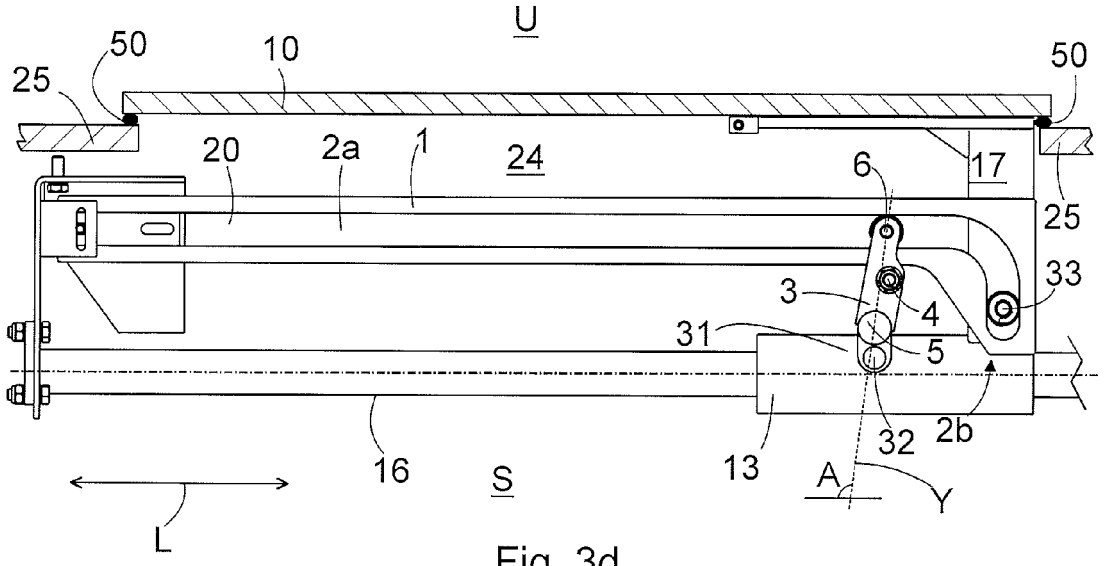
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Fig. 3d

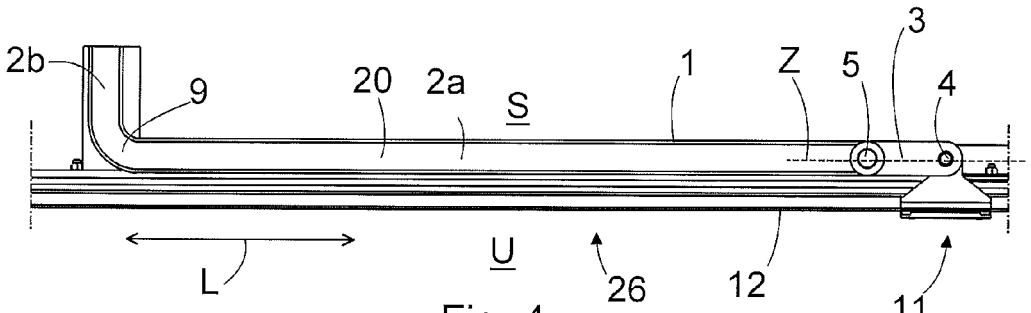

Fig. 4a

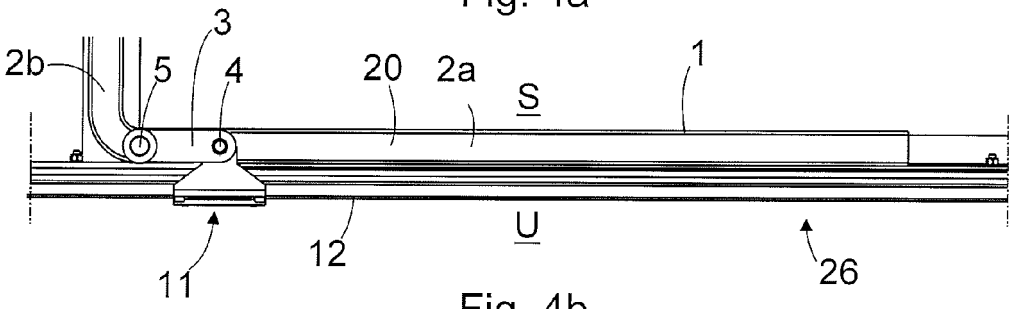

Fig. 4b

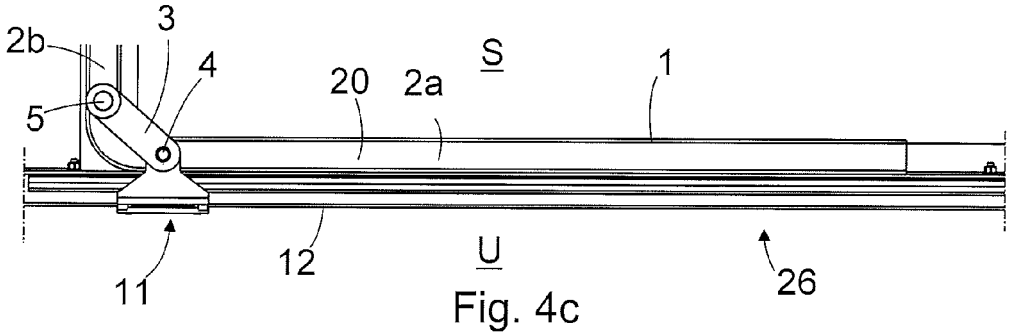

Fig. 4c

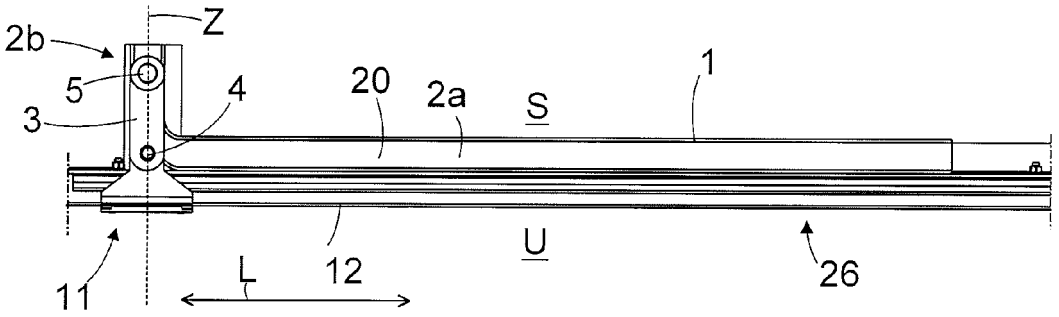

Fig. 4d

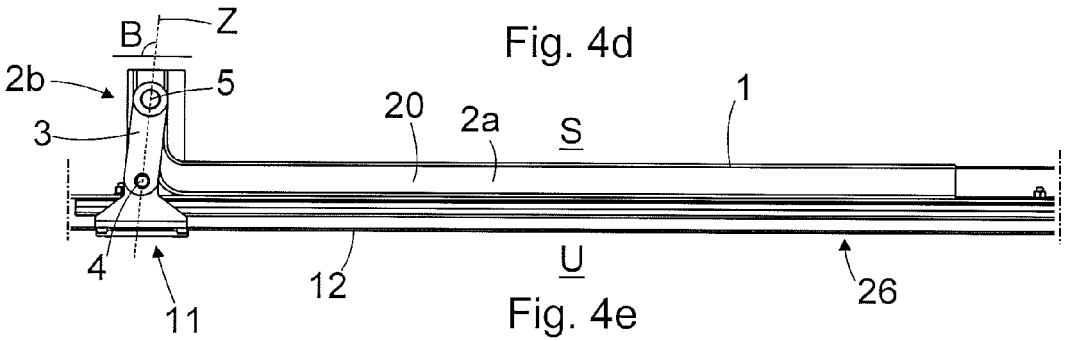

Fig. 4e

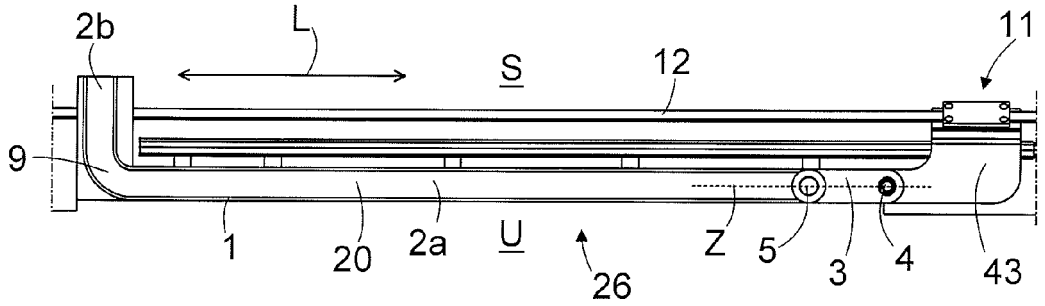

Fig. 5a

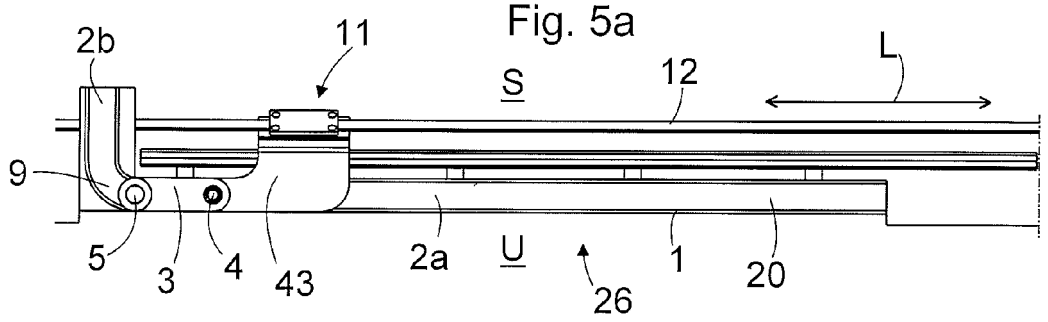

Fig. 5b

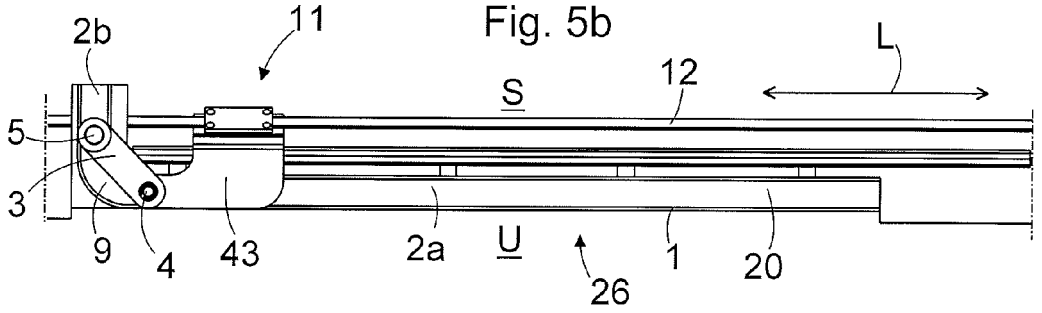

Fig. 5c

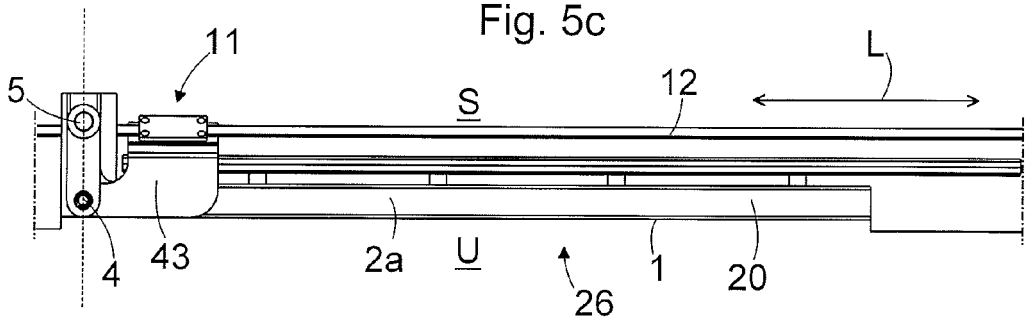

Fig. 5d

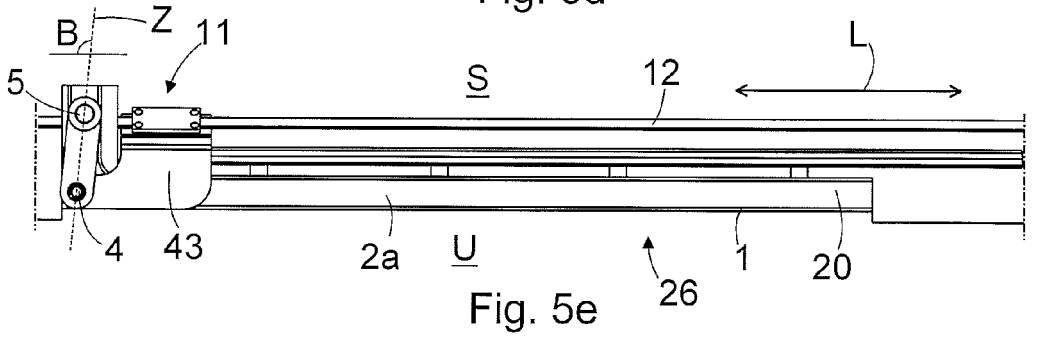

Fig. 5e

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EUROPEAN SEARCH REPORT

Application Number
EP 10 15 4092

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 574 652 A1 (ROMERO MARTINEZ MANUEL [ES] ALBATROS S L [ES]) 14 September 2005 (2005-09-14)	1,2,4,5, 9,11,12	INV. E05D15/10
A	* figures 2-4 * * paragraphs [0002], [0008], [0009], [0012] - [0017] *	3,6-8,10	
X	EP 1 197 413 A2 (WESTINGHOUSE AIR BRAKE TECHNOL [US]) 17 April 2002 (2002-04-17) * figure 7 * * paragraphs [0009], [0033], [0034] * * claim 1 *	1,11,12	

TECHNICAL FIELDS SEARCHED (IPC)

E05D
E05F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5 July 2010	Klemke, Beate

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05-07-2010

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