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- (54) Title:** RAIL VEHICLE WITH FRONTAL CURVED SLIDING DOOR AND METHOD FOR COUPLING AND DECOUPLING RAIL VEHICLES

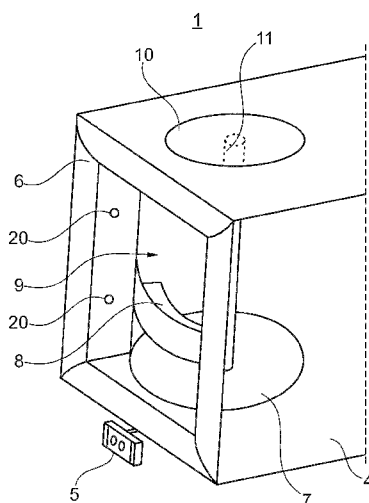


Fig. 3

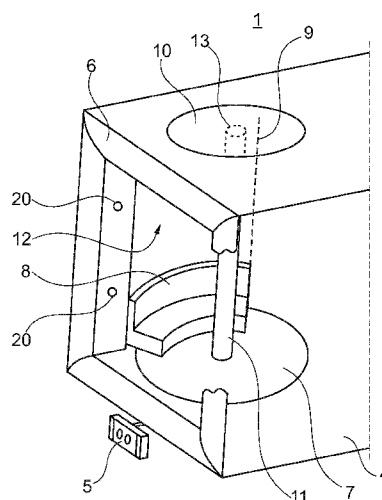


Fig. 4

- (57) Abstract:** A rail vehicle with a device for opening and closing a front end (1, 1A, 1B) of the vehicle is proposed. The device comprises a turning device with a laterally displaceable curved sliding door (9) that closes the front of the rail vehicle (4, 4A, 4B) in a first position and allows frontal access to the rail vehicle (4, 4A, 4B) in a second position, wherein the turning angle essentially amounts to no more than 90°.

DESCRIPTION

Rail vehicle with frontal curved sliding door and method for coupling and decoupling rail vehicles

Technical field

[0001] The invention pertains to the field of rail vehicle technology and concerns a rail vehicle with a curved sliding door for closing a front end of the vehicle.

Prior art

[0002] For economic reasons, it is desirable to adapt the length of rail vehicle trains to the respective passenger volume by shortening or lengthening the train, i.e., by changing the number of operationally coupled vehicles, in order to prevent the train from operating below capacity. In this case, individual rail vehicles are coupled to or decoupled from the train, wherein this is usually carried out in workshops. Since modern rail vehicle trains comprise rail vehicles that are connected in a continuously accessible fashion, this type of adaptation is associated with special requirements because the crossings between the individual rail vehicles need to be reliably disconnected from or connected to one another for the passengers and open crossings needs to be suitably closed.

[0003] EP 0 187 413 B1 discloses a rail vehicle with a device for closing a front end of the vehicle. The device comprises a hinged door with a window, on the inner side of which a control panel is provided. The hinged door can be opened in order to provide a passage to a coupled rail vehicle.

[0004] Sliding doors are known from the field of building services engineering, for example from DE 10 2007 019 214 A1 and JP 2006-348723.

Disadvantages of the prior art

[0005] However, the known solution is not entirely satisfactory because it requires a relatively large space and in the opened state significantly restricts the clear width of the passenger compartment in the region of the opened passage.

Problem definition

[0006] The present invention therefore is based on the objective of proposing a rail vehicle that can be easily and reliably coupled and decoupled and simultaneously makes it possible to reliably produce a connecting passage and to reliably produce a termination without having to transfer the trains into a workshop. Instead, it should be possible to carry out this coupling or decoupling at any location in the railway network, at which such a procedure is deemed necessary operationally and with respect to providing a demand-oriented capacity.

Inventive solution

[0007] This objective is attained with a rail vehicle according to Claim 1. This objective is furthermore attained with a method according to Claim 16 or 18. Other embodiments, modifications and improvements result from the following description and the attached claims.

[0008] According to one embodiment, a rail vehicle with a device for opening and closing a front end of the vehicle is proposed. The device comprises a curved sliding door that is connected to at least one turning device and can be laterally displaced, or is laterally slidable, wherein this curved sliding door closes the rail vehicle on its front end in a first position and allows frontal access to the rail vehicle in a second position, and wherein the turning angle essentially amounts to no more than 90°.

[0009] The design of the frontally arranged door in the form of a curved sliding door represents a simple and robust constructive solution. It allows an increased load bearing capacity, for example, of convex surfaces for door constructions in rail vehicles, particularly an increased stability against the high stresses occurring on a frontal door or a frontal window due to the relative wind. The curved sliding door is used as crossing termination. The turning device can be turned by a maximum turning angle of 90°, for example between the first and second position. This suffices for completely opening or closing the door.

[0010] The proposed solution furthermore makes it possible to reliably and automatically shorten or lengthen rail vehicle trains such as, for example, subway trains during their operational use without requiring personnel at the coupling point. The solution is suitable for use in metro trains or commuter trains with wide and open crossings at any arbitrary location of the interconnected train. This enables the operator to immediately react to a changing passenger volume during the day with a quickly adaptable vehicle configuration. Interconnected trains that are adapted in accordance with the passenger volume prevent the inefficient utilization (empty running) of individual vehicles and therefore lower the energy consumption, the maintenance costs and ultimately the operating costs. Personnel costs are also saved due to the fully automatic coupling and decoupling function.

[0011] Another advantage can be seen in that the curved sliding door can be guided, for example, behind screens or the like or in the first position engage into recesses or behind screens on both sides or on the side of the doorstep. This increases the reliability because the curved sliding door is held on both sides. In addition, a lateral displacement can be reliably prevented with suitable measures such as, for example, blocking of the turning device.

[0012] The curved sliding door can be curved, for example, in the shape of a section of the surface of a circular cylinder. This arrangement is very space-saving. Other shapes are also possible. For example, the curved sliding door can

also be plane or partially curved. It would furthermore be possible that the outer side of the curved sliding door is curved, for example, in the shape of a section of the surface of a circular cylinder while the inner side is plane or only slightly curved. In the context of the present application, the term "curved sliding door" describes a door that essentially is laterally displaced along an arc and, in particular, a circular arc. However, a special shape of the door is not required.

[0013] According to one embodiment, the turning device and a horizontal inner surface of the rail vehicle essentially form one plane. In this way, a continuous floor without steps is formed that on the one hand improves the comfort and on the other hand increases the passenger safety.

[0014] According to one embodiment, the turning device comprises a bottom and/or top turntable or rotary ring that is or are rotatably supported about an axis of rotation and is or are rigidly connected to and guides or guide the curved sliding door. According to one embodiment, the turning device comprises a turntable on the floor side that is rotatably supported about the axis of rotation and a turntable on the ceiling side that is rotatably supported about the axis of rotation, wherein said turntables are rigidly connected to the curved sliding door and axially connected to one another by means of a connecting element.

[0015] The turning device can comprise a turntable in the floor and/or ceiling that guides the curved sliding door. This turntable or these turntables secure and guide the curved sliding door and increase its load bearing capacity. The double guidance by means of turntables on the side of the floor and on the side of the ceiling results in an improved stability. It is also possible to combine the turntable on the floor side with a guide rail on the ceiling side. It is likewise possible to combine a turntable on the ceiling side with a guide rail on the floor side.

[0016] The connecting element can be realized, for example, in the form of a rod or a tube that additionally improves the stability. In addition, the connecting element that is typically arranged coaxial to the turntables can simultaneously

serve as a handrail for passengers. The connecting element can also be realized in the form of a shaft for transmitting a torque if only one of the two turntables or only the connecting element is directly driven.

[0017] According to one embodiment, the turning device is supported in a torsionally elastic fashion, wherein individual rollers or roller segments that are designed for absorbing passenger loads are used for carrying the turntable on the floor side. An advantage of such a support can be seen in the low-maintenance operation of such individual rollers or roller segments, as well as in the uniform load distribution.

[0018] According to one embodiment, the turning device comprises a rail that extends around an axis of rotation along a segment of a circular arc and laterally guides the curved sliding door. The rail can generally be curved and is typically designed in such a way that the curved sliding door is laterally slidable in or on the rail. As mentioned above, individual rollers or roller segments can run in or on the curved rail and simultaneously carry the load of the curved sliding door. The realization of the turning device in the form of a curved rail represents a very space-saving solution.

[0019] According to one embodiment, the axis of rotation of the turning device extends perpendicular to the longitudinal direction of the rail vehicle. An axis of rotation that is centrally arranged in the vehicle centre makes it possible, if applicable, to symmetrically displace the curved sliding door to both sides. A handrail can be realized along the axis of rotation and produce a mechanical connection between the vehicle floor and the vehicle ceiling directly in the centre of the aisle.

[0020] The turntable and the rail are largely installed flush in the floor and/or the ceiling. The top and the bottom turntable can be centrally connected to one another for stabilization purposes. The top and the bottom turntable are connected

to one another independently thereof in their edge regions by means of the curved sliding door.

[0021] According to one embodiment, the device comprises locking elements for locking the curved sliding door in the first (closed) and/or the second (open) position. The locking elements can be directly engaged with and separably lock the curved sliding door. However, it is also possible that the locking elements act upon the turntable or a drive used for moving the curved sliding door. All in all, the locking elements make it possible to produce a rigid yet separable or unlockable connection. In this case, the connecting elements can be connected to one another by means of mechanical and/or electromechanical and/or magnetic and/or electromagnetic adherence or catch devices.

[0022] When the curved sliding door is in the first position, it is laterally sealed in an airtight and/or watertight fashion. This can be realized by means of the locking elements. Sealing elements can be alternatively or additionally utilized.

[0023] According to one embodiment, the device is adapted in such a way that a change between the first position and the second position of the curved sliding door depends on the occupancy status of a vehicle coupling of the rail vehicle, wherein the second position can only be assumed in a completely coupled state.

[0024] According to one embodiment, the device is adapted in such a way that a change between the first position and the second position of the curved sliding door depends on the occupancy status of a vehicle coupling of the rail vehicle, wherein the first position is automatically assumed when a decoupling operation or process is initiated.

[0025] The displacement or slide of the curved sliding door therefore takes place in dependence on the coupling status only. This coupling status defines whether or not it is possible to slide or displace the curved sliding door. For example, the curved sliding door can only be displaced, in particular, into the second position in

order to access the passenger compartment from the front side of the vehicle in a completely coupled state in order to reliably prevent accidents. In a manner of speaking, the sliding or displacement represents the end of the entire coupling operation or process or the beginning of the decoupling operation or process.

[0026] During a decoupling operation or process, in contrast, the curved sliding door is initially slid, or laterally displaced, into the first position in order to close the vehicle end, i.e., in a generally still completely coupled state. Consequently, the curved sliding door can only be displaced from the first position into the second position and vice versa in a completely coupled state.

[0027] According to one embodiment, the device for closing the front end of a vehicle comprises a drive for laterally displacing the curved sliding door, wherein the drive can be arranged, in particular, stationary relative to the rail vehicle outside the turning device. According to one embodiment, the drive comprises a linear drive. According to another embodiment, the drive comprises a rotary drive. According to yet another embodiment, the drive comprises a friction drive. The drive can comprise or consist of an electric and/or manual and/or hydraulic and/or pneumatic drive including any combination. Linear drives preferably act directly upon the curved sliding door, for example, if it is guided in a rail. Rotary drives are preferably used in connection with turntables, wherein these turntables can also be driven by means of linear drives realized, for example, in the form of hydraulic cylinders. In addition to the drives that can be used for an automatic actuation, the curved sliding door can alternatively or additionally also be displaced manually by means of a suitable actuating device.

[0028] According to one embodiment, the drive is arranged on the outer side of the turntable, wherein the turntable comprises a gear rim that is engaged with a driven pinion gear. The gear rim does not have to extend over the entire circumference because only rotations of approximately 90° are typically carried out. The curved sliding door can be precisely moved into both positions with a suitable

transmission ratio. A suitable minimal incrementation of the drive also provides the advantage of a simple and precise control without an additional gear mechanism. In addition, the force to be generated for a position change can be realized comparatively low with a corresponding transmission ratio such that driving motors with less power can also be used. With respect to a manual drive, this reduces the force to be exerted by the operator. A friction drive can also be used instead of the drive with a gear rim.

[0029] According to one embodiment, the device for closing the front end of a vehicle comprises a control unit for controlling the drive and a sensor for detecting persons and/or objects that is connected to the control unit. The control unit only makes it possible to change the curved sliding door between the first position and the second position if no persons and/or objects were detected by the sensor at least in the region of the device. The change of position basically takes place in the empty state of the rail vehicle that needs to be operationally ensured, e.g., during a turnaround of the train.

[0030] A change between the first position and the second position of the curved sliding door is defined by an output signal of the sensor on the front end of the vehicle that makes it possible to reliably distinguish between the presence and/or absence of persons, particularly children and infants, domestic animals and/or farm animals. This measure also promotes the operational safety and the accident prevention and, if applicable, allows an automatic coupling and decoupling of the rail vehicle. It would also be possible to monitor the region of the rotary device with a video monitoring system such that the release for displacing the curved sliding door or generally the release for a coupling or decoupling operation or process can take place manually. In this case, the actual coupling or decoupling operation can take place automatically after the release. Additional monitoring by means of the sensor or sensors then ensures that the coupling operation and, in particular, the sliding, or lateral displacement, of the curved sliding door are automatically interrupted when a person enters the monitored region.

[0031] According to one embodiment, the curved sliding door has an inner side and an outer side, wherein one or more passenger seats and/or a luggage rack and/or a bicycle rack and/or a driver's desk is or are optionally arranged on the inner side of the curved sliding door and can be displaced together with the curved sliding door. This provides the advantage that a rail vehicle, the front end of which is closed by means of the curved sliding door, can be used as front vehicle of a rail vehicle train (interconnected train) if a driver's desk is arranged on the inner side of the curved sliding door.

[0032] According to one embodiment, the curved sliding door is realized with such a stability that the front end of the vehicle can be used as a leading end of the rail vehicle train.

[0033] According to one embodiment, the curved sliding door comprises on its outer side a luminaire and/or a floodlight and/or a reflector that can be utilized when the rail vehicle is used as leading or trailing end of the rail vehicle train.

[0034] According to one embodiment, the front end of the vehicle comprises a pneumatically sprung rubber crossing or a bellows crossing. Crossings of this type seal the passage between coupled rail vehicles relative to the outside and prevent the admission of air, water or contaminants and dirt particles in the coupled state.

[0035] According to one embodiment, a method for coupling rail vehicles that on their facing front ends respectively comprise a device for opening and closing the vehicle ends is proposed. In this case, the rail vehicles are moved relative toward one another with respectively closed vehicle ends until automatic couplings of the rail vehicles produce electrical and mechanical connections between the two rail vehicles. After the rail vehicles have been coupled to one another, a passenger crossing bridge is produced between the coupled rail vehicles and a passage for passengers is ultimately released between the coupled rail vehicles by laterally displacing the respective curved sliding doors into the second position. The rail vehicles are typically moved toward one another with a defined coupling speed.

This may take place automatically, wherein it is relevant if either of the two rail vehicles or both rail vehicles is/are moved.

[0036] According to one embodiment, a sensor ensures that no persons and/or objects are situated in the region of the turning device before the coupling operation is initiated.

[0037] According to one embodiment, a method for decoupling rail vehicles that are coupled to one another and on their facing front ends respectively comprise a device for opening and closing the vehicle ends is made available. In this case, it is initially verified that no persons or objects are situated in the region of the passage between the two coupled rail vehicles, as well as in the region of the respective turning device. If these regions are clear, the front ends of the coupled rail vehicles are closed by laterally displacing the respective curved sliding doors into the first position and the rail vehicles are decoupled.

[0038] The proposed solution can be designed for manual, semiautomatic and automatic operation and is particularly suitable for use in local public transport, for example in the metro systems. In addition, this solution can also be used in other vehicle segments such as people movers, regional trains, light rail vehicles (LRV) and high-speed trains.

[0039] The above-described embodiments can be arbitrarily combined with one another.

Figures

[0040] The attached drawings show embodiments of the invention and serve for elucidating the principles of the invention together with the description. The elements of the drawings are relative to one another and not necessarily true-to-scale. Identical reference symbols accordingly identify similar components.

[0041] Figure 1 shows the front end of a rail vehicle with a closed curved sliding door.

[0042] Figure 2 shows two coupled rail vehicles, wherein one of the rail vehicles comprises a curved sliding door that allows the passage to the adjacent rail vehicle.

[0043] Figure 3 shows a perspective representation of the front end of a rail vehicle with a curved sliding door in the first (closed) position.

[0044] Figure 4 shows a perspective representation of the front end of a rail vehicle with a curved sliding door in the second (open) position.

[0045] Figure 5 shows a rotatably supported turntable on the ceiling side according to one embodiment.

[0046] Figure 6 shows a sectional representation of the support of the turntable on the floor side.

[0047] Figure 7 shows a detail of Figure 6.

Exemplary Embodiments

[0048] Figure 1 schematically shows a view of the front end 1 of a rail vehicle 4 with a railcar body 3, a vehicle coupling 5, a pediment or front end 6 that is realized in the form of a bellows in this case and a rotatably supported turntable 7 on the floor side with integrated equipment 8 in a first, closed position of the curved sliding door 9.

[0049] Figure 2 schematically shows a view of a vehicle crossing 2 between the coupled front ends 1A and 1B of two rail vehicles 4A, 4B. The rotatably supported turntable 7 (rotary platform) is in its second position that allows the passage at the front end from the first vehicle 1A to the second vehicle 1B and vice versa. The

curved sliding door 9 can approximately correspond to the surface area of a half cylinder or a quarter cylinder or lie in between.

[0050] The curved sliding door 9 can cover the clear cross-sectional area of the vehicle crossing with transparent or with non-transparent materials.

[0051] Figure 3 shows the front end 1 of a rail vehicle 4 with a disengaged coupling 5 and a curved sliding door 9 in the first, closed position. In this case, the curved sliding door 9 is completely transparent and equipped with a bench 8 on its inner side. The curved sliding door 9 is connected to a plate or turntable 7 that is rotatably supported on the vehicle floor. The rotatably supported turntable 7 on the floor side is connected to a rotary disk 10 on the vehicle ceiling by means of a rod 11.

[0052] Figure 4 schematically shows a view of a front end 1 of a rail vehicle 4 with a curved sliding door 9 in the second, open position of the curved sliding door 9. The coupled second rail vehicle is not illustrated in this figure in order to provide a better view into the passage between the adjacent rail vehicles 4 that is released in the second position. This is the reason why the coupling 5 appears to be disengaged. The curved sliding door 9 with the equipment 8 arranged on its inner side 12, in this case a bench, releases the passage to the coupled rail vehicle. A rod 11 or a tube connects the turntable 7 on the floor side to a rotary disk 10 on the ceiling of the rail vehicle 3. During a change between the first and the second position of the revolving door 9, the turntable 7 on the floor side and the rotary disk 10 are able to jointly turn about the axis of rotation that perpendicularly extends through the pivot point 13. In this case, the axis of rotation of the connection 11 between the floor plate 7 and the rotary disk 10 can be realized, for example, in the form of a handrail and run through an axis of symmetry extending adjacent to or along the vehicle centre or a plane of symmetry extending vertically.

[0053] Figure 5 shows the arrangement of the turntable 7 in the floor 14 of the rail vehicle. The axis of rotation of the circular turntable 7 extends through the centre

of the turntable 7 in the example shown and is realized as a rigid connection in the form of a handrail 11 in this case. A gap 15 extends between the bottom 14 of the rail vehicle and the turntable 7 on the floor side. This gap 15 can be largely closed with a suitable edge design. A plane of section through the floor plate is identified by the reference symbol AA and illustrated in Figure 6.

[0054] Figure 6 shows a section through the central pivot point of the turntable 7 on the floor side. On its underside, the turntable 7 is equipped with a plurality of support wheels 16. The support wheels 16 or rollers 16 run in a continuous recess 17 of the vehicle floor 14 in this case. During a change in position of the curved sliding door 9 from a first into a second position or vice versa, the plate 7 on the floor side that is connected to the curved sliding door 9 is moved on its outer side by means of a drive 18. The outer side of the plate 7 on the floor side can be at least sectionally realized in the form of a toothed rack moved by the drive 18 that is rigidly connected to the railcar body 3. A pinion gear can be arranged on the axis of the drive 18 for this purpose. The drive can comprise or consist of an electric motor or be manually operated by means of a (not-shown) rod assembly.

[0055] Figure 7 shows a detail of an embodiment of the connecting point between the vehicle floor 14 and the turntable 7 with load-absorbing support wheels 16 on the floor side. The support wheels 16 are mounted on the underside of the turntable 7 on the floor side and run in a recess 17 in the floor 14 of the rail vehicle. This recess 17 can also be realized in the form of a curved rail.

[0056] The proposed solution is based on the principle of closing the front end of the rail vehicle without a fixed driver's station by means of a rotatable device. This rotatable device functions similar to a ball valve in pipelines. In the open position, conventional passenger traffic between two vehicles is possible while the vehicle end is sealed in a completely tight fashion in the closed position.

[0057] In addition, equipment objects (e.g., a front wall and passenger seats or a driver's desk) can be moved on the rotatable turntable 7 in such a way that the

crossing either allows the free passage between two coupled vehicles or the vehicle end is reliably closed and provides additional seats or space for bicycles.

[0058] In normal instances, the rail vehicles 4, 4A, 4B are operated conventionally, i.e., the railcar bodies 3 are securely connected by means of the coupling 5 and the passengers can change between the rail vehicles as required via the coupled crossing 2. In this case, the turntable 7 is in the idle position and the seats shown are arranged laterally as indicated in Figure 1.

[0059] If so required, the rail vehicles 4, 4A, 4B can be decoupled and the open vehicle end can be closed by means of the curved sliding door 9 connected to the turntable 7.

[0060] In order to couple two rail vehicles to one another, they are moved together with a defined coupling speed such that the automatic coupling 5 produces a mechanical and electrical connection. Once this coupling operation is completed, the crossing bellows 6 is also automatically connected. In the case of bellows crossings, the two halves are mechanically interlocked. In the variation with pneumatically sprung rubber crossings, the connection is produced exclusively due to the contact pressure between the two halves exerted by the coupling 5. During this process, a crossing bridge is also automatically produced. In the last step, the turntable 7 in both vehicle ends turns by 90° and releases the passage for the passengers. This step completes the coupling operation. The entire operation takes place automatically without the presence of personnel. The end region of the vehicle needs to be clear of passengers during the coupling operation. A corresponding sensor arrangement 20 ensures that the individual processes take place in sequence and that a reliably locked state is achieved.

[0061] In order to initiate a decoupling operation, it is initially verified that the region of the turning device is clear of persons and movable objects. After verifying the absence of passengers, the turntables 7 in both vehicle ends are turned by 90° such that the respective vehicle ends are completely closed. Subsequently, the

halves of the pneumatically sprung rubber crossing or the crossing bellows 6 are unlocked and, if applicable, crossing bridges are retracted and the mechanical and electrical coupling 5 is automatically decoupled. The two rail vehicles can then move apart from one another. This decoupling operation can take place in a completely automated fashion without the presence or intervention of personnel. However, a manual intervention is possible, for example, in order to react to malfunctions or emergencies.

[0062] According to another embodiment, the sensor 20 can be realized in the form of a proximity sensor or motion sensor that operates, for example, on the basis of ultrasound or infrared radiation. It would also be possible to utilize inductive or capacitive, electronic, optical or mechanical sensors 20. The sensor 20 has the function of reliably detecting the presence and/or absence of persons and movable objects in the front region of the rail vehicle 4 and of preventing the initiation of a coupling or decoupling operation as long as persons and/or objects are situated on the front end 1, 1A, 1B.

[0063] In a preferred embodiment, the turning device either comprise or consist of a combination of a turntable on the floor side and a rotary disk on the ceiling side or of an annular segment such as, for example, a rail that is largely installed flush in the floor and in the ceiling. The upper and the lower turntable/rotary disk are connected to one another by the curved sliding door. In order to achieve an additional stabilization, they can be centrally connected to one another, e.g., by means of a central tube that can simultaneously function as a handrail.

[0064] The curved sliding door that forms the crossing termination is either realized transparently (e.g. of safety glass or polycarbonate) or of non-transparent solid material (e.g. in the form of a sandwich element) or in the form of a combination thereof. In addition, the curved sliding door can be realized in an airtight and/or watertight fashion on its lateral ends, for example, by means of suitable seals. The entire crossing termination, i.e., the curved sliding door

including its anchoring, has such a stability that it is able to withstand the relative wind stresses as a leading train vehicle according to valid standards and is designed in accordance with valid standards with respect to the admission of foreign matter. When utilizing transparent material, a windshield wiper can be additionally arranged on the curved sliding door. In both instances, marker lights can be installed on the partition wall.

[0065] The turntable/rotary disk or ring segment is turned by a drive. A purely mechanical drive with manual actuation would optionally also be possible. The drive can be realized in a purely mechanical fashion, but also electrically or hydraulically or pneumatically. The drive can be arranged centrally, e.g., in the form of a geared motor drive, but also laterally above the bottom or top disk with the aid of linearly acting drives (e.g. hydraulic cylinders). The drive locks in the end positions such that no motion can occur while the rail vehicle is in motion. Another drive option comprises or consists of the utilization of a gear rim with a pinion gear.

[0066] In the variation with a bellows crossing, a device recessed into the end of the bellows automatically locks and unlocks the two crossing halves with the aid of an electric, pneumatic or hydraulic drive. This lock prevents the two crossing halves from shifting relative to one another, e.g., while the rail vehicle travels through curves.

[0067] The design of the door arranged on the front end of the rail vehicle in the form of a curved sliding door 9 represents a simple and robust technical implementation of such a door without having to rely on an otherwise obligatory hinge for a hinged door leaf. A hinged door leaf that is abruptly opened under impact pressure can represent a danger for persons standing behind the door, but a curved sliding door is largely supported symmetrically under impact pressure and practically cannot be opened due to impact pressure. With respect to the construction of rail vehicles, the design of the door in the form of a curved sliding door makes it possible to realize a load bearing capacity of the door leaf from the

convex side that is increased in comparison with plane surfaces, particularly against the high stresses that occur on the front of the vehicle due to the relative wind.

[0068] The above-described embodiments can be arbitrarily combined with one another.

[0069] Although specific embodiments are illustrated and described in this application, the scope of the present invention also includes suitable modifications of the described embodiments without deviating from the scope of validity of the present invention. The following claims represent a first, nonbinding attempt to generally define the invention.

LIST OF REFERENCE SYMBOLS

1, 1A, 1B	Front end of rail vehicle
2	Vehicle crossing between two coupled rail vehicles
3	Railcar body of rail vehicle
4, 4A, 4B	Rail vehicle
5	Coupling
6	Pediment: bellows or pneumatically sprung crossing
7	Turntable on floor side
8	Equipment
9	Curved sliding door
10	Rotary disk on ceiling side
11	Connection between plate on floor side and rotary disk
12	Inner side of curved sliding door
13	Pivot point of turntable
14	Floor of rail vehicle
15	Floor gap
16	Support roller/support wheel
17	Recess
18	Drive
20	Sensor and/or motion sensor

CLAIMS

1. A rail vehicle with a device for opening and closing a front end (1, 1A, 1B) of the vehicle, characterized in that the device comprises a curved sliding door (9) that is connected to at least one turning device and can be laterally displaced, wherein the curved sliding door closes the front of the rail vehicle (4, 4A, 4B) in a first position and allows frontal access to the rail vehicle (4, 4A, 4B) in a second position, and wherein the turning angle essentially amounts to no more than 90°.
2. The rail vehicle according to Claim 1, characterized in that the turning device and a horizontal inner surface of the rail vehicle essentially form one plane.
3. The rail vehicle according to Claim 1 or 2, characterized in that the turning device comprises a turntable (7) and/or a rotary ring on the floor side and/or the ceiling side that is or are rotatably supported about an axis of rotation and rigidly connected to the curved sliding door (9).
4. The rail vehicle according to Claim 3, characterized in that the turning device comprises a turntable (7) on the floor side that is rotatably supported about the axis of rotation and a turntable (7) on the ceiling side that is rotatably supported about the axis of rotation, wherein said turntables (7) are rigidly connected to the curved sliding door (9) and axially connected to one another by means of a connecting element (11).

5. The rail vehicle according to Claim 3 or 4, characterized in that the turning device is supported in a torsionally elastic fashion, wherein individual rollers (16) or roller segments (16) that are designed for absorbing passenger loads are used for supporting the turntable (7) on the floor side.
6. The rail vehicle according to Claim 1 or 2, characterized in that the turning device comprises a rail that extends around an axis of rotation along a segment of a circular arc and laterally guides the curved sliding door (9).
7. The rail vehicle according to one of Claims 1 to 6, characterized in that the axis of rotation of the turning device extends perpendicular to the longitudinal direction of the rail vehicle (4, 4A, 4B).
8. The rail vehicle according to one of Claims 1 to 7, characterized in that the device for opening and closing the front end comprises locking elements for locking the curved sliding door in the first and/or the second position.
9. The rail vehicle according to one of Claims 1 to 8, characterized in that the device for opening and closing the front end is adapted in such a way that a change between the first position and the second position of the curved sliding door (9) depends on the occupancy status of a vehicle coupling (5) of the rail vehicle (4, 4A, 4B), wherein the second position can only be assumed in a completely coupled state.

10. The rail vehicle according to one of Claims 1 to 8, characterized in that the device for opening and closing the front end is adapted in such a way that a change between the first position and the second position of the curved sliding door (9) depends on the occupancy status of a vehicle coupling (5) of the rail vehicle (4, 4A, 4B), wherein the first position is automatically assumed when a decoupling operation is initiated
11. The rail vehicle according to one of Claims 1 to 10, characterized in that the device for opening and closing the front end comprises a drive (18) for laterally displacing the curved sliding door (9), wherein the drive is arranged stationary relative to the rail vehicle and, in particular, outside the turning device.
12. The rail vehicle according to Claim 11, characterized in that the drive (18) comprises a linear drive, a rotary drive or a friction drive.
13. The rail vehicle according to Claim 11 or 12, characterized in that the device comprises a control unit for controlling the drive (18) and a sensor (20) that is connected to the control unit and serves for detecting persons and/or objects, wherein the control unit only allows a change between the first position and the second position of the curved sliding door (9) if no persons and/or objects were detected by the sensor (20) at least in the region of the device.

14. The rail vehicle according to one of Claims 1 to 13, characterized in that the curved sliding door (9) has an inner side (12) and an outer side, and in that at least one decorative inner surface and/or at least one passenger seat and/or at least one luggage rack and/or at least one bicycle rack and/or a driver's desk is or are arranged on the inner side (12) and can be displaced together with the curved sliding door (9).
15. The rail vehicle according to one of Claims 1 to 14, characterized in that the curved sliding door is realized with such a stability that the front end of the vehicle can be used as leading or trailing end of a train.
16. A method for coupling rail vehicles that on their facing front ends respectively comprise a device for opening and closing the vehicle ends according to one of Claims 1 to 15, characterized in that
 - the rail vehicles are moved relative toward one another with respectively closed vehicle ends until automatic couplings of the rail vehicles produce electrical and mechanical connections between the two rail vehicles;
 - after the rail vehicles have been coupled to one another, a passenger crossing bridge is produced between the coupled rail vehicles; and
 - a passage for passengers is ultimately released between the coupled rail vehicles by laterally displacing the respective curved sliding doors into the second position.

17. The method according to Claim 16, characterized in that a sensor verifies that no persons and/or objects are situated at least in the region of the turning device before a coupling operation is initiated.
18. A method for decoupling coupled rail vehicles that on their facing front ends respectively comprise a device for opening and closing the vehicle ends according to one of Claims 1 to 15, characterized in that
 - it is initially verified that no persons or objects are situated in the region of the passage between the two coupled rail vehicles, as well as at least in the region of the respective turning device;
 - the front ends of the coupled rail vehicles are closed by laterally displacing the respective curved sliding doors into the first position; and
 - the rail vehicles are subsequently decoupled.

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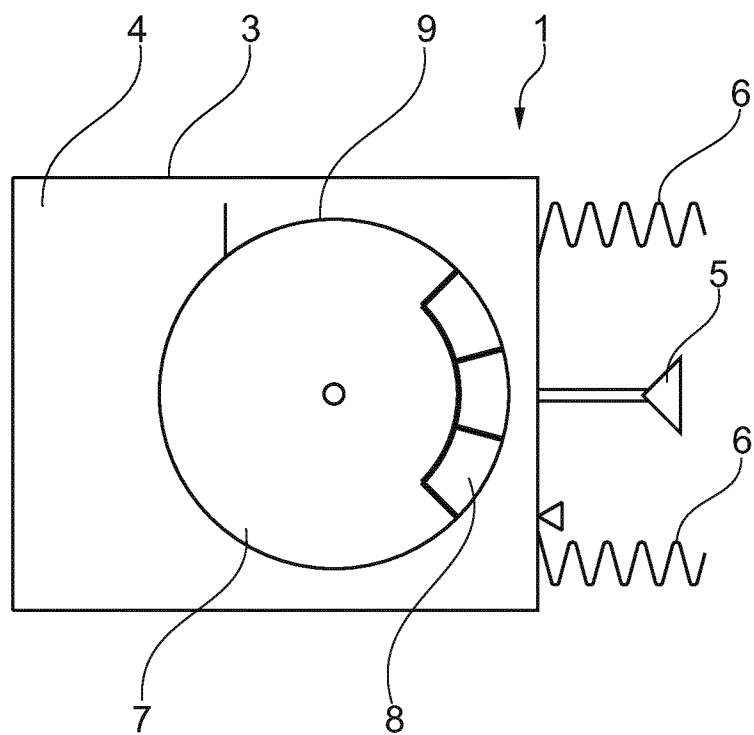


Fig. 1

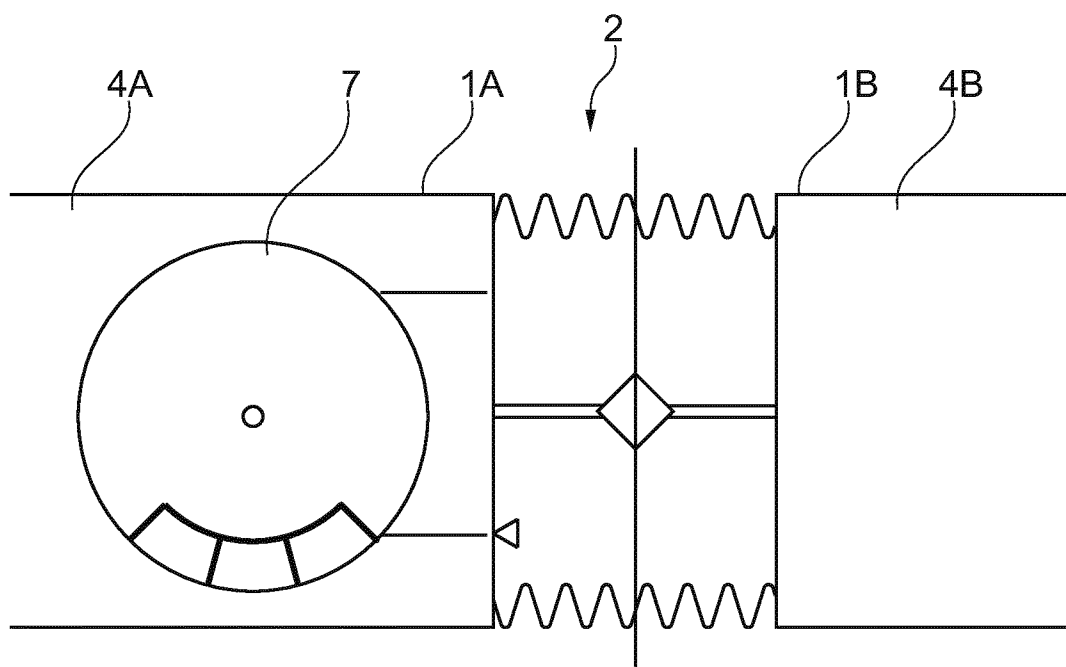


Fig. 2

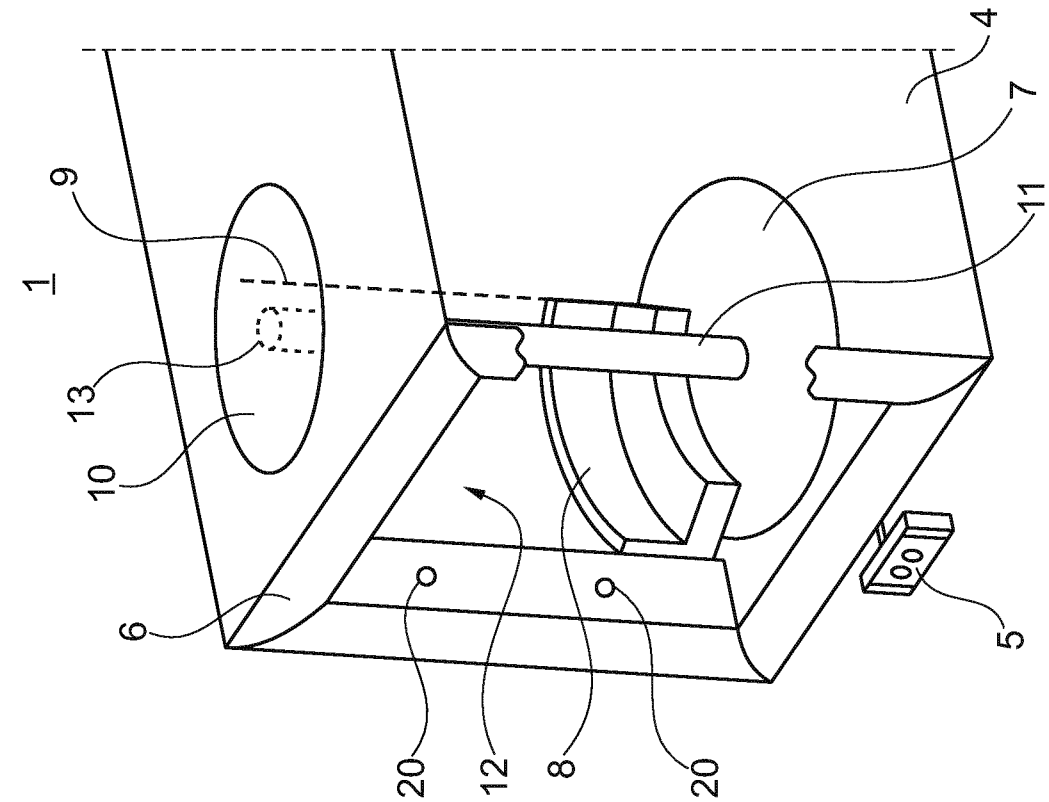


Fig. 3

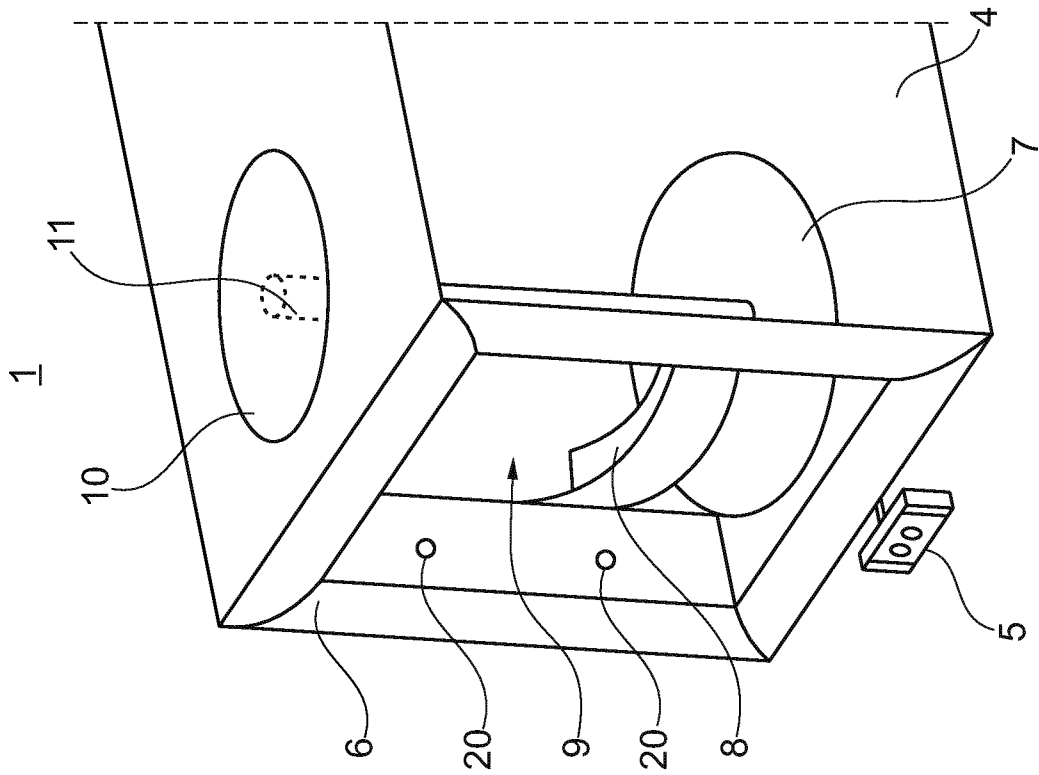


Fig. 4

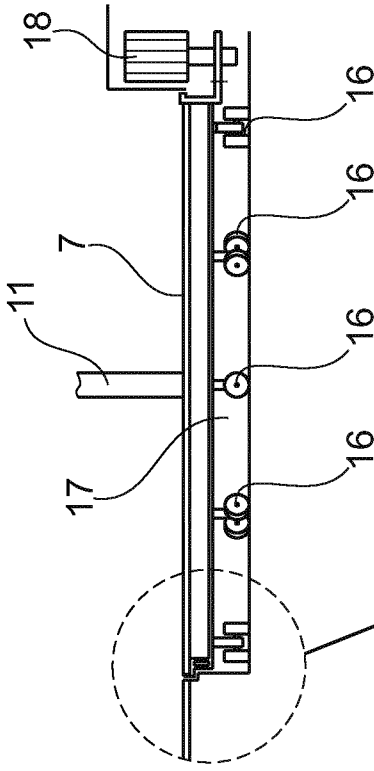


Fig. 6

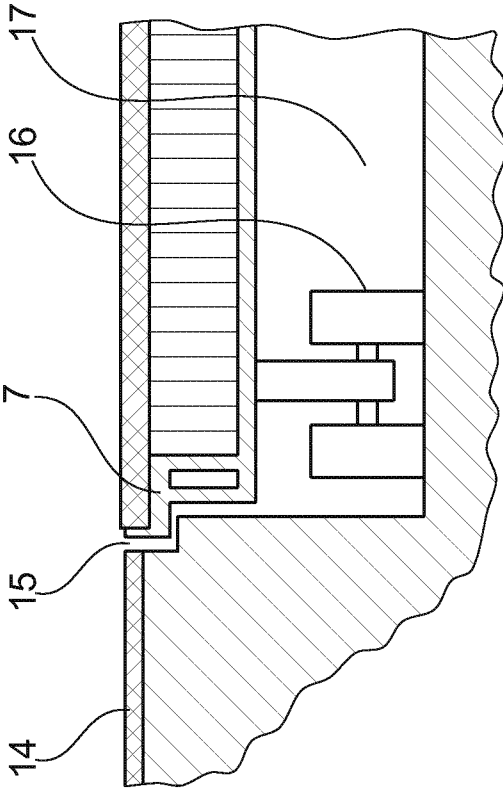


Fig. 7

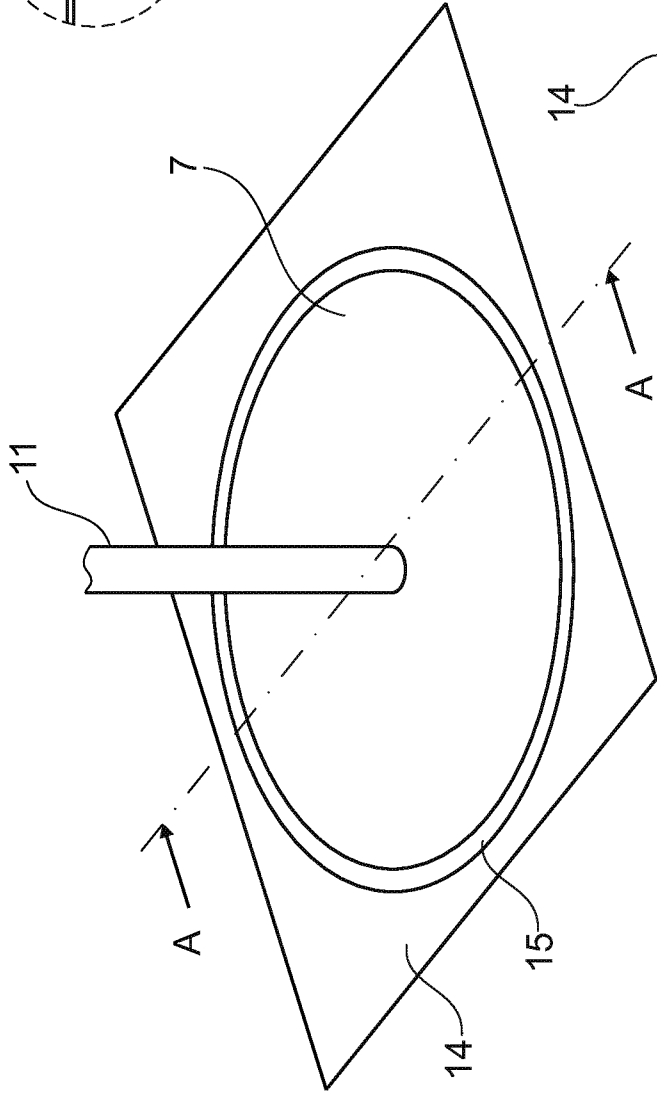


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/067343

A. CLASSIFICATION OF SUBJECT MATTER

INV. B61D17/20 B61D19/02 B61G7/14
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)

B61D B61G

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, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 187 413 B1 (DANSKE STATSBAER [DK]) 16 August 1989 (1989-08-16) cited in the application the whole document	1-3,7-18
X	DE 12 20 463 B (KLOECKNER HUMBOLDT DEUTZ AG) 7 July 1966 (1966-07-07) the whole document	1,2, 6-12,15, 16,18
A	EP 1 700 763 A2 (SICK AG [DE]) 13 September 2006 (2006-09-13) the whole document	1-18
A	US 2005/132652 A1 (TONG HAIBO [US] ET AL) 23 June 2005 (2005-06-23) the whole document	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

18 November 2013

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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