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(54) **Railway vehicle having shock absorbing structures**

Schienenfahrzeug mit einer Energieverzehr-Struktur

Véhicule ferroviaire doté d'une structure d'absorption d'énergie

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Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention relates to railway vehicles having a doorway through which passengers get on and off the vehicle disposed on longitudinal ends of the railway vehicle (hereinafter referred to as car ends), and especially relates to railway vehicles having a doorway arranged astride a crushable region that will be crushed during collision to absorb the shock and a survival region that will not be crushed during collision and maintains its space.

Description of the related art

[0002] A railway vehicle is formed with high rigidity, having strength members such as pillars and reinforcement members arranged if necessary to respective sections of the structure, so that the vehicle can endure, for example, the weight of passengers and electric devices such as main circuits disposed therein, the load applied from rails and couplers when the vehicle is running, and the pressure difference between the interior and the exterior of the vehicle when the vehicle passes through a tunnel. The doorway through which passengers get on and off the vehicle is disposed at an opening section formed on a structure (side structure) of the railway vehicle, and a doorway frame is disposed on a circumference of the opening section so as to ensure the strength of the opening section. Further, pillars and reinforcement members are disposed at given portions at the ends of the railway vehicle to ensure enough strength to endure the impact caused when cars are connected during reassembling operation of a railway vehicle formation.

[0003] In order to prepare against any unexpected collision with an obstacle on a railway that may occur when the vehicle is running, a railway vehicle may generally have a crushable region (shock absorbing region) for absorbing impact (collision energy) by actively plastically deforming a certain portion of the railway vehicle during collision, so as to relieve the shock applied to the passengers and crews. When the railway vehicle having multiple cars connected together collides against an obstacle on a railway, a front end of a leading car collides against the obstacle at first, and then the front ends and rear ends of the respective cars of the car formation collide against one another. Thus, the shockabsorbing structures are disposed at longitudinal ends of the respective cars.

[0004] Therefore, it is desirable that the shock absorbing structure disposed on the railway vehicle has sufficient strength so as not to be crushed by a small load (not affecting the passengers and crews) caused for example when reassembling and coupling the cars, but functions as a shock absorbing mechanism absorbing the impact and the collision energy (hereinafter referred to as impact) by crushing when a load greater than a predetermined level is applied. Furthermore, the shock absorbing structure must function as a shock absorbing mechanism even if the obstacle of collision (the size or weight) or the condition of collision (the position of collision or the speed of collision) vary.

[0005] Further, since railway vehicles must transport a large number of passengers in a short time, in some vehicles, the doorways are disposed at the car ends of the vehicle and the cabins are disposed at the longitudinal center sections of the cars so as to ensure a large cabin space. If collision of railway vehicles adopting such arrangement occurs, the doorways disposed on the car ends may be crushed when the car ends are crushed. The passengers aboard the railway vehicle having crushed doorways must move through the connected cars to reach an escapable doorway or to escape through windows or escape ports disposed on car body structures to the exterior of the vehicle, and then to evacuate to a safe place. However, for smooth evacuation and rescue operation of passengers, it is desirable that the passengers are capable of escaping through the nearest possible doorway. Therefore, it is necessary to provide a railway vehicle having a shock absorbing structure, capable of ensuring the doorways as escape routes while sufficiently absorbing the impact during collision.

[0006] Patent document 1 (Japanese patent application laid-open publication No.2008-62817) discloses an example of a railway vehicle having a shock absorbing structure composed of a rigid member and a rib member functioning as an energy absorber disposed on the car ends. The shock absorbing structure of the railway vehicle disclosed in patent document 1 is composed of a rigid member disposed along the circumferential direction of the vehicle on the end of the vehicle body, a rib member disposed along the circumferential direction at a position rearward from the rigid member, a rib member disposed along the longitudinal direction of the vehicle body and connecting both the rigidmember and the rib member, and an outer panel covering them. The rib member disposed along the longitudinal direction of the vehicle body is composed of two flanges and a web connecting the two flanges, wherein the side having the web is welded to the outer panel by fillet-welding. A notch opened to the edge of each flange is formed at the center of the longitudinal direction of the rib member. When a collision load is applied to the end of the car body, the notch is folded to an opposite side from the outer panel, so that the bending of the rib member does not cause deformation of the outer panel, according to which the collision load can be absorbed.

[0007] In a railway vehicle having a shock absorbing structure disposed on the car ends and doorways arranged at the car ends, if the shock absorbing structure disposed on the car ends can absorb the impact effectively, not only the level of impact applied on the passengers and crews can be relieved, but also a wide cabin

space can be provided in the longitudinal center section of the vehicle.

[0008] Therefore, the problem to be solved in a railway vehicle is to enable the car end structure including a doorway to function as a shock absorbing mechanism capable of crushing during collision to absorb sufficient shock, and to provide sufficient strength to a portion of the doorway not being crushed by collision so that it can be used as an escape port.

[0009] EP0802100A1 proposes a railway vehicle with a driver's compartment having an energy absorbing structure with progressive deformation. EP 1006034 A1 proposes a box type structural body and vehicle end sill.

SUMMARY OF THE INVENTION

[0010] The object of the present invention is to provide a railway vehicle having doorways disposed on the longitudinal ends of the railway vehicle, the doorway being arranged astride a crushable region and a survival region, having a collision relieving structure capable of relieving shock during collision and to enable a portion of the doorway not being crushed by collision to be used as an escape port.

[0011] The above-mentioned object is achieved by providing a railway vehicle according to claim 1.

[0012] According to the present invention, even if a large impact exceeding a predetermined level is applied along the longitudinal direction of the railway vehicle and a portion of the doorway belonging to the crushable region is crushed, the remaining portion of the doorway belonging to the survival region will not be crushed, ensuring a width of the doorway as an escape port through which passengers can evacuate to the exterior. Therefore, even when collision occurs, the passengers can evacuate to the exterior of the vehicle through the nearest doorway.

[0013] Further, by providing on the horizontal portion of the doorway frame a shock absorbing device composed of a fixed member having a space formed in the interior thereof, and a movable member connected to the fixed member and being pushed into the interior of the fixed member when absorbing shock, the movable member is guided to the interior of the fixed member simultaneously when absorbing shock, thereby controlling the crushing behavior of the end section of the car body to which the movable member is connected.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1 is a perspective view showing schematically one example of a railway vehicle having a doorway disposed on a longitudinal end thereof;
FIG. 2 is a perspective view showing in enlarged view a car end of the railway vehicle illustrated in FIG. 1;
FIG. 3 is a side view of the car end illustrated in FIG. 2;
FIG. 4 is an A-A cross-section of FIG. 3;
FIG. 5 is a B-B cross-section of FIG. 3;
FIG. 6 is a C-C cross-section of FIG. 3;
FIG. 7 is a D-D cross-section of FIG. 3;
FIG. 8 is an explanatory view of the car end illustrated in FIG. 3, showing a state in which a roof structure end section, a third doorway frame and an underframe end section disposed in the crushable region are crushed;
FIG. 9 is a side view of the car end of the railway vehicle having a block connected to a roof structure disposed on an upper first doorway frame;
FIG. 10 is an F-F cross-section of FIG. 9;
FIG. 11 is a side view showing schematically an example of a car end structure of the railway vehicle having a doorway frame incorporating a shock absorbing device;
FIG. 12 is a conceptual diagram showing one example of a shock absorbing device disposed on the doorway frame;
FIG. 13 is a conceptual diagram showing one example of another shock absorbing device disposed on the doorway frame;
FIG. 14 is an explanatory view showing a state in which the shock absorbing device disposed on the doorway frame arranged astride the crushable region and the survival region on the car end has absorbed the shock;
FIG. 15 is a side view of the car end of the railway vehicle having a survival region, a crushable region and a survival region disposed in the named order from the endmost section in the longitudinal direction of the car toward the longitudinal direction of the railway vehicle;
FIG. 16 is a G-G cross-section of FIG. 15; and
FIG. 17 is an explanatory view showing the state in which the crushable region of the railway vehicle shown in FIG. 15 is crushed to absorb the shock.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Now, a railway vehicle having doorways disposed on longitudinal ends (hereinafter referred to as "car ends") according to the present invention will be described with reference to the drawings, having the doorway arranged astride a crushable region being crushed during collision for absorbing shock and a survival region not being crushed during collision and maintaining its space.

[0016] FIG. 1 is a perspective view showing schematically one example of a railway vehicle having doorways mainly used by passengers getting on and off the railway vehicle arranged on the car ends of the railway vehicle. The railway vehicle 1 has a substantially hexahedral railway vehicle structure, composed of an underframe 50 constituting a floor surface thereof, side structures 20

constituting both side walls of the car body erected on width-direction ends of the car body of the underframe 50 (only one side of which is shown), end structures 30 erected on both car ends of the underframe 50 (only one of which is shown), and a roof structure 40 disposed on upper ends of the side structure 20 and the end structures 30.

[0017] The side structures 20 have openings such as window sections 62 for arranging windows and doorway sections 60 used for arranging the doorways. In general, doorway frames 70 for reinforcement are disposed on the circumference of the doorway sections 60 for getting on and off.

[0018] A survival region 100 maintaining survival space for passengers and the like which will not be crushed during collision is arranged at the longitudinal center section of the railway vehicle 1, and crushable regions 200 connected to the survival region 100 are disposed at both longitudinal end sections of the railway vehicle 1 which will be crushed during collision so as to absorb the collision energy. The roof structure 40 and the underframe 50 arranged within the survival region 100 has enough strength so as not to be crushed during collision. On the other hand, the roof structure end sections 42 and the underframe end sections 52 arranged within the crushable region 200 has such strength so as not to crush when an impact load smaller than a predetermined load is applied but to crush when an impact load greater than the predetermined load is applied.

[0019] With reference to FIGS. 2 through 7, the structure of the roof structure end sections 42 and the underframe end sections 52 arranged in the crushable region 200, and the structure of the roof structure 40 and the underframe 50 arranged in the survival region 100 will be described.

[0020] FIG. 2 is a perspective view showing in enlarged view the car ends of the railway vehicle 1 shown in FIG. 1. The roof structure 40 is manufactured by first arranging a given number of extruded shape members in the direction orthogonal to the direction of extrusion thereof into the shape of a flat panel, then butting the extruded shape members against each other in the width direction of the extruded shape members (direction orthogonal to the direction of extrusion), and joining the butted ends of the extruded shape members via friction stir welding or welding.

[0021] The roof structure end sections 42 are manufactured by subjecting the width-direction ends (direction of arrow 500) of the panel to a bending process, to thereby process the shape thereof to correspond to the outer shape of the railway vehicle 1. The formed roof structure end sections 42 are connected to the car ends of the roof structure 40, the upper end of the doorway frame 70 and the upper end of the end structure 30, to thereby form the railway vehicle structure of the railway vehicle 1.

[0022] Similarly, the underframe 50 is formed by arranging a predetermined number of extruded shape members in the direction orthogonal to the direction of extrusion thereof into the shape of a panel, butting the ends thereof in the width direction 500 (direction orthogonal to the direction of extrusion), and joining the ends of the extruded shape members via friction stir welding or welding.

[0023] The underframe end section 52 is composed of an extruded shape member formed of a single face plate having on one plane thereof a plurality of ribs (not shown) having a T-shaped cross-section perpendicular to the direction of extrusion. The extruded shape members constituting the underframe end sections 52 are connected to the car ends of the underframe 50, the lower end of the doorway frame 70 and the lower end of the end structures 30, so that the direction of extrusion thereof is arranged along the width direction (direction of arrow 500) of the railway vehicle 1, thereby forming the railway vehicle structure of the railway vehicle 1.

[0024] FIG. 3 is a side view showing the car end of the railway vehicle 1 illustrated in FIG. 2. The doorway frame 70 is composed of a first doorway frame 72 disposed in a vertical direction within the plane of the side structure 20 within the survival region 100 disposed at the center section in the longitudinal direction of the railway vehicle 1, a second doorway frame 74 disposed in a vertical direction within the plane of the side structure 20 and connected to the end structure 30 in the crushable region 200, and third doorway frames arranged along the longitudinal direction of the side structure 20 in the crushable region 200 and connecting the respective upper ends and lower ends of the first doorway frame 72 and the second doorway frame 74. Further, the first doorway frame 72 can have sections 72a and 72b extending horizontally from the upper and lower ends in the height direction thereof toward the second doorway frame 74. FIG. 3 shows an A-A cross-section position of the roof structure end section 42 and an upper third doorway frame 76a disposed in the crushable region 200, a B-B cross-section position of the roof structure 40 and an upper first doorway frame 72a disposed in the survival region 100, a C-C cross-section position of the underframe end section 52 and a lower third doorway frame 76b disposed in the crushable region 200, and a D-D cross-section position of the underframe 50 and a lower first doorway frame 72b disposed in the survival region 100.

[0025] FIG. 4 is an A-A cross-section view of FIG. 3. The roof structure end section 42 and the upper third doorway frame 76a disposed in the crushable region 200 are both single plate-shaped members, and the end in the width direction (direction of arrow 500) of the roof structure end section 42 and the upper end section of the upper third doorway frame 76a are connected via welding or the like. A thickness t1 of the upper third doorway frame 76a is selected to a thickness so that the member crushes along a longitudinal direction 510 of the railway vehicle 1 to absorb the shock when an impact greater than a predetermined impact is applied by collision.

[0026] FIG. 5 is a B-B cross-sectional view of FIG. 3. The roof structure 40 disposed in the survival region 100

is composed of extruded shape members having two opposing face plates connected via ribs. Similarly, the upper first doorway frame 72a is also composed of a single panel, but a thickness t2 thereof is greater than the thickness t1 of the upper third doorway frame 76a (FIG. 3), and selected to provide the member with enough strength so as not to crush during collision. The end section in the width direction (direction of arrow 500) of two face plates constituting the roof structure 40 and the upper end of the upper first doorway frame 72b are connected via welding or the like. Even when a large impact is applied in the longitudinal direction (direction of arrow 510) of the railway vehicle 1 during collision, the roof structure 40 and the upper first doorway frame 72a has sufficiently high strength so as not to be crushed, ensuring the survival region 100 (FIG. 3).

[0027] FIG. 6 is a C-C cross-section of FIG. 3. An underframe end section 52 disposed in the crushable region 200 has a hollow section 52a at each end in the width direction (direction of arrow 500) of the railway vehicle 1, and the portion close to the center in the width direction (direction of arrow 500) has a floor section 52b composed of a single panel. The hollow section 52a can be formed by assembling a horizontally arranged panel and a vertically arranged panel and connecting the same via welding or the like, or can be formed of a hollow extruded shape member. The plate thickness of the respective face plates constituting the underframe end section 52 is selected so that when a load greater than the predetermined load is applied in the longitudinal direction (direction of arrow 510) of the railway vehicle 1, the underframe end section 52 can be crushed along the longitudinal direction of the railway vehicle 1.

[0028] Furthermore, the lower third doorway frame 76b is composed of a channel member having two horizontal portions formed continuously from an upper end and a lower end of a vertical portion, and a panel 80a connecting the opened ends of the horizontal portions. A plate thickness t4 of the vertical portion of the lower third doorway frame 76b, a plate thickness t3 of the horizontal portions thereof and a plate thickness t5 of the panel 80a are selected so that when a load greater than a predetermined load is applied, the members can be crushed along the longitudinal direction (direction of arrow 510) of the railway vehicle 1.

[0029] FIG. 7 is a D-D cross-section of FIG. 3. The underframe 50 disposed in the survival region 100 has a hollow section 50a at each end in the width direction (direction of arrow 500) of the railway vehicle 1. A floor section 50b composed of a hollow extruded shape member having two opposing face plates connected via ribs is disposed at a center section in the width direction (direction of arrow 500) of the underframe adjacent to the hollow sections 50a. The underframe 50 and the floor section 50b are connected via welding or the like. The plate thickness of respective face plates constituting the underframe 50 and the plate thickness of the ribs and the respective face plates constituting the floor section 50b is selected so that the underframe 50 and the floor section 50b will not be crushed in the longitudinal direction of the railway vehicle 1 even when a large impact in the longitudinal direction (direction of arrow 510) of the railway vehicle 1 is applied, thereby ensuring the survival region 100.

[0030] Further, the lower first doorway frame 72b is composed of a channel member having two horizontal portions formed continuously from an upper end and a lower end of a vertical portion, and a panel 80b connecting the opened ends of the horizontal portions. A panel 81b is disposed horizontally from a center section in the height direction of the panel 80b toward the lower first doorway frame 72b, thereby reinforcing the strength of the lower first doorway frame 72b in the longitudinal direction of the railway vehicle 1 (direction of arrow 510), and ensuring the survival region 100.

[0031] FIG. 8 is an explanatory view showing the state in which the roof structure end section 42, the upper and lower third doorway frames 76a and 76b and the underframe end section 52 disposed within the crushable region are crushed so as to absorb the shock at the car end illustrated in FIG. 3. When the railway vehicle is subjected to collision in the direction of arrow 510, the impact is first received by the end structure 30 constituting the railway vehicle 1, and thereafter, propagated to the roof structure end section 42 and the underframe end section 52 disposed adjacent to the end structure 30. Substantially at the same time, the impact is transmitted via the second doorway frame 74 connected to the end structure 30 to the upper third doorway frame 76a and the lower third doorway frame 76b. If the level of impact is greater than a predetermined level, the roof structure end section 42, the underframe end section 52, the upper third doorway frame 76a and the lower third doorway frame 76b disposed within the crushable region 200 are crushed and subjected to plastic deformation in the longitudinal direction (direction of arrow 510) of the railway vehicle 1, thereby absorbing the impact (collision energy), and relieving the shock applied to the passengers and crews on board the railway vehicle. The width L1 of the doorway section 60 after absorbing shock becomes smaller than a width L0 (FIG. 3) of the doorway section 60 prior to absorbing shock, but since the first doorway frame 72 (72a and 72b), the roof structure 40 and the underframe 50 disposed within the survival region 100 has sufficient strength, they will not be crushed and the doorway width L1 is ensured. Therefore, even when the railway vehicle 1 experiences collision and the shock absorbing structures disposed on the railway vehicle 1 (the roof structure end sections 42, the upper and lower third doorway frames 76a and 76b and the underframe end sections 52) absorb the shock, the passengers and crews can escape to the exterior of the vehicle through the non-crushed width L1 of the nearest doorway section 60 as escape port.

[0032] FIG. 9 is a side view of the car end of the railway vehicle comprising a block 45 connecting the roof struc-

ture 40 and the upper first doorway frame 72a, and FIG. 10 is an F-F cross-section shown in FIG. 9. The embodiment shown in FIG. 9 illustrates an alternative structure of the upper third doorway frame 76a and the upper first doorway frame 72a shown in FIGS. 3 through 5, having considered the crushing characteristics and the fabrication performance of the vehicle. As shown in FIG. 10, a block 45 is connected to the in-car side of the upper first doorway frame 72a, and the upper end of the block 45 is connected to a roof structure 40 disposed in the survival region 100. The plate thickness of the upper third doorway frame 76a (FIG. 9) is the same as the plate thickness of the upper first doorway frame 72a (FIG. 10), wherein the same plate thickness is selected so as to improve the fabrication performance and to reduce the mass of the upper first doorway frame 72a. Although not shown, the structure shown in FIG. 9 can be applied to the lower first doorway frame 72b, in which the lower end of the block 45 is connected to the underframe 50 and the in-car side of the lower first doorway frame 72b is connected to the block 45.

[0033] When the railway vehicle experiences a heavy collision in the direction of arrow 510, the impact is first received by the end structure 30 constituting the railway vehicle 1, and then transmitted to the roof structure end section 42 and the underframe end section 52 adjacent to the end structure 30. Since the impact is received by the block 45 connected to the strong roof structure 40 disposed in the survival region 100, the upper third doorway frame 76a starts crushing. Substantially at the same time, the roof structure end section 42, the underframe end section 52 and the lower third doorway frame 76b disposed in the crushable region 200 are crushed and plastically deformed in the longitudinal direction of the railway vehicle 1 (direction of arrow 510), absorbing the impact (collision energy) during the process and relieving the impact applied to the passengers and crews on board the railway vehicle.

[0034] In the embodiment illustrated in FIGS. 9 and 10, the width L1 (refer to FIG. 8) of the doorway section 60 after absorbing the impact becomes smaller than the width L0 (FIG. 3) of the doorway section 60 prior to absorbing impact, but since the first doorway frame 72 (72a, 72b), the roof structure 40 and the underframe 50 disposed in the survival region 100 have sufficient strengths, they will not be crushed so as to ensure a doorway width L1. Therefore, even after the railway vehicle 1 experiences collision and the shock absorbing structure disposed in the railway vehicle 1 (the roof structure end section 42, the upper and lower third doorway frames 76a and 76b, and the underframe end section 52) has absorbed the shock, the passengers and crews can escape to the exterior of the vehicle through the portion of width L1 not being crushed of the nearest doorway section 60 as escape port.

[0035] FIG. 11 is a side view showing schematically one example of the car end structure of the railway vehicle 1 having a doorway frame incorporating the shock absorbing structure. If the doorway used by passengers and the like getting on and off the vehicle is disposed on each longitudinal end of the railway vehicle 1, a doorway frame 70 is disposed along the edge of the doorway section 60 formed on the side structure 20. In general, since the rigidity of the doorway frame 70 is greater than the rigidity of the side structure, the plate thickness of the upper and lower third doorway frames 76a and 76b disposed in the crushable region 200 is made smaller than the plate thickness of the upper and lower first doorway frames 72a and 72b disposed in the survival region 100 so as to promote crushing and absorb the shock. FIG. 11 is an example in which a shock absorbing device 300 capable of ensuring a greater shock absorbing quantity (shock absorbing quantity per unit volume) is disposed on the doorway frame arranged astride the survival region 100 and the crushable region 200, instead of the upper and lower third doorway frames 76a and 76b shown in FIGS.4 and 6.

[0036] FIG. 12 is a conceptual diagram showing one example of the shock absorbing device 300 disposed on the doorway frame. The shock absorbing device 300 is composed of a fixed member 1241 having a space 1245 formed in the interior thereof, and a movable member 1231 connected tandemly to the fixed member 1241. One longitudinal end section of the movable member 1231 is inserted to the other longitudinal end of the fixed member 1241, and the overlapped portion of the movable member 1231 and the fixedmember 1241 is engaged via engagement members 1242, 1242 such as bolts. The shock absorbing device 300 is disposed on the doorway frame 70 so that the longitudinal direction thereof corresponds to the longitudinal direction (direction of arrow 510) of the railway vehicle 1. Themovable member 1231 of the shock absorbing device 300 is fixed via bolts or the like to the doorway frame 76 disposed in the crushable region 200, and the fixed member 1241 of the shock absorbing device 300 is fixed via bolts or the like to the doorway frame 72 disposed in the survival region 100. In other words, the movable member 1231 of the shock absorbing device 300 is disposed in the crushable region 200, and the fixedmember 1241 of the shock absorbing device is disposed in the survival region 100.

[0037] When an impact greater than the predetermined impact is applied in the longitudinal direction of the shock absorbing device 300, at first, the engagement members 1242 receive shearing force and are fractured. Next, the movable member 1231 is pushed into the space 1245 provided in the fixed member 1241. The impact (collision energy) is absorbed during the process in which the engagement members 1242 are fractured and by the friction between the surface of the movable member 1231 and the fixed member 1241 when the movable member 1231 is pushed into the space 1245 of the fixed member 1241. The shock absorbing quantity can be controlled by the number and strength of the engagement members 1241, and by adjusting the outer dimension of the movable member 1231 and the inner diameter of the space

within the fixed member 1241.

[0038] FIG. 13 is a conceptual diagram showing another example of a shock absorbing device disposed on the doorway frame. The shock absorbing device 300 is composed of a fixed member 1241 having a space 1245 formed therein, and a movable member 1231 connected tandemly to the fixed member 1241. An intrusive member 1235 disposed on one longitudinal end section of the movable member 1231 is connected in such a manner as to be inserted to the other longitudinal end of the fixed member 1241. The height dimension D of the cylindrical intrusive member 1235 is greater than the height dimension H of the space 1245 formed in the fixed member 1241. The movable member 1231 is fixed via bolts or the like to the doorway frame 76 disposed in the crushable region 200, and the fixed member 1241 is fixed via bolts or the like to the doorway frame 72 disposed in the survival region 100. In other words, the movable member 1231 of the shock absorbing device 300 is disposed in the crushable region 200, and the fixed member 1241 of the shock absorbing device 300 is disposed in the survival region 100. The shape of the intrusive member 1235 does not necessarily have to be cylindrical, and can be a triangular prism shape or a trapezoidal pole shape having perpendicular cross-sections gradually reduced from the movable member 1231 toward the direction of the fixed member 1241.

[0039] When an impact greater than a predetermined impact is applied in the longitudinal direction of the shock absorbing device 300, the intrusive member 1235 connected to the movable member 1231 is pushed forcibly into the space 1245 of the fixed member 1241. The impact (collision energy) is absorbed during the process in which the intrusive member 1235 is pushed into the space 1245 formed in the fixedmember 1241, and the impact (collision energy) corresponding to a work volume realized by the resisting force composed of the friction between the surface of the intrusive member 1235 and the inner wall surface of the space 1245 of the fixed member 1241 and the deformation of the fixed member 1241 when the intrusive member 1235 is pushed forcibly into the space 1245 is absorbed. The shock absorbing quantity can be controlled by appropriately adjusting the dimension D of the intrusive member 1235 and the dimension H of the space 1245.

[0040] FIG. 14 is an explanatory view showing the state in which the shock absorbing device incorporated in the doorway frame arranged astride the crushable region and the survival region at the car end has absorbed the shock. When the railway vehicle collides in the direction of arrow 510, the impact is first received by the end structure 30 constituting the railway vehicle 1, and thereafter, transmitted to the roof structure end section 42 and the underframe end section 52 disposed adjacent to the end structure 30. Substantially at the same time, the impact is transmitted via the second doorway frame 74 connected to the end structure 30 to the upper third doorway frame 76a and the lower third doorway frame 76b. The roof structure end section 42 and the underframe end section 52 disposed in the crushable region 200 is crushed and plastically deformed in the longitudinal direction (direction of arrow 510) of the railway vehicle 1, and substantially at the same time, the movable members 1231 constituting the shock absorbing devices 300 and 300 disposed on the upper and lower third doorway frames 76a and 76b are pushed into the interior of the fixed member 1241.

[0041] The impact (collision energy) is absorbed in the above-described process, so that the impact applied on the passengers and crews on board the railway vehicle may be relieved. The width L1 of the doorway after absorbing shock becomes smaller than a width L0 (FIG. 3) of the doorway prior to absorbing shock, but since the first doorway frame 72, the roof structure 40 and the underframe 50 disposed within the survival region 100 has sufficient strength, they will not be crushed and the doorway width L1 is ensured. Therefore, even after the shock absorbing structures disposed on the railway vehicle 1 (the roof structure end sections 42, the shock absorbing device 300 disposed on the upper and lower third doorway frame 7 6a and 7 6b and the underframe end sections 52) absorb the shock, the passengers and crews can escape to the exterior of the vehicle through the non-crushed portion of width L1 of the nearest doorway section 60 as escape port.

[0042] Since the movable member 1231 is pushed forcibly into the interior of the space 1245 of the fixed member 1241 during the process in which the roof structure end sections 42 and the underframe end sections 52 are crushed in the shock absorbing device 300, the shock absorbing device 300 both functions to absorb the shock by itself and to control the crushing behavior of the endmost section of the car composed for example of the end structure 30, by guiding the roof structure end sections 42 and the underframe end sections 52 to be crushed in the longitudinal direction of the vehicle (direction of arrow 510). Since the shock absorbing device 300 is fixed to the first doorway frame 72 and the second doorway frame 74 via bolts or the like, these bolts can be disengaged to facilitate replacement thereof with another shock absorbing device 300 if necessary, such as when the device 300 has absorbed shock.

[0043] FIG. 15 is a side view of the car end of the railway vehicle having disposed in the named order from the endmost longitudinal portion of the railway vehicle 1 toward the longitudinal center section of the railway vehicle a first survival region 100a, a crushable region 200 and a second survival region 100b, wherein the doorway frame 70 is disposed in the first survival region 100a. The passenger cabin is disposed in the second survival region 100b. Details will follow, but the underframe end section 52 disposed in the first survival region 100a will be crushed to absorb the shock when an impact greater than a predetermined impact is applied via the end structure 30 to the railway vehicle 1.

[0044] FIG. 16 is a G-G cross-section of FIG. 15. A first

doorway frame 72 constituting a doorway frame 70 and disposed toward a longitudinal center section of the side structure 20 has a hollow section formed in the interior thereof, and one of the vertical edges of a face plate 24 constituting the side structure 20 is connected via welding or the like to the longitudinal center area of the vehicle of the first door frame 72. The other vertical edge of the face plate 24 is connected via welding or the like to the extruded shape member 22 constituting the side structure 20. The horizontal edge at the upper end of the face plate 24 is connected to the roof structure end section 42, and the horizontal edge at the lower end of the face plate 24 is connected to the underframe 50. In other words, the face plate 24 connecting the first doorway frame 72 and the extruded shape member 22 is disposed in the crushable region 200. Further, the extruded shape member 22 is a hollow extruded shape member in which two opposing face plates are connected via ribs.

[0045] FIG. 17 shows a state in which the crushable region 200 of the car end shown in FIG. 15 is crushed to absorb the shock. When the railway vehicle experiences collision in the direction of arrow 510, the impact is first received by the end structure 30 constituting the railway vehicle 1, and thereafter, transmitted to the roof structure end section 42 and the underframe end section 52 adjacent to the end structure 30. Substantially at the same time, the impact is transmitted to a face plate 24 (FIG. 16) constituting the side structure 20 via a doorway frame 70 connected to the end structure 30. When an impact greater than a predetermined size is applied, the roof structure end section 42 disposed in the crushable region 200 and the face plate 24 (FIG. 16) constituting the side structure 20 is crushed, and the connection between the lower end section of the doorway frame 70 and the upper end in the width direction of the railway vehicle 1 (direction of arrow 500) of the underframe 50 is fractured, by which the car end including the doorway frame 70 moves toward the longitudinal center area of the railway vehicle 1.

[0046] The impact (collision energy) is absorbed in the process in which the roof structure end section 42 and the face plate 24 of the side structure 20 are plastically deformed, relieving the impact applied on the passengers and crews on board the railway vehicle. At this time, the underframe end section 52 is disposed in the first survival region 100a, but it is crushed in the area below the floor portion of the railway vehicle 1 (on the side of the rail) having only a small influence on the passengers. The width L0 of the doorway frame 70 after absorbing shock maintains substantially the same doorway width L0 as the doorway width L0 (FIG. 15) prior to absorbing shock, since the whole body of the end section of the vehicle including the doorway frame 70 is moved toward the longitudinal center section of the railway vehicle 1. Therefore, the passengers and crews can escape to the exterior of the vehicle through the nearest doorway section 60 substantially remaining without being crushed.

Claims

1. A railway vehicle (1) comprising an underframe (50), side structures (20) erected on opposing sides of the underframe (50), end structures (30) erected on longitudinal ends of the underframe (50), and a roof structure (40) connected to upper ends of the side structures (20) and the end structures (30), wherein:

   a survival region (100) is disposed at a longitudinal center section of the railway vehicle (1), and crushable regions (200) are disposed on longitudinal ends of the railway vehicle (1) in such a manner as to be connected to the survival region (100); and
   a doorway section (60) for getting on and off is disposed on a longitudinal end of the side structure so as to span the crushable region (200) and the survival region (100);
   further wherein:

      the railway vehicle (1) comprises a roof structure end section (42) disposed on the longitudinal end of the roof structure (40), and an underframe end section (52) disposed on the longitudinal end of the underframe (50);
      the doorway section (60) comprises a doorway frame (70) disposed on an edge of an opening disposed on the longitudinal end of the side structure, the doorway frame (70) comprising: a first doorway frame (72) disposed in a perpendicular direction within the survival region (100); a second doorway frame (74) disposed in a perpendicular direction at a longitudinal end section of the side structure (20) and connected to the end structure (30); and two third doorway frames (76a, 76b) respectively connected to upper ends and lower ends of the first doorway frame (72) and the second doorway frame (74), and extending in the longitudinal direction of the side structure (20);
      the roof structure end section (42), the second doorway frame (74), the third doorway frame (76a, 76b) and the underframe end section (52) are disposed in the crushable region (200);

   further wherein:

      the roof structure end section (42) is a single panel connected to the longitudinal end of the roof structure (40); and
      the underframe end section (52) is composed of a single panel formed by arranging and welding butted ends of extruded shape members together, wherein the extruded

shape members are connected to the longitudinal end of the underframe (50) so that a direction of extrusion of the extruded shape members corresponds to a width direction (500) of the railway vehicle (1);

characterized in that:

a plate thickness of the third doorway frame (76a, 76b) connected to the upper end section of the second doorway frame (74) is smaller than a plate thickness of the upper end section of the first doorway frame (72); the third doorway frame (76a, 76b) connected to the lower end section of the second doorway frame (74) is composed of a channel member having two horizontal portions connected to an upper end and a lower end of a perpendicular portion, and a panel (80a) connecting opened ends of the horizontal portions; and
a lower end of the first doorway frame (72) connected to the third doorway frame (76a, 76b) being connected to the lower end section of the second doorway frame (74) is composed of a channel member having two horizontal portions connected to an upper end and a lower end of a perpendicular portion, a panel (80b) connecting opened ends of the horizontal portions, and a panel (81 b) extending from a center section in a height direction of the panel (80b) toward the perpendicular portion.

2. The railway vehicle according to claim 1, wherein a block (45) is connected to an in-car side of one side of the first doorway frame (72), and an end section of the block is connected to the roof structure (40).

3. The railway vehicle according to claim 1, wherein a block (45) is connected to an in-car side of one side of the first doorway frame (72), and an end section of the block is connected to the roof structure; and
a block is connected to an in-car side of the other side of the first doorway frame (72), and an end section of the block is connected to the underframe (50).

Patentansprüche

1. Schienenfahrzeug (1), das einen Unterrahmen (50), an gegenüberliegenden Seiten des Unterrahmens (50) errichtete Seitenstrukturen (20), an Längsenden des Unterrahmens (50) errichtete Endstrukturen (30) und eine mit oberen Enden der Seitenstrukturen (20) und der Endstrukturen (30) verbundene Dachstruktur (40) umfasst, wobei:

ein Überlebensbereich (100) in einem mittigen Längsabschnitt des Schienenfahrzeugs (1) angeordnet ist, und knautschbare Bereiche (200) an Längsenden des Schienenfahrzeugs (1) in einer solchen Weise angeordnet sind, dass sie mit dem Überlebensbereich (100) verbunden sind; und
ein Türabschnitt (60) zum Ein- und Ausstieg an einem Längsende der Seitenstruktur angeordnet ist, um den knautschbaren Bereich (200) und den Überlebensbereich (100) zu umfassen;
wobei ferner:

das Schienenfahrzeug (1) einen an dem Längsende der Dachstruktur (40) angeordneten Dachstruktur-Endabschnitt (42) und einen an dem Längsende des Unterrahmens (50) angeordneten Unterrahmen-Endabschnitt (52) umfasst;
der Türabschnitt (60) einen Türrahmen (70) umfasst, der an einem Rand einer an dem Längsende der Seitenstruktur angeordneten Öffnung angeordnet ist, wobei der Türrahmen (70) umfasst: eine in senkrechter Richtung innerhalb des Überlebensbereichs (100) angeordnete erste Türzarge (72); eine in senkrechter Richtung an einem Längsendabschnitt der Seitenstruktur (20) angeordnete mit der Endstruktur (30) verbundene zweite Türzarge (74); und zwei in der Längsrichtung der Seitenstruktur (20) verlaufende dritte Türzargen (76a, 76b), die mit den oberen Enden beziehungsweise den unteren Enden der ersten Türzarge (72) und der zweiten Türzarge (74) verbunden sind;
der Dachstruktur-Endabschnitt (42), die zweite Türzarge (74), die dritte Türzarge (76a, 76b) und der Unterrahmen-Endabschnitt (52) in dem knautschbaren Bereich (200) angeordnet sind;

wobei ferner:

der Dachstruktur-Endabschnitt (42) ein mit dem Längsende der Dachstruktur (40) verbundenes einzelnes Paneel ist; und
der Unterrahmen-Endabschnitt (52) aus einem einzelnen Paneel zusammengesetzt ist, das durch Anordnen und Zusammenschweißen von anliegenden Enden extrudierter Formteile gebildet ist, wobei die extrudierten Formteile mit dem Längsende des Unterrahmens (50) so verbunden sind, dass eine Extrusionsrichtung der extrudierten Formteile einer Breitenrichtung (500)

des Schienenfahrzeugs (1) entspricht;

dadurch gekennzeichnet, dass:

eine Plattendicke der mit dem oberen Endabschnitt der zweiten Türzarge (74) verbundenen dritten Türzarge (76a, 76b) kleiner als eine Plattendicke des oberen Endabschnitts der ersten Türzarge (72) ist;
die mit dem unteren Endabschnitt der zweiten Türzarge (74) verbundene dritte Türzarge (76a, 76b) aus einem Kanalelement zusammengesetzt ist, das zwei horizontale Abschnitte, die mit einem oberen Ende und einem unteren Ende eines senkrechten Abschnitts verbunden sind, und ein die offenen Enden der horizontalen Abschnitte verbindendes Paneel (80a) umfasst; und
ein unteres Ende der ersten Türzarge (72), die mit der mit dem unteren Endabschnitt der zweiten Türzarge (74) verbundenen dritten Türzarge (76a, 76b) verbunden ist, aus einem Kanalelement zusammengesetzt ist, das zwei horizontale Abschnitte, die mit einem oberen Ende und einem unteren Ende eines senkrechten Abschnitts verbunden sind, ein offene Enden der horizontalen Abschnitte verbindendes Paneel (80b) und ein von einem Mittenabschnitt in Höhenrichtung des Paneels (80b) in Richtung des senkrechten Abschnitts verlaufendes Paneel (81b) umfasst.

2. Schienenfahrzeug nach Anspruch 1, wobei ein Block (45) mit einer Waggoninnenseite einer Seite der ersten Türzarge (72) verbunden ist, und ein Endabschnitt des Blocks mit der Dachstruktur (40) verbunden ist.

3. Schienenfahrzeug nach Anspruch 1, wobei ein Block (45) mit einer Waggoninnenseite einer Seite der ersten Türzarge (72) verbunden ist, und ein Endabschnitt des Blocks mit der Dachstruktur verbunden ist; und
ein Block mit einer Waggoninnenseite der anderen Seite der Türzarge (72) verbunden ist, und ein Endabschnitt des Blocks mit dem Unterrahmen (50) verbunden ist.

Revendications

1. Véhicule ferroviaire (1) comportant un sous châssis (50), des structures latérales (20) érigées sur des côtés opposés du sous châssis (50), des structures d'extrémité (30) érigées sur des extrémités longitudinales du sous châssis (50), et une structure de toit (40) reliée à des extrémités supérieures des structures latérales (20) et des structures d'extrémité (30), dans lequel :

une zone de survie (100) est disposée au niveau d'une section centrale longitudinale du véhicule ferroviaire (1), et des zones déformables (200) sont disposées sur les extrémités longitudinales du véhicule ferroviaire (1), de telle manière à être reliées à la zone de survie (100), et
une section de porte (60) pour monter et descendre est disposée sur une extrémité longitudinale de la structure latérale de façon à être placée à cheval sur la zone déformable (200) et la zone de survie (100),
en outre dans lequel :

le véhicule ferroviaire (1) comporte une section d'extrémité de structure de toit (42) disposée sur l'extrémité longitudinale de la structure de toit (40), et une section d'extrémité de sous châssis (52) disposée sur l'extrémité longitudinale du sous châssis (50),
la section de porte (60) comporte un châssis de porte (70) disposé sur un bord d'une ouverture disposée sur l'extrémité longitudinale de la structure latérale, le châssis de porte (70) comportant : un premier châssis de porte (72) disposé dans une direction perpendiculaire à l'intérieur de la zone de survie (100), un deuxième châssis de porte (74) disposé dans une direction perpendiculaire à une section d'extrémité longitudinale de la structure latérale (20) et relié à la structure extrémité (30), et deux troisième châssis de porte (76a, 76b) reliés respectivement aux extrémités supérieures et aux extrémités inférieures du premier châssis de porte (72) et du deuxième châssis de porte (74), et s'étendant dans la direction longitudinale de la structure latérale (20),
la section d'extrémité de structure de toit (42), le deuxième châssis de porte (74), le troisième châssis de porte (76a, 76b) et la section d'extrémité de sous châssis (52) sont disposés dans la zone déformable (200),

en outre dans lequel :

la section d'extrémité de structure de toit (42) est un panneau unique relié à l'extrémité longitudinale de la structure de toit (40), et
la section d'extrémité de sous châssis (52) est constituée d'un panneau unique formé en agençant et en soudant ensemble des extrémités en butée d'éléments de forme extrudée, les éléments de forme extrudée

étant reliés à l'extrémité longitudinale du sous châssis (50) de sorte qu'une direction d'extrusion des éléments de forme extrudée correspond à une direction de largeur (500) du véhicule ferroviaire (1),

caractérisé en ce que :

une épaisseur de plaque du troisième châssis de porte (76a, 76b) relié à la section d'extrémité supérieure du deuxième châssis de porte (74) est inférieure à une épaisseur de plaque de la section d'extrémité supérieure du premier châssis de porte (72),
le troisième châssis de porte (76a, 76b) relié à la section d'extrémité inférieure du deuxième châssis de porte (74) est constitué d'un élément de canal ayant deux parties horizontales reliées à une extrémité supérieure et à une extrémité inférieure d'une partie perpendiculaire, et un panneau (80a) reliant des extrémités ouvertes des parties horizontales, et
une extrémité inférieure du premier châssis de porte (72) relié au troisième châssis de porte (76a, 76b) étant reliée à la section d'extrémité inférieure du deuxième châssis de porte (74) est constituée d'un élément de canal ayant deux parties horizontales reliées à une extrémité supérieure et à une extrémité inférieure d'une partie perpendiculaire, un panneau (80b) reliant des extrémités ouvertes des parties horizontales, et un panneau (81b) qui s'étend depuis une section centrale dans une direction de hauteur du panneau (80b) en direction de la partie perpendiculaire.

2. Véhicule ferroviaire selon la revendication 1, dans lequel
un bloc (45) est relié à un côté de la voiture d'un côté du premier châssis de porte (72), et une section d'extrémité du bloc est reliée à la structure de toit (40).

3. Véhicule ferroviaire selon la revendication 1, dans lequel
un bloc (45) est relié à un côté de la voiture d'un côté du premier châssis de porte (72), et une section d'extrémité du bloc est reliée à la structure de toit, et
un bloc est relié à un côté de la voiture de l'autre côté du premier châssis de porte (72), et une section d'extrémité du bloc est reliée au sous châssis (50).

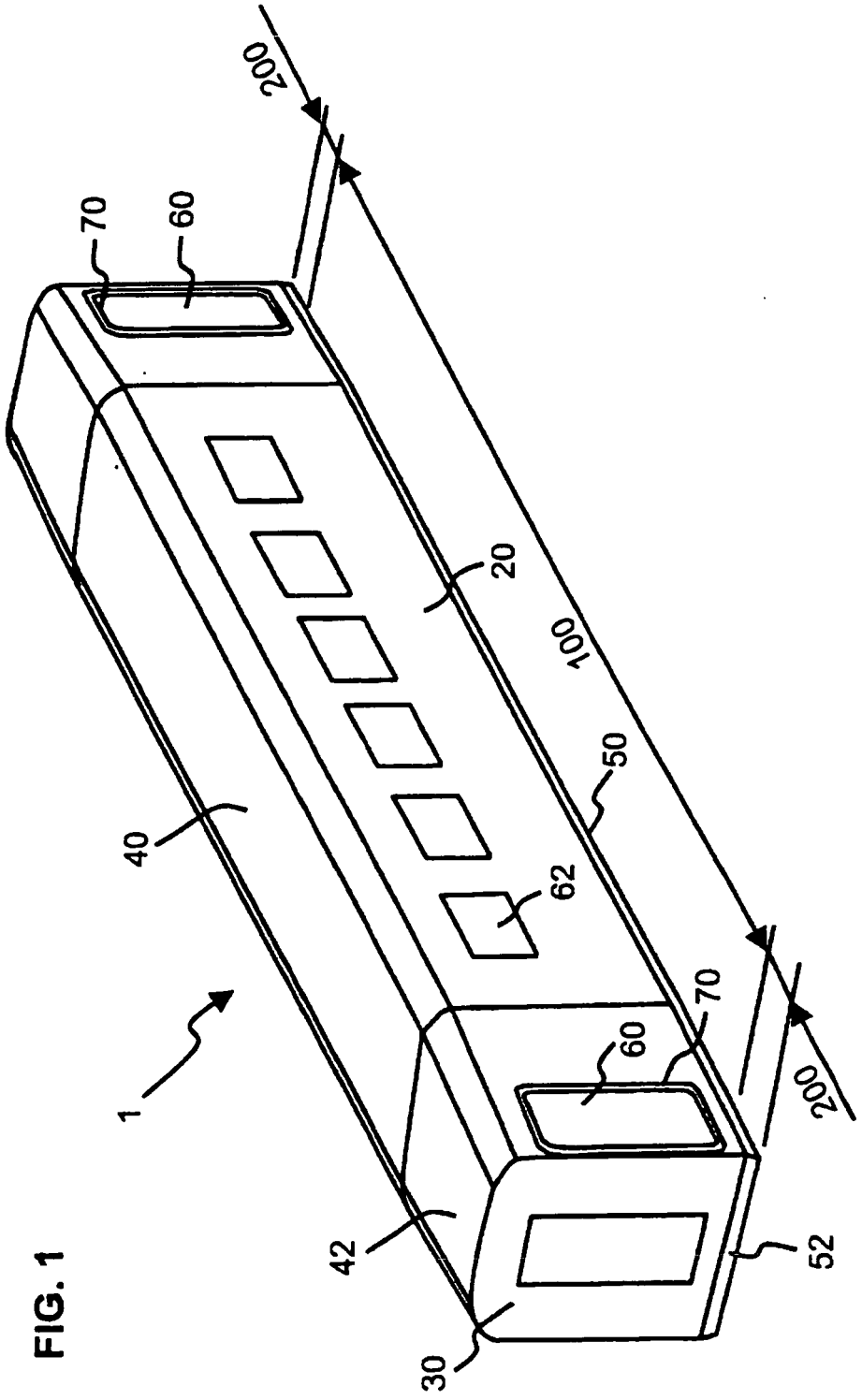


FIG. 1

FIG. 2

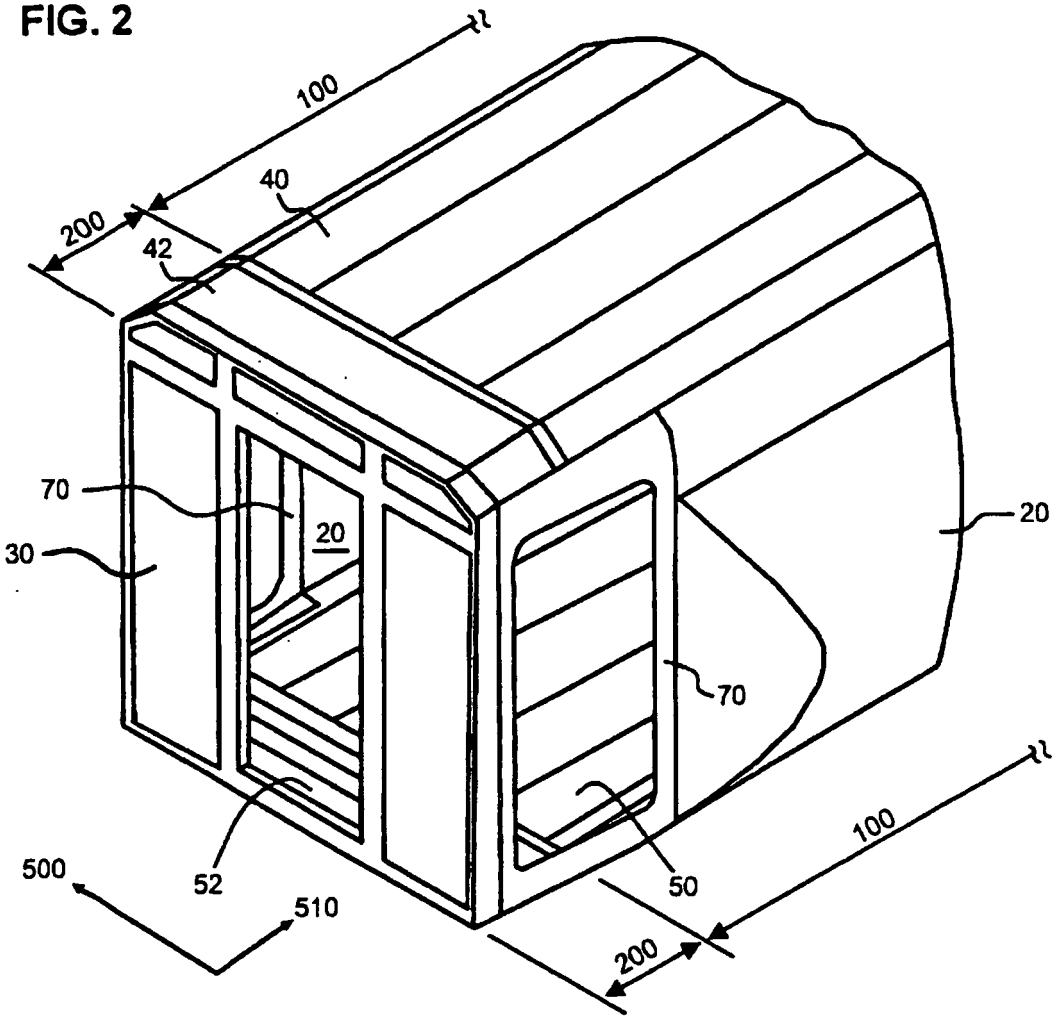


FIG. 3

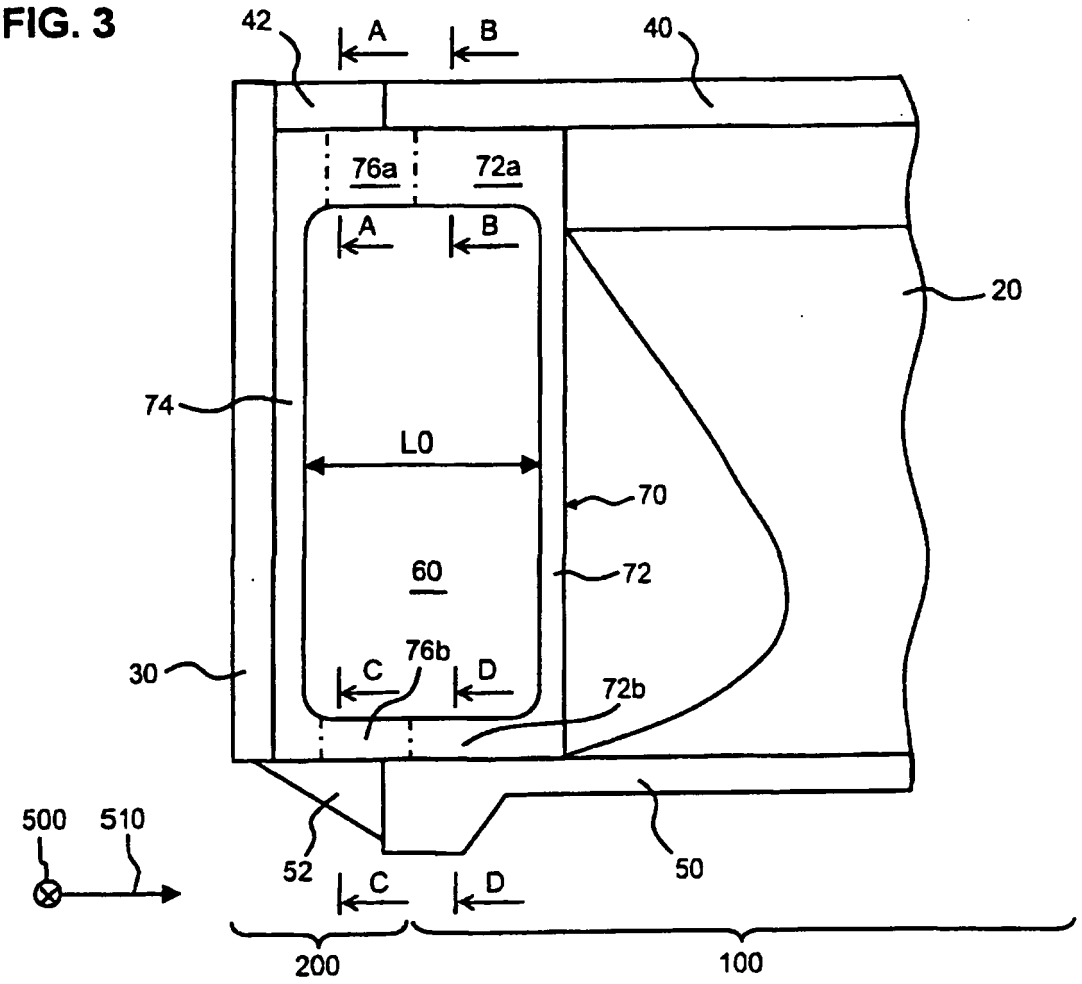

42
A
B
40
76a
72a
A
B
20
74
L0
70
60
72
30
76b
C
D
72b
500
510
52
C
D
50
200
100

FIG. 4

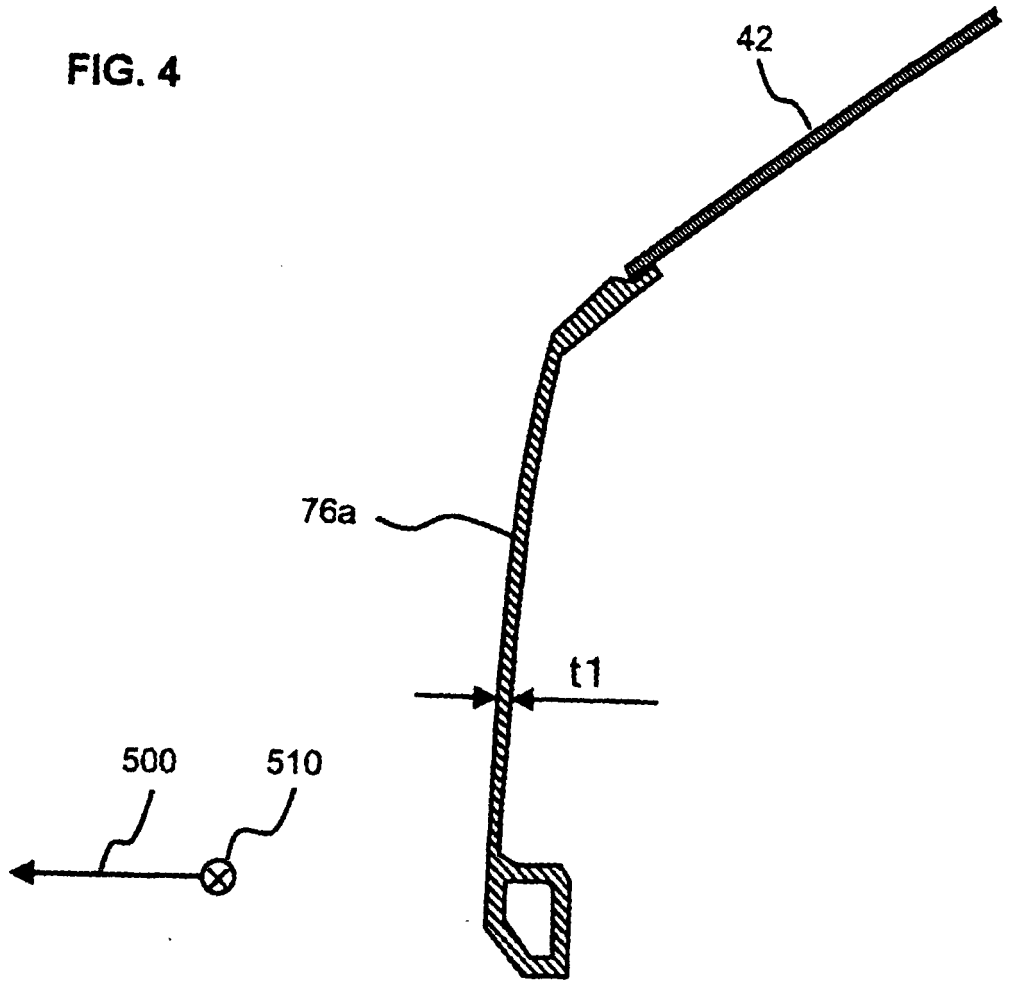


FIG. 5

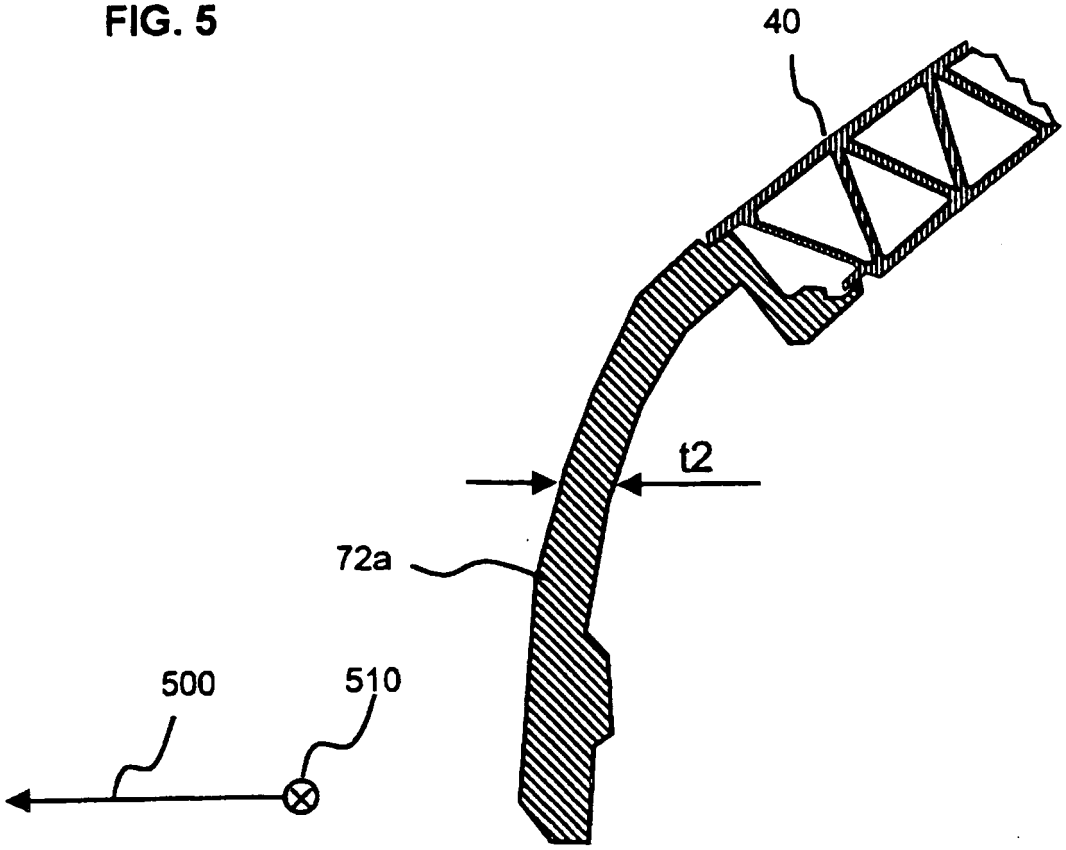


FIG. 6

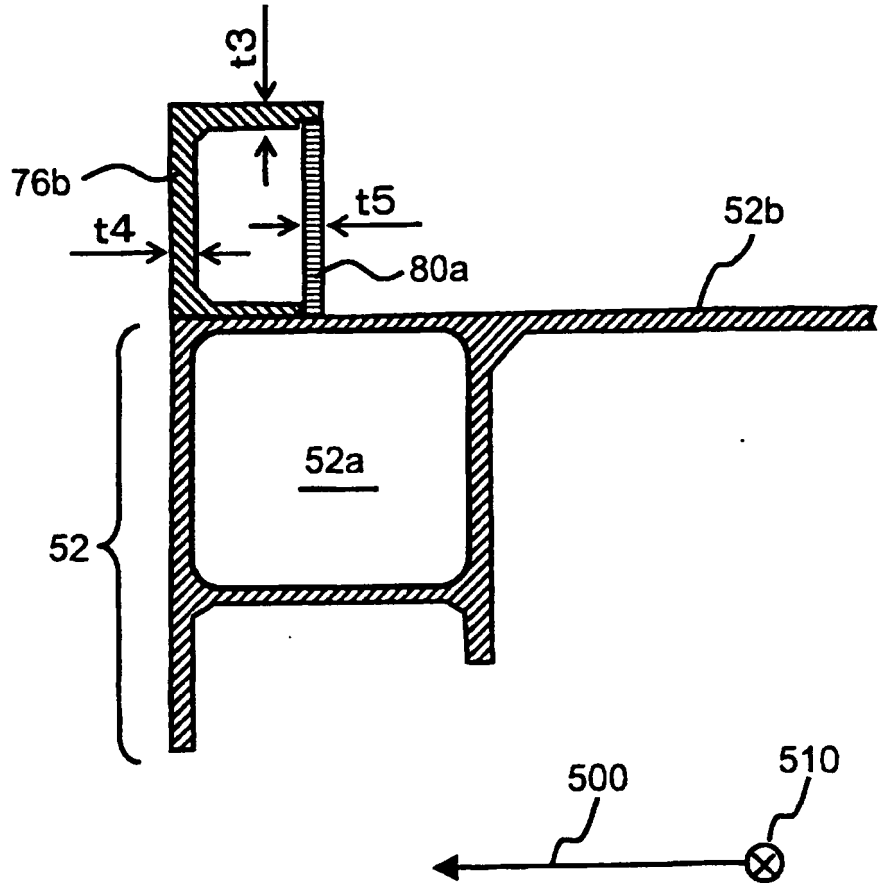
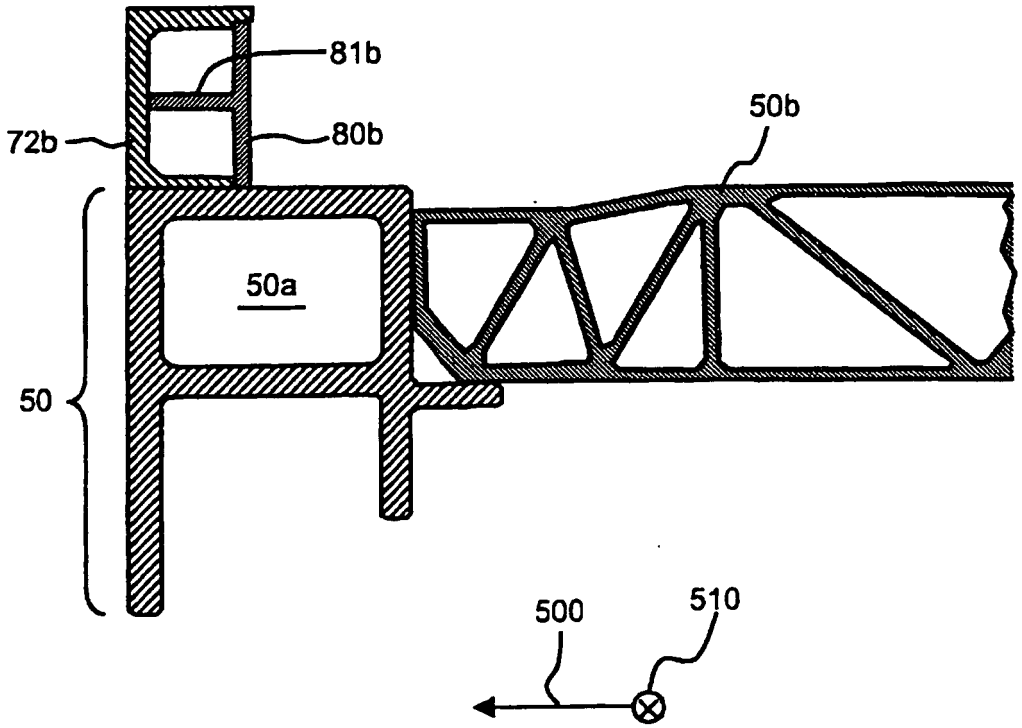


FIG. 7



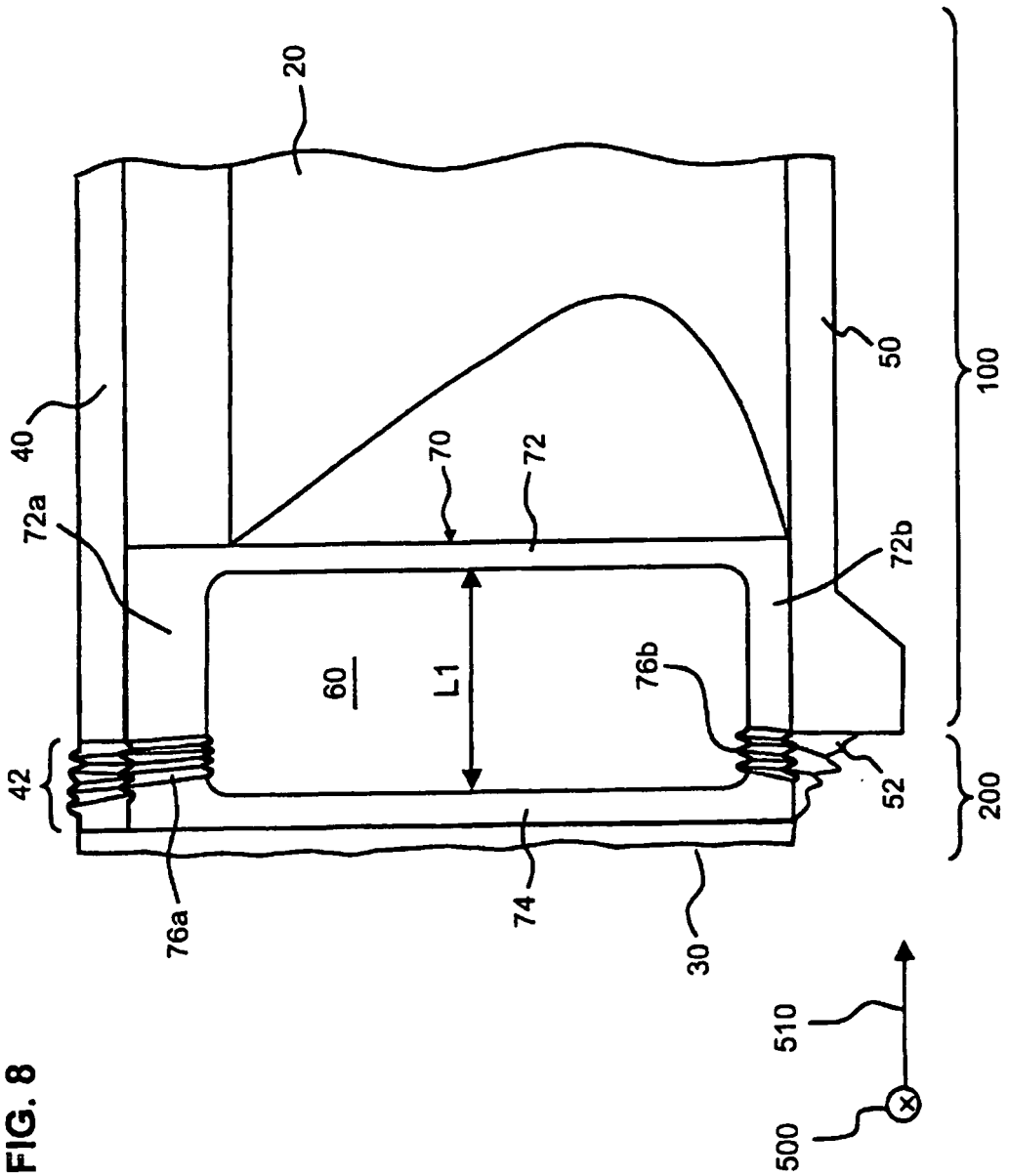


FIG. 8

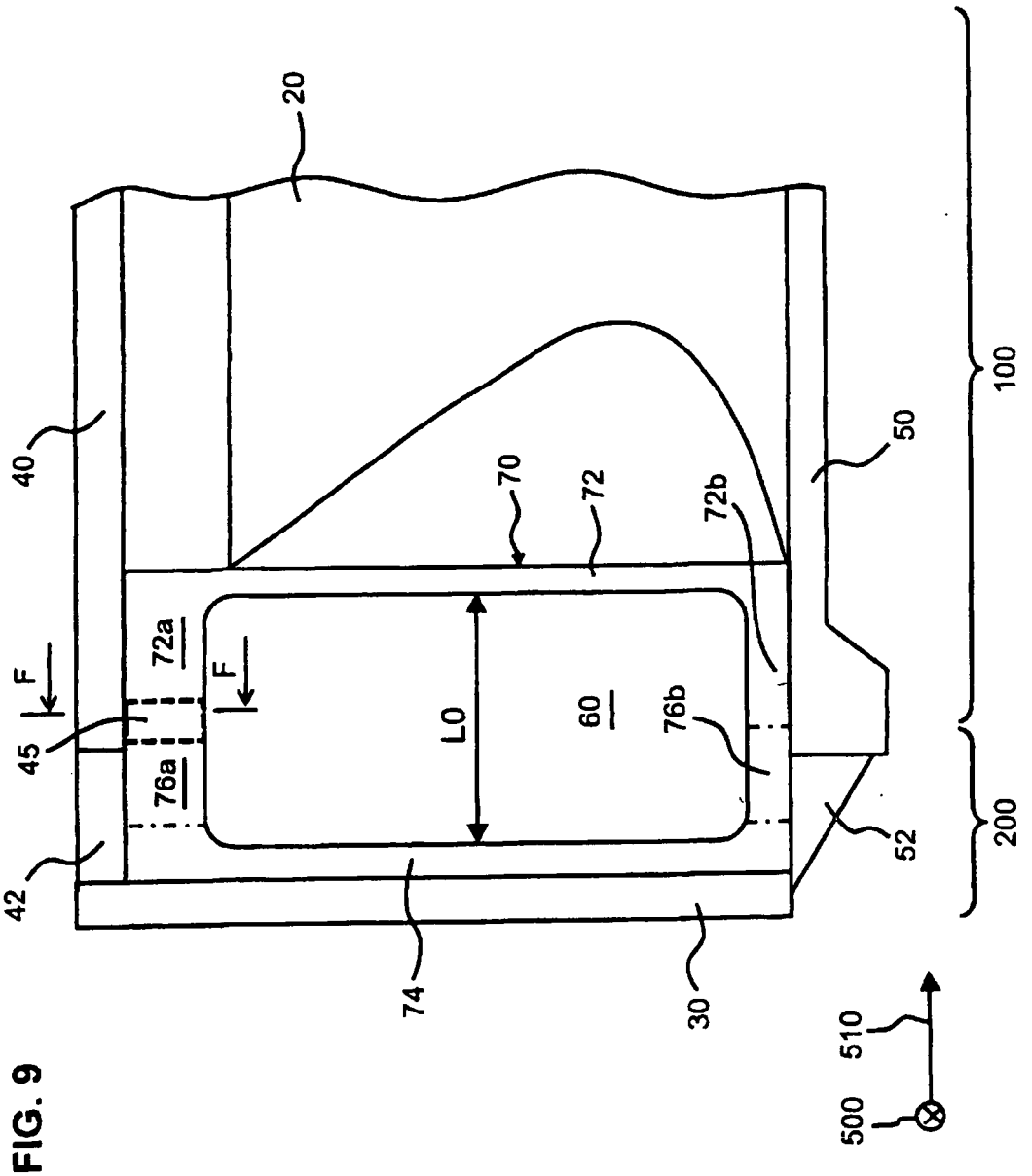

20
40
70
72
72b
50
100
72a
F
F
45
76a
L0
60
76b
42
52
200
74
30
510
500

FIG. 9

FIG. 10

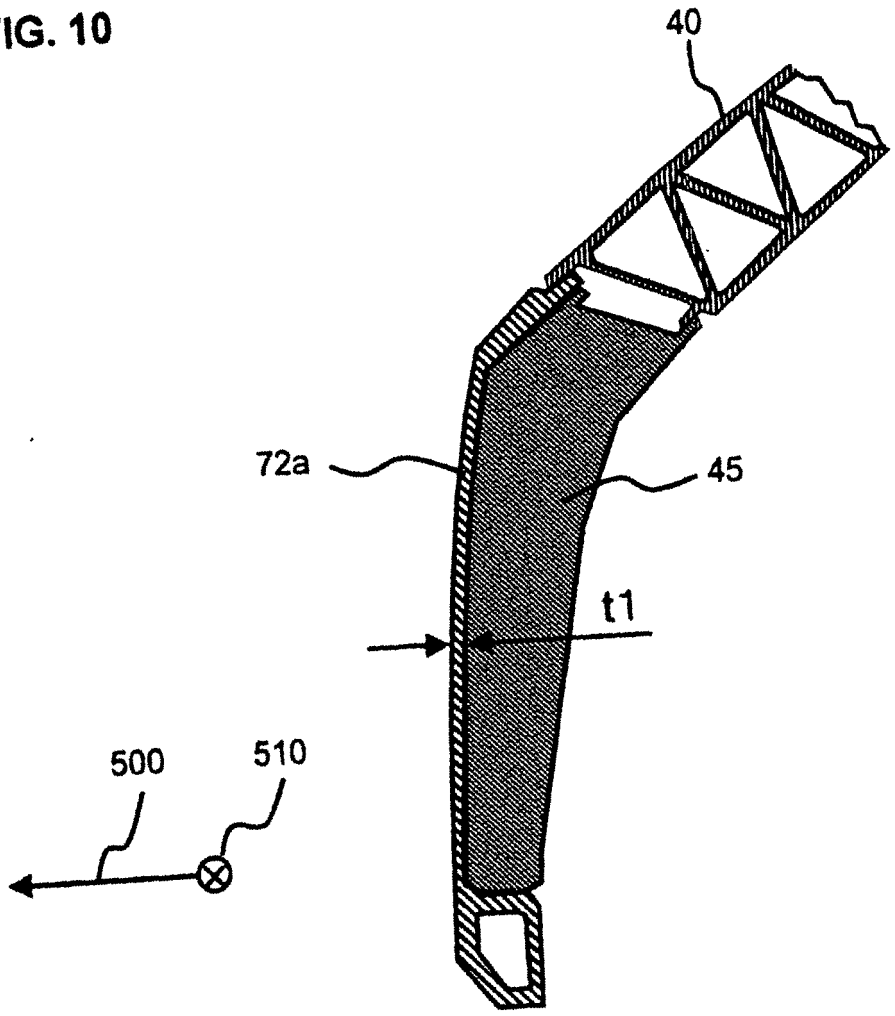


FIG. 11

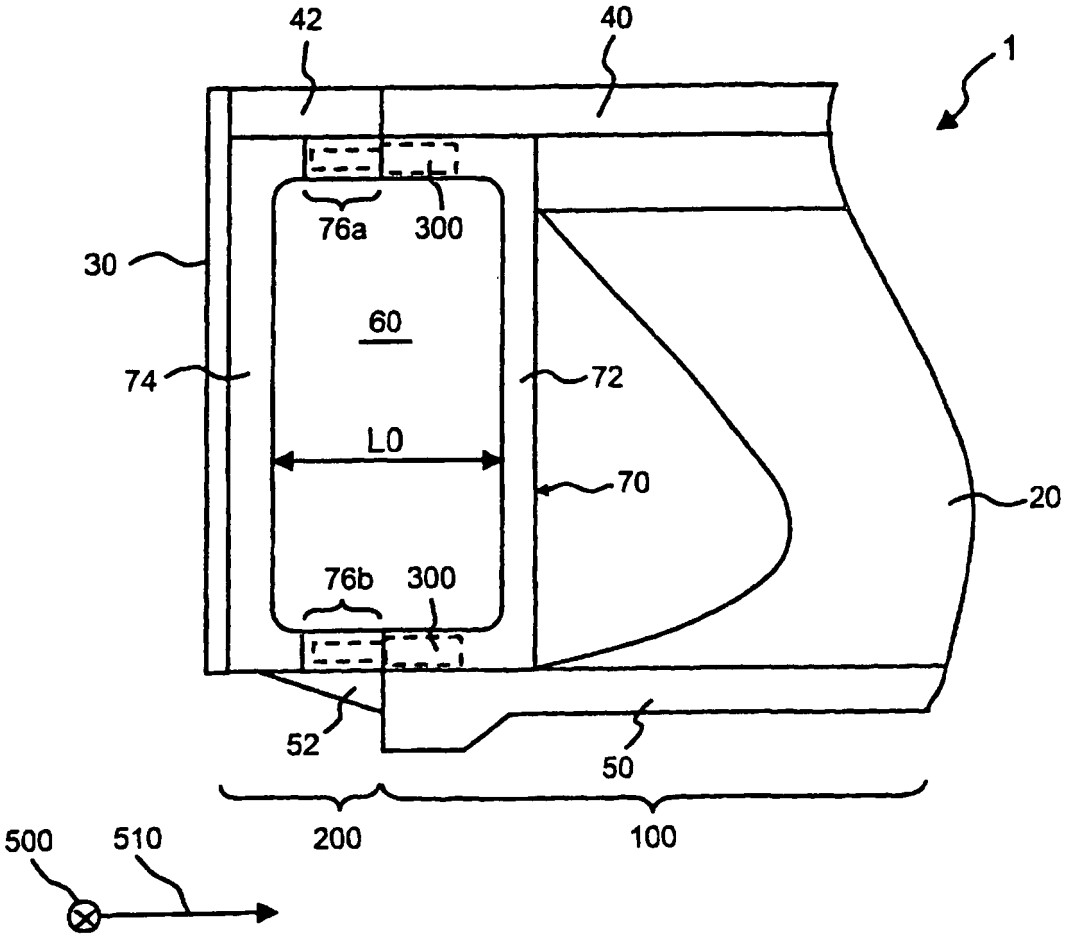


FIG. 12

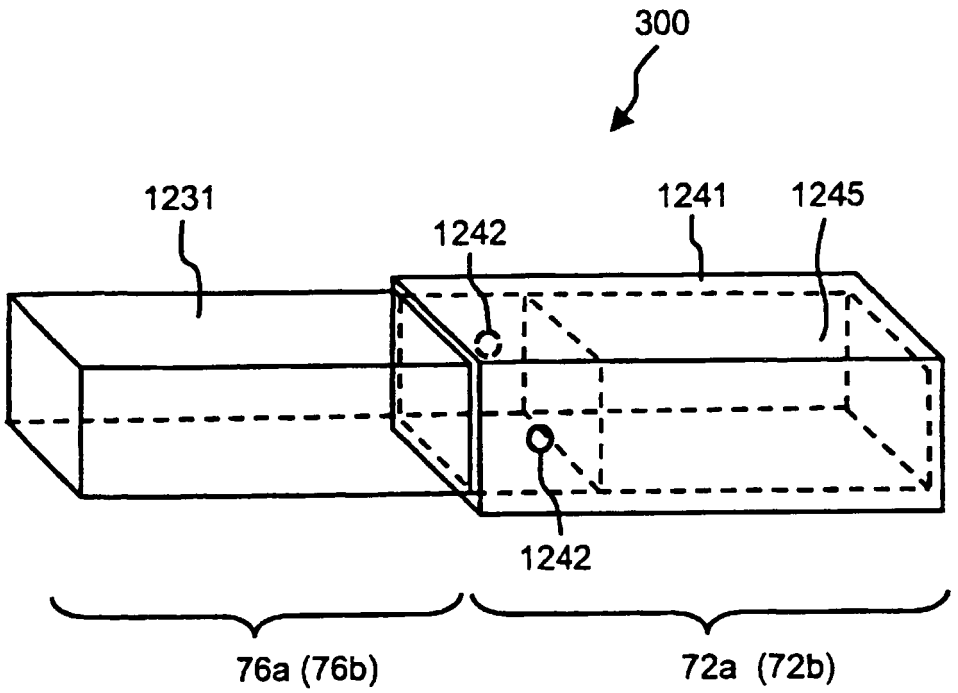


FIG. 13

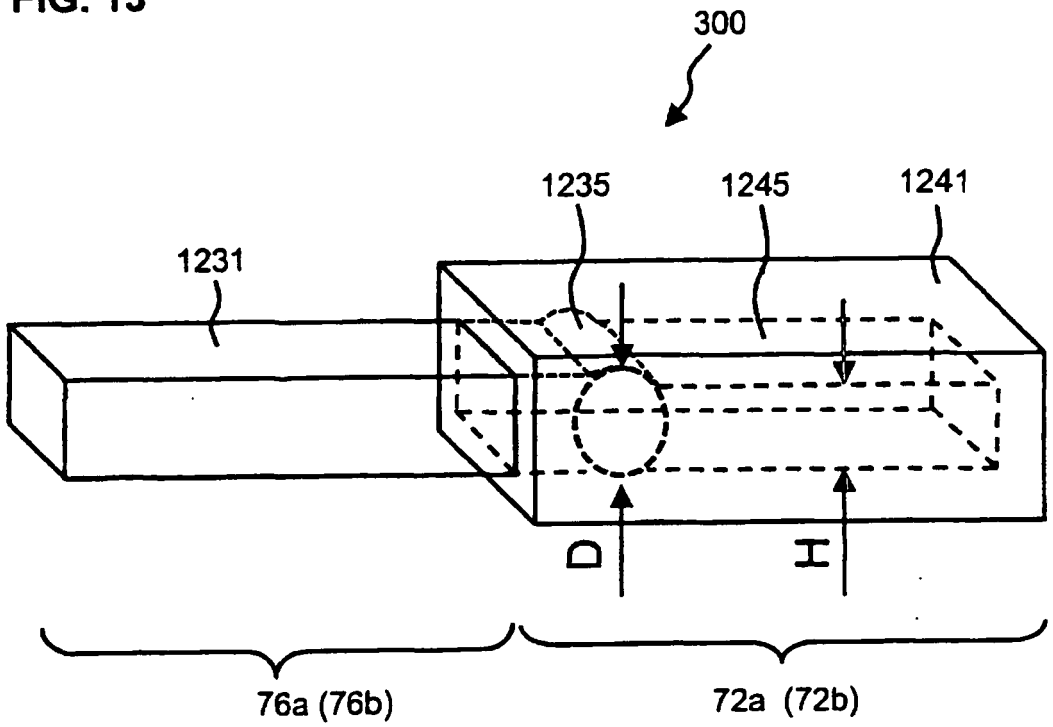
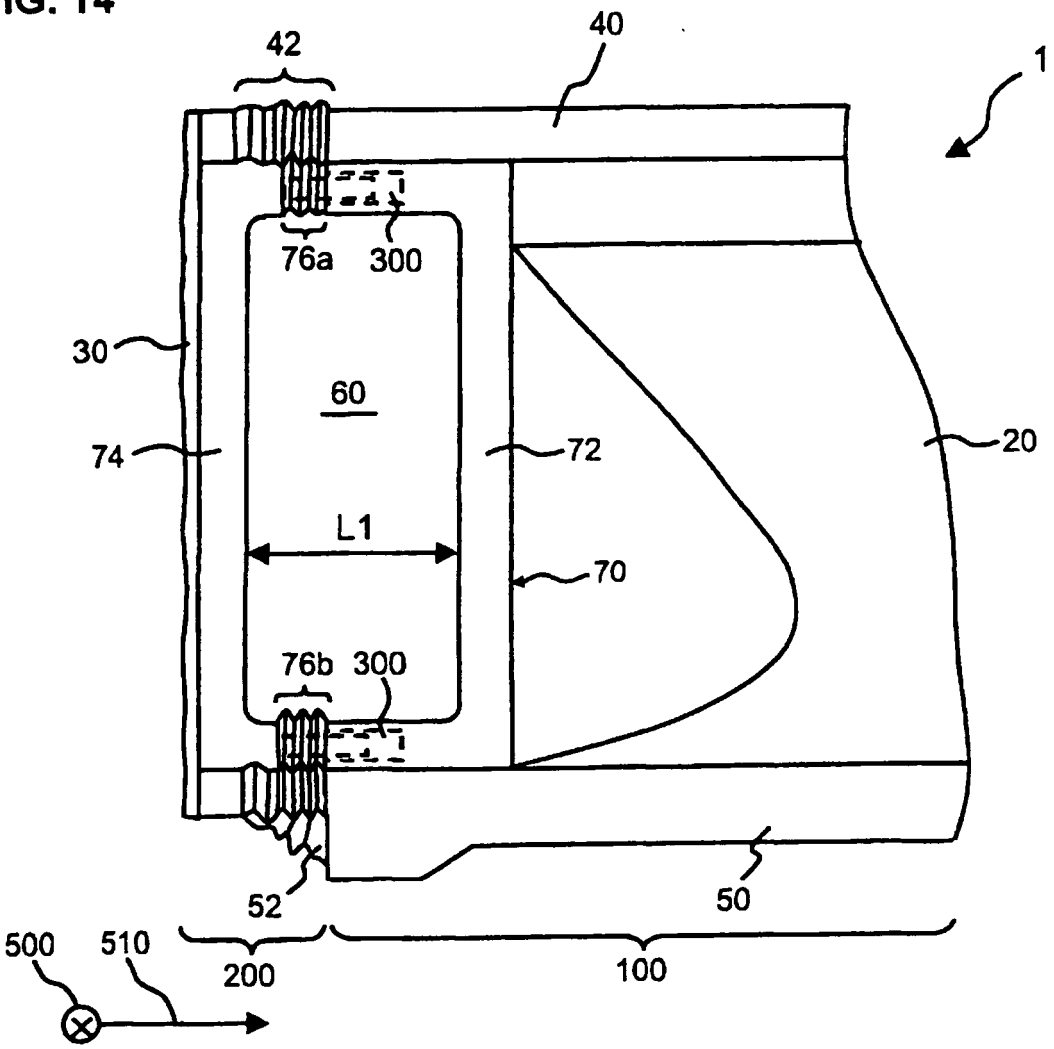


FIG. 14



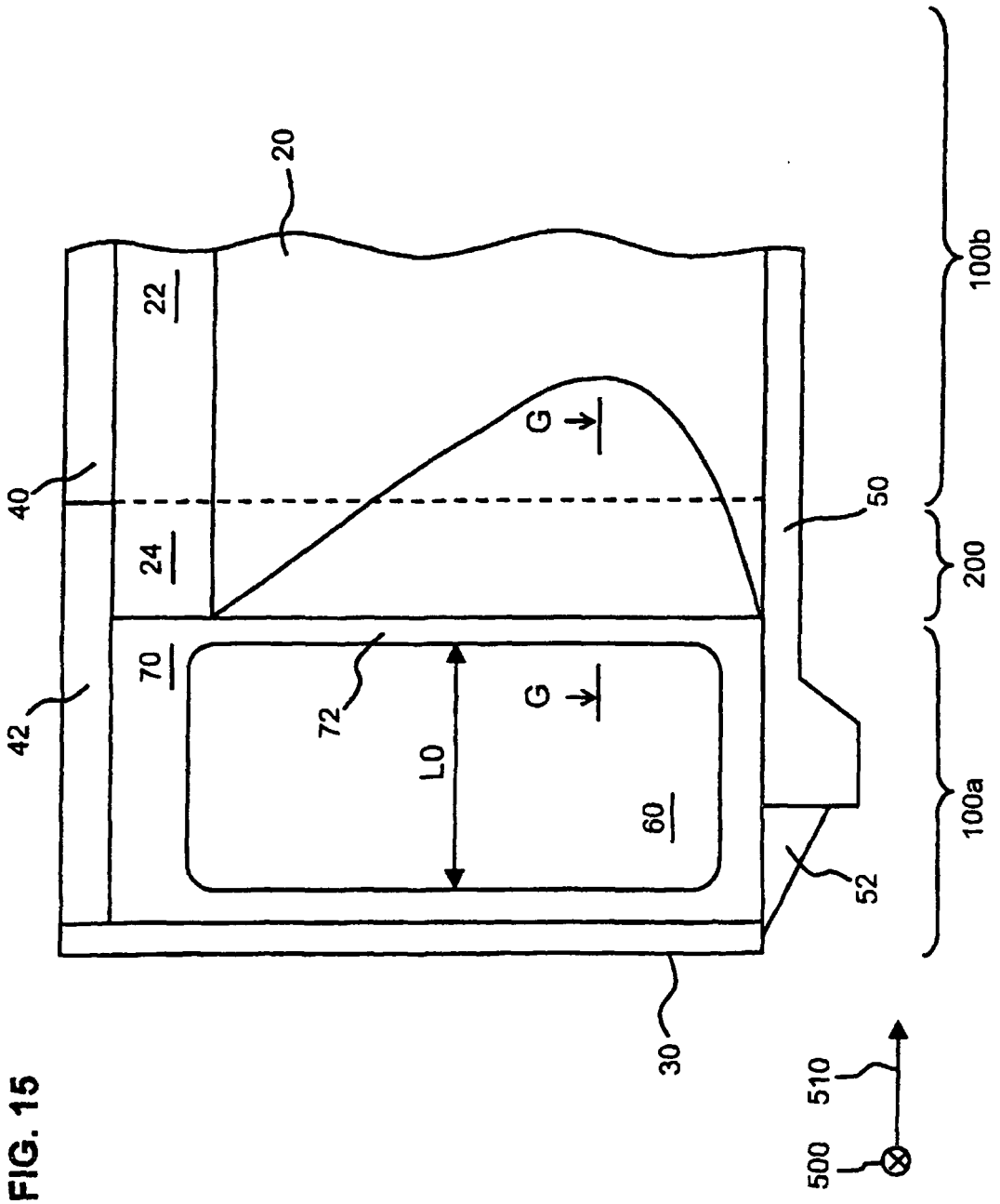


FIG. 15

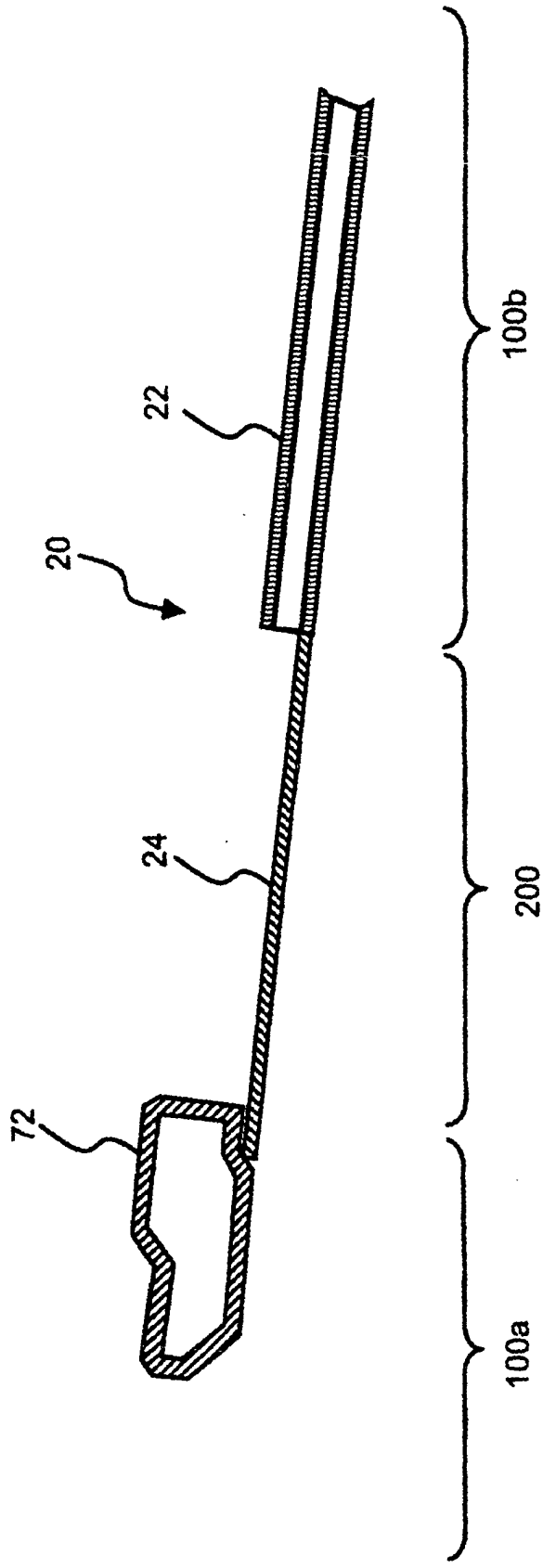


FIG. 16

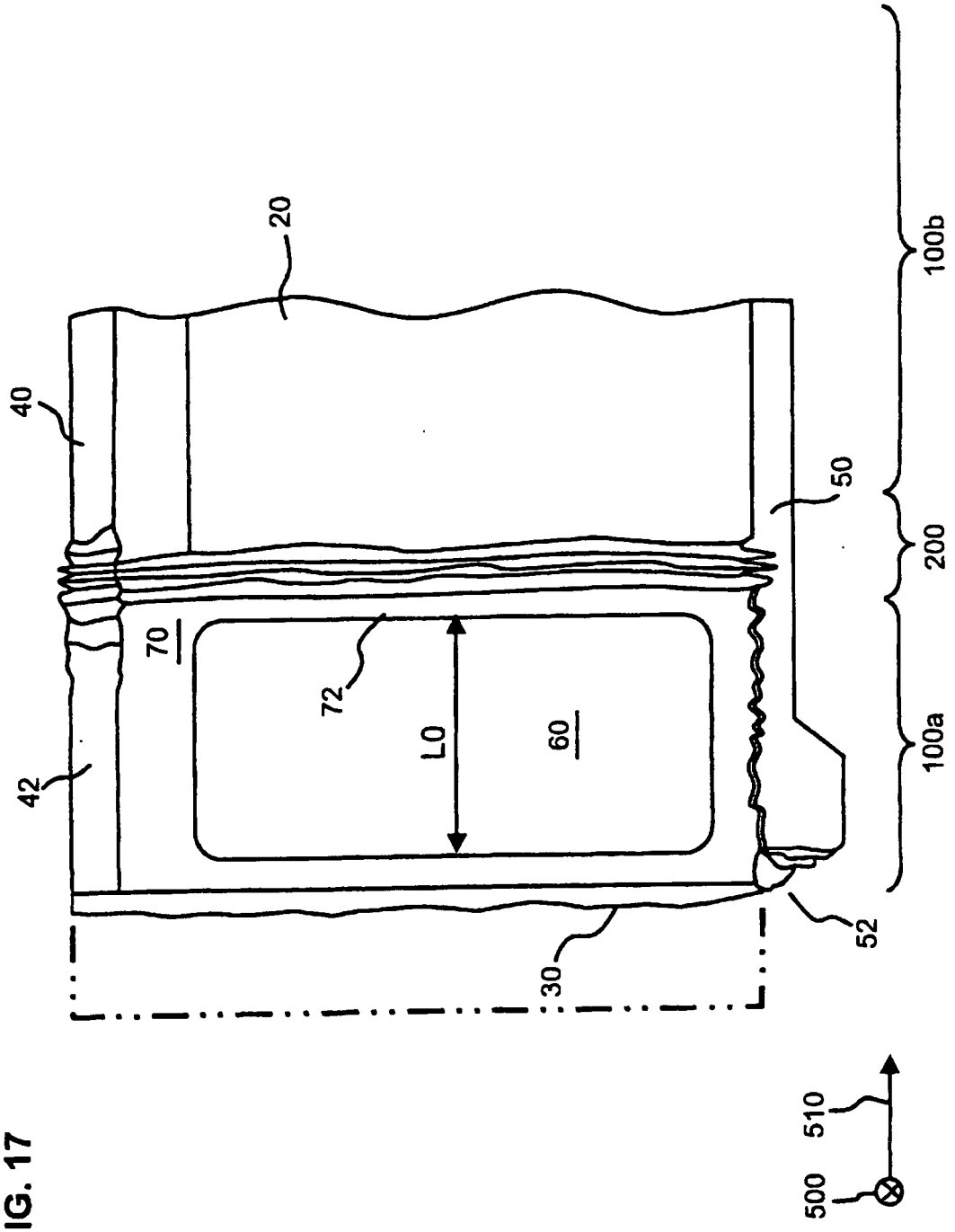


FIG. 17

REFERENCES CITED IN THE DESCRIPTION

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