

SPECIFICATION

EMERGENCY EXIT DOORS FOR RAIL VEHICLES

5 This invention relates to doors for use as emergency exits in public service rail vehicles. The problem in providing a door for use as an emergency exit in such vehicles are that the height of the vehicle floor above the ground is substantial, and in some locations the access and exit clearance is very restricted, for example in narrow cuttings or tunnels. Furthermore, the door must meet the requirements and specifications for safety both in normal use and in emergency conditions such as fire or crash. These requirements include the facility for persons, on use of the door, to reach the ground without difficulty and without waiting for outside assistance, and for the door to provide a rapid rate of exit without risk.

20 It is an object of this invention to provide a door which overcomes the foregoing problems and which has an improved construction.

25 According to the present invention, we provide a rail vehicle sliding plug door mounted for sliding movement in normal use of the door by means of a guide system from which the door can be released in an emergency to allow the door to pivot outwardly of the vehicle body to provide an exit ramp, the door comprising an outer panel which is hingedly mounted adjacent a lower transverse edge of the panel, and an inner panel which overlies the outer panel and is hinged thereto adjacent an upper transverse edge of the outer panel, the arrangement being such that for emergency use of the door the outer panel can be pivoted outwardly of the vehicle body generally about its lower transverse edge and the inner panel can be pivoted away from the outer panel to extend contiguous therewith, the outer panel providing a first ramp part connected and leading to a second ramp part provided by the inner panel.

35 As will be appreciated, in use of the door the inner panel initially overlies the outer panel as pivots outwardly. At a suitable position of deployment, the inner panel is adapted for its pivotal or unfolding movement relative to the outer panel.

40 Preferably, the door includes means for controlling the rate of deployment of the outer panel. This means may comprise a rotary brake on which a flexible strap is wound with the end of the strap being connected to the outer panel so that the flexible strap is unwound at a controlled rate as the outer panel and the inner panels are deployed. The rotary brake may be a hydraulic dashpot secured to a fixed structure of the vehicle adjacent to the door. The control of the rate of deployment ensures that there are no sudden loads or high stresses in the various hinge parts during deployment.

60 Another preferred feature of this invention comprises a handrail system which is erected on

65 the unfolding movement of the inner panel relative to the outer panel. The handrail system includes a rail for each side of the ramp. The opposed ends of each rail are pivotally connected to primary and secondary stanchions respectively with the primary stanchion being pivotally connected to the outer panel and the secondary stanchion being pivotally connected to the inner panel. The arrangement of the handrail system is such that before the inner panel is unfolded relative to the outer panel, on each side of the door, the rail and primary and secondary stanchions are folded to lie alongside the inner panel overlying the adjacent edge of the outer panel. As the inner panel is unfolded, a force is applied to each primary stanchion to cause it to pivot upwardly, and such movement of the primary stanchion is translated through the pivotal connections to the associated rail and secondary stanchion to cause the secondary stanchion to move upwardly raising the rail. The force applied to each primary stanchion is through a respective connection to a main support extending between the fixed structure of the vehicle and the outer panel. The inner panel may include stop means which prevents erection of the handrail system until the inner panel is unfolded relative to the outer panel.

90 The main support may comprise a pair of flexible straps each having a fixed length for controlling the extent of maximum deployment of the outer panel and thus the inclination of the first ramp part and the contiguous second ramp part in use.

95 The hinge connection of the outer and inner panels may include means to control the rate of unfolding movement of the inner panel relative to the outer panel and/or to prevent the development of high loads or stresses during the unfolding movement.

100 It is an important aspect of this invention that the weight of the outer and inner panels is used, in part, to develop the forces required to complete deployment. However, in view of the high loads which could be developed careful control of the deployment during the descent and unfolding of the panels is essential.

105 The vehicle door being in the form of a sliding plug door, the outer panel is adapted to be displaced outwardly from the structure, by any suitable means, for sliding movement by means of the guide system.

115 The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings wherein:

120 *Figure 1* is a vertical section through a sliding plug door according to the invention;

Figure 2 is an elevation of the door shown in *Figure 1* viewed from the inside of the vehicle;

Figure 3 is a side elevation of the door shown in *Figures 1* and *2*;

Figure 4 is a side elevation of the door in an intermediate operational position; and

Figure 5 is a side elevation showing the door in the final operational position.

The door shown in the accompanying drawings comprises an outer panel 1 and an inner panel 2 hingedly connected at 3 along their adjacent upper transverse edges. The door has a shape and configuration to fit into an aperture in a rail vehicle body with the outer panel 1 engaging a flexible seal 4 extending around the edge of the aperture when the door is closed.

The door is of the sliding plug type and is mounted for sideways sliding movement relative to the vehicle body between the closed position and an open position by means of upper and lower roller guide assemblies 5 and 6 engaging upper and lower track members 7 and 8 respectively.

The door is also operable as an emergency exit in accordance with the present invention. Thus the upper roller guide assembly is releasable from the upper track member 7 allowing the door to pivot outwards away from the door frame under the control of primary control means 9 and the inner panel 2 to be unfolded relative to the outer panel 1 under the control of secondary control means 10 to provide an exit ramp with the outer and inner panel contiguous. The door also includes a handrail system 11 which is erected during the unfolding movement of the inner panel.

The upper roller assembly 5 comprises a roller 12 rotatably mounted at one end of an arm 13, the other end of which is pivotally connected to the inner face of the outer panel. A strut 14 acts between the arm 13 and a crash pull handle 15 to retain the arm 13 in a position in which the roller 12 engages the inverted channel-section member 7. The handle 15 is manually operable through the strut 14 to lower the arm 13 to release the roller 12 from the member 7 and allow operation of the door as an emergency exit.

The lower roller guide assembly 6 comprises a set of rollers 16 rotatably mounted on a carrier 17 and engaging the I-section track member 8. A base plate 18 fixed to the lower transverse edge of the outer panel 1 is hingedly connected at 19 to the carrier 17 to allow the door to pivot outwards away from the vehicle body after the upper roller guide assembly 5 has been released from the track member 7.

A respective striker plate 20 is mounted on each side of the inner face of the outer panel and is engaged by a respective one of a pair of fasteners 21 (one only shown in Figure 1) to hold the door in the closed position. One fastener 21 is integral with a manually operable release handle 22 which is mounted on an adjacent part of the vehicle body, for example a side pillar, by means of a mounting plate 23. Rotation of handle 22 operates fastener 21 and simultaneously operates the other fastener 21 through a Bowden cable 24. The other fastener 21 is also operable independently of the fastener 21 integral with handle 22 by means of a manually operable release handle (not shown) mounted on an adjacent part of the vehicle body, for example a side pillar, by means of a mounting plate. Thus in the event of the Bowden cable 24 breaking both fasteners 21 are operable independently to open the door. The door locking mechanism is enclosed

within respective panels 25 (one only shown in Figure 1) secured to the vehicle body on each side of the door and the release handles are operable through a respective opening 26 in each panel. A knob 27 mounted on the outside of the vehicle body below the lower track member 8 is connected to the handle 22 by a Bowden cable 28 so that the handle 22 can be actuated to operate the fasteners 21 to open the door. The door can therefore be opened for its normal use as a sliding plug door from inside or outside the vehicle body.

The inner and outer panels are held together by a retainer 29. The retainer 29 is rotatably mounted on the inner panel 2 and has a stem portion (not shown) extending through the inner panel terminating in a head portion (not shown) which locates in an opening (not shown) in the outer panel. One end of a cable 30 is connected to the retainer 29 and the other end is connected to the handle 15 by a pin 31 so that on pulling the handle 15 to release the roller guide assembly 5 from the track member 7 the retainer 29 is simultaneously rotated and the head portion is spring urged out of the opening in the outer panel to allow the inner panel to be unfolded relative to the outer panel. The pin 31 is removable to release the end of the cable 30 from the handle 15 so that operation of the handle does not release the retainer 29.

The handrail system 11 comprises a respective primary stanchion 32 attached to each side of the outer panel by a pivot 33 and a respective secondary stanchion 34 attached to each side of the inner panel by a pivot 35 with a respective rail 36 extending between the respective primary and secondary stanchions and pivotally attached thereto at each end.

A respective flexible support strap 37 extends between each side of the outer panel and an element 38 fixed to a header rail 39 extending across the aperture in the vehicle body. Each strap 37 has a respective short connector strap 37a connected to the primary stanchion on that side of the outer panel. One of the straps 37 has a loop engaging a hook 40 secured to the adjacent rail 36.

In the folded position of the door, i.e. with the inner panel overlying and secured to the outer panel, the primary and secondary stanchions 32 and 34 and the associated rail 36 on each side of the door extend along the opposed side edges of the inner panel and are held down against the outer panel 1 by respective pads 41 secured to the inner panel 2 and engaging the associated rail 36. The pads 41 prevent the handrail system 11 being erected before the inner panel 2 is unfolded relative to the outer panel.

The straps 37 control the angle of inclination of the outer panel and hence the ramp in use. In the folded position of the door a respective portion of each strap 37 is held between the primary stanchion 32 and rail 36 on that side of the door so that when the outer panel 1 pivots about the hinge connection 19 and the door falls down under the control of the primary control means 9 the outer panel 1 falls to a position in which it extends in a generally horizontal direction. Simultaneously the

engagement of the loop with the hook 40 causes the inner panel 2 to pivot about the hinge connection 3 and the free transverse edge of the inner panel is raised to a position where the operator can easily grip the inner panel 2 to unfold the inner panel 2 relative to the outer panel 1. During unfolding movement of the inner panel the portion of each strap which was previously held is released allowing the outer panel to pivot to its final inclined position and simultaneously the connector straps 37a cause the handrail system to be erected.

The primary control means 9 comprises a rotary dashpot brake 42 on which a flexible strap 43 is wound. The brake 42 is secured to the header rail 39 adjacent to one of the elements 38. The strap 43 passes through guide loops 37b on the adjacent support strap 37 and the free end is secured to the outer panel adjacent to the hinge connection 3.

The secondary control means 10 comprises a progressive damper 44, a strut 45 and a flexible strap 46. One end of the damper 44 is pivotally connected to the outer panel 1 and the other end is connected to one end of the strut 45. The other end of the strut 45 is pivotally mounted co-axially with the hinge connection 3. The strap 46 is connected to the inner panel 2 and the strut 45 so that when the inner panel is unfolded the load of the inner panel is transmitted through the strap 46 to cause the strut 45 to lift under the damped and braked control of the damper 44.

In the folded position of the door the secondary control means 10 is folded down and lies alongside the end of the adjacent rail 36.

The vehicle motive power supply circuit includes a microswitch 47 mounted on the vehicle body adjacent to the door. The microswitch 47 is held closed while the door is closed but if the door is inadvertently opened either for normal sliding movement or for use as an emergency exit the microswitch opens cutting off the power to the vehicle traction equipment and applying the braking system to stop the vehicle. Additionally a warning light or siren may be actuated in the driver's cab to tell the driver that the door has been opened.

Operation of the door as a sliding plug door is as follows, starting from the position shown in Figure 1, the handle 22 is pulled to release the fasteners 21. The track members 7 and 8 have arcuate end portions so that the door is displaced slightly outwards relative to the vehicle body by the roller guide assemblies 5,6 engaging these arcuate end portions whereupon the door is slid sideways to the open position. On closing the door these arcuate end portions ensure the door moves inwards towards the vehicle body in the closed position to obtain an effective seal between the outer panel 1 and the seal 4. To facilitate opening/closing movement of the door a pair of handles 48 is mounted on the inner panel. When the door is used as an emergency exit the handles 48 are on the reverse or underside of the ramp and do not present a hazard to people using the ramp.

Operation of the door as an emergency exit is as

follows, starting from the position shown in Figure 1 the handle 22 is operated to release the fasteners 21. The handle 15 is then pulled to release the upper roller guide assembly 5 from the track member 7 and simultaneously release the retainer 29. The door is then pushed outwards relative to the vehicle body until it passes over centre whereupon it falls down under the control of the dashpot brake 42 to the intermediate position in which the outer panel is horizontal.

Simultaneously the inner panel is raised slightly by the engagement of the hook 40 on the rail 36 with the loop on the support strap 37. The loop is released from the hook 40 and the inner panel 2 is raised until it also passes over centre and falls down under the control of the damper 44. As shown in Figure 4 as the inner panel is raised the primary stanchions 32 remain alongside the adjacent edges of the outer panel 1 and the secondary stanchions 34 and rails 36 remain alongside the adjacent edges of the inner panel 2. When the inner panel falls down under the control of the damper 44 the trapped length of each support strap 37 is released allowing the outer panel 1 to fall to its final position and the connector straps 37a raise the primary stanchions 32 which in turn raise the associated secondary stanchions 34 and rails 36. In the fully assembled position shown in Figure 5 the outer and inner panels extend contiguously to form the exit ramp with a handrail assembly on each side.

The above described door is particularly suited for use in underground rail vehicles which travel mostly in tunnels. In the event of an accident in a tunnel the passengers cannot leave the vehicle quickly through the normal side doors or may even be prevented from leaving the doors jamming or by the closeness of the tunnel walls. Thus the door according to the invention may be located at either end of such vehicles so that in the event of an accident the door can be opened to provide an exit ramp down which the passengers can quickly and safely walk with the handrail system 11 and the support straps 37 preventing any likelihood of a passenger falling from the side of the ramp. A further advantage of providing the door at the ends of the vehicle is that the height from the hinge connection 19 to the rails will be substantially constant and therefore the length of the support straps 37 can be selected so that in use the free transverse edge of the inner panel 2 engages the rails or the ground between the rails.

A second dashpot brake 42 could be provided with the free end of the associated strap 43 connected to the other side of the outer panel.

Furthermore the dashpot brake 42 and strap 43 may be replaced by any other suitable control means for regulating the rate of descent of the outer panel. Likewise the damper 44 may be replaced by any other suitable means, for example a rotary dashpot pivotally connected to the outer panel 1 and coupled to a linear damper of the recirculating ball lead screw type which is connected to the strut 45.

In yet another modification a torsion bar system

may be located adjacent the hinge connection 3 with the torsion bar being pre-loaded in the folded condition so that by releasing the torsion bar system, for example by a latch, the inner panel is pushed away from the outer panel and deployment is automatic.

Furthermore the handrail system may comprise one handrail assembly of primary and secondary stanchions with interconnecting rail on one side of the outer panel 1 only. Additionally one support strap 37 only may be provided.

Finally the faces of the inner and outer panels which form the tread face of the ramp may have a special surface, for example a grip or anti-slip covering.

CLAIMS

1. A rail vehicle sliding plug door mounted for sliding movements in normal use of the door by means of a guide system from which the door can be released in an emergency to allow the door to pivot outwardly of the vehicle body to provide an exit ramp, the door comprising an outer panel which is hinged adjacent a lower transverse edge of the panel, and an inner panel which overlies the outer panel and is hinged thereto adjacent an upper transverse edge of the outer panel, the arrangement being such that for emergency use of the door the outer panel can be pivoted outwardly of the vehicle body generally about its lower transverse edge and the inner panel can be pivoted away from the outer panel to extend contiguous therewith, the outer panel providing a first ramp part connected and leading to a second ramp part provided by the inner panel.

2. A vehicle door according to claim 1 including primary control means for controlling the rate of deployment of the outer panel.

3. A vehicle door according to claim 2 wherein the primary control means comprises a rotary brake adapted to be secured to the vehicle body and a flexible strap wound on the brake with the free end of the strap connected to the outer panel.

4. A vehicle door according to claim 3 wherein the rotary brake comprises a hydraulic dashpot.

5. A vehicle door according to any one of the preceding claims including secondary control means for controlling the rate of deployment of the inner panel.

6. A vehicle door according to claim 5 wherein the secondary control means comprises brake means connected to the outer panel and to a strut mounted co-axially with the hinge connection between the inner and outer panels with a flexible strap extending between the inner panel and the strut.

7. A vehicle door according to claim 6 wherein the brake means comprises a progressive damper.

8. A vehicle door according to any one of the preceding claims including a handrail system arranged and adapted to be erected during deployment of the outer and inner panels.

9. A vehicle door according to claim 8 wherein the inner panel includes stop means in engagement with the handrail system to prevent erection of the handrail system before the inner panel is unfolded relative to the outer panel.

10. A vehicle door according to claim 8 or claim 9 wherein the handrail system includes an assembly comprising a primary stanchion pivotally connected to the outer panel, a secondary stanchion pivotally connected to the inner panel and a rail, the opposed ends of which are pivotally connected to the primary and secondary stanchions respectively, the handrail system lying alongside one edge of the inner panel overlying the adjacent edge of the outer panel.

11. A vehicle door according to any one of the preceding claims including a main support strap one end of which is connected to the outer panel and the other end of which is adapted to be connected to the vehicle body.

12. A vehicle door according to claim 11 in combination with claim 10 wherein the main support strap has a connector strap connected to the primary stanchion to erect the handrail system during unfolding movement of the inner panel relative to the outer panel.

13. A vehicle door according to claim 12 wherein a portion of the main support strap is held between the primary stanchion and the rail to limit initial outward pivotal movement of the outer panel in use.

14. A vehicle door according to claim 13 wherein the main support strap has a loop connected to a hook on the rail to raise the inner panel relative to the outer panel during initial outward pivotal movement of the outer panel.

15. A vehicle door according to any one of claims 12, 13 or 14 wherein the handrail system comprises a pair of said assemblies, each assembly lying alongside a respective one of the opposed edges of the inner panel overlying the adjacent edge of the outer panel and each primary stanchion is connected to a respective one of a pair of main support straps by an associated connector strap.

16. A vehicle door according to any one of the preceding claims having upper and lower roller guide assemblies adapted in use to engage upper and lower track members respectively on the vehicle body, release means being operable to disengage the upper roller guide assembly from the upper track member.

17. A vehicle door according to claim 16 wherein the upper roller guide assembly comprises a roller mounted at one end of an arm the other end of which is pivotally connected to the outer panel and the release means comprises a handle operable through a strut to lower the arm.

18. A vehicle door according to either of claims 16 and 17 including a retainer securing the inner and outer panels together, the retainer being operatively connected to the release means



may be located adjacent the hinge connection 3 with the torsion bar being pre-loaded in the folded condition so that by releasing the torsion bar system, for example by a latch, the inner panel is pushed away from the outer panel and deployment is automatic.

Furthermore the handrail system may comprise one handrail assembly of primary and secondary stanchions with interconnecting rail on one side of the outer panel 1 only. Additionally one support strap 37 only may be provided.

Finally the faces of the inner and outer panels which form the tread face of the ramp may have a special surface, for example a grip or anti-slip covering.

CLAIMS

1. A rail vehicle sliding plug door mounted for sliding movements in normal use of the door by means of a guide system from which the door can be released in an emergency to allow the door to pivot outwardly of the vehicle body to provide an exit ramp, the door comprising an outer panel which is hingedly mounted adjacent a lower transverse edge of the panel, and an inner panel which overlies the outer panel and is hinged thereto adjacent an upper transverse edge of the outer panel, the arrangement being such that for emergency use of the door the outer panel can be pivoted outwardly of the vehicle body generally about its lower transverse edge and the inner panel can be pivoted away from the outer panel to extend contiguous therewith, the outer panel providing a first ramp part connected and leading to a second ramp part provided by the inner panel.

2. A vehicle door according to claim 1 including primary control means for controlling the rate of deployment of the outer panel.

3. A vehicle door according to claim 2 wherein the primary control means comprises a rotary brake adapted to be secured to the vehicle body and a flexible strap wound on the brake with the free end of the strap connected to the outer panel.

4. A vehicle door according to claim 3 wherein the rotary brake comprises a hydraulic dashpot.

5. A vehicle door according to any one of the preceding claims including secondary control means for controlling the rate of deployment of the inner panel.

6. A vehicle door according to claim 5 wherein the secondary control means comprises brake means connected to the outer panel and to a strut mounted co-axially with the hinge connection between the inner and outer panels with a flexible strap extending between the inner panel and the strut.

7. A vehicle door according to claim 6 wherein the brake means comprises a progressive damper.

8. A vehicle door according to any one of the preceding claims including a handrail system arranged and adapted to be erected during deployment of the outer and inner panels.

9. A vehicle door according to claim 8 wherein the inner panel includes stop means in engagement with the handrail system to prevent erection of the handrail system before the inner panel is unfolded relative to the outer panel.

10. A vehicle door according to claim 8 or claim 9 wherein the handrail system includes an assembly comprising a primary stanchion pivotally connected to the outer panel, a secondary stanchion pivotally connected to the inner panel and a rail, the opposed ends of which are pivotally connected to the primary and secondary stanchions respectively, the handrail system lying alongside one edge of the inner panel overlying the adjacent edge of the outer panel.

11. A vehicle door according to any one of the preceding claims including a main support strap one end of which is connected to the outer panel and the other end of which is adapted to be connected to the vehicle body.

12. A vehicle door according to claim 11 in combination with claim 10 wherein the main support strap has a connector strap connected to the primary stanchion to erect the handrail system during unfolding movement of the inner panel relative to the outer panel.

13. A vehicle door according to claim 12 wherein a portion of the main support strap is held between the primary stanchion and the rail to limit initial outward pivotal movement of the outer panel in use.

14. A vehicle door according to claim 13 wherein the main support strap has a loop connected to a hook on the rail to raise the inner panel relative to the outer panel during initial outward pivotal movement of the outer panel.

15. A vehicle door according to any one of claims 12, 13 or 14 wherein the handrail system comprises a pair of said assemblies, each assembly lying alongside a respective one of the opposed edges of the inner panel overlying the adjacent edge of the outer panel and each primary stanchion is connected to a respective one of a pair of main support straps by an associated connector strap.

16. A vehicle door according to any one of the preceding claims having upper and lower roller guide assemblies adapted in use to engage upper and lower track members respectively on the vehicle body, release means being operable to disengage the upper roller guide assembly from the upper track member.

17. A vehicle door according to claim 16 wherein the upper roller guide assembly comprises a roller mounted at one end of an arm the other end of which is pivotally connected to the outer panel and the release means comprises a handle operable through a strut to lower the arm.

18. A vehicle door according to either of claims 16 and 17 including a retainer securing the inner and outer panels together, the retainer being operatively connected to the release means

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whereby operation of the release means releases the retainer to allow unfolding movement of the inner panel relative to the outer panel.

19. A rail vehicle sliding plug door substantially as hereinbefore described with reference to the accompanying drawings.