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(54) Rail guard support structure of a railway vehicle

(57) In a rail guard support structure of a railway vehicle with crashworthiness, an energy absorbing pipe member 5 is provided behind a rail guard 1, a rear end portion of the energy absorbing pipe member 5 is connected to an energy absorbing element support device (support members 6, 7L, 7R, 8L, and 8R) attached to a vehicle body frame, and upper edge portions of right and left side portions of the rail guard 1 are supported by the vehicle body frame by means of a rail guard support device at a location behind a crush zone S at the front portion of the vehicle body and lateral of the energy absorbing element support device.

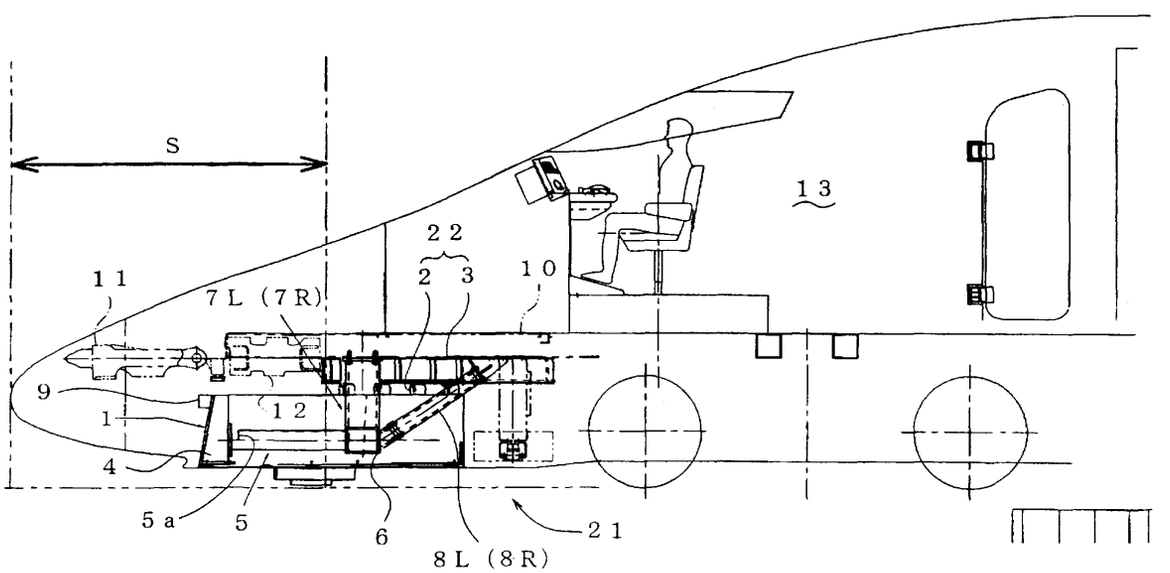

Fig. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a rail guard support structure of a railway vehicle such as a bullet train.

2. Related Art

[0002] Generally, in a railway vehicle, a rail guard device is mounted at a front portion of a vehicle to eliminate obstacles (e.g., obstacles with weight of about 100kg or less) on a track so as to be moved off the track. In order to minimize damage to a vehicle body when the rail guard device moves the obstacles off the track, it is desired that the rail guard device be hardly affected by collision energy in collision. To this end, typically, a component that is hardly deformed is provided at the front portion of the vehicle and is connected to the vehicle body through an impact absorber.

[0003] Figs. 7 and 8 show an example of the conventional rail guard support structure in which an impact absorbing plate 102 comprised of a plurality of plate springs 102a superposed to have a spacing equal to a plate thickness is provided behind and in conformity to a steel rail guard 101 that is curved to project forwardly in a direction in which the vehicle travels. In this support structure, the impact absorbing plate 102 is intended to absorb energy which remains unabsorbed as a result of deformation of the rail guard 101. The impact absorbing plate 102 is mounted to a vehicle body frame 105 (see Fig. 7) by means of an impact absorbing plate support device 103 and a mounting bracket 104. The rail guard 101 is mounted at right and left side portions to the vehicle body frame 105 through mounting brackets 106. Reference numeral 107 denotes a lug member for preventing falling of the rail guard 101.

[0004] In this structure, to deal with collision energy that increases with an increasing speed of the vehicle, a required plate thickness correspondingly increases. So, the rail guard 101 is comprised of a steel plate thicker than the vehicle body frame 105. For this reason, in collision with an obstacle, the rail guard 101 is hardly deformed, thereby causing a large collision load to be applied on the vehicle body.

[0005] As a solution to this, Japanese Laid-Open Patent Application Publication No. Hei. 2001 - 55141 discloses a lightweight rail guard device intended to enhance a function of moving obstacles off the track and minimize a collision load applied on a vehicle body. This rail guard device is structured such that both sides of a steel rail guard curved to project forwardly in the traveling direction are connected by means of a cross beam and a hollow member made of aluminum alloy is provided between the rail guard and the cross beam on a center line of the rail guard.

[0006] Since the role of the rail guard device is to eliminate obstacles on the track as described above, its rail guard (front end skirt) is firmly fixed to the cross beam of the vehicle body frame. This greatly increases strength of the front portion of the vehicle body. Therefore, when vehicles having such rail guard device actually collide with each other, impact generated in collision is tremendous. In some cases, a driver's cabin located behind the rail guard device at the front portion of the vehicle body might crush before the front portion of the vehicle body crushes. The crashworthiness of the vehicle having such a rail guard is poor, and this is undesirable to a driver and passengers. As used herein, the "crashworthiness" means that a survival zone for the driver and passengers is ensured and impact on them is relieved.

SUMMARY OF THE INVENTION

[0007] The present invention has been made under the circumstances, and an object of the present invention is to provide a rail guard support structure capable of sufficiently resisting collision.

[0008] According to the present invention, there is provided a rail guard support structure of a railway vehicle by which a rail guard for eliminating an obstacle on a track during traveling of the vehicle is supported by a vehicle body frame, characterized in that an energy absorbing element is provided behind a front portion of the rail guard to extend in a longitudinal direction of the vehicle, and a rear end portion of the energy absorbing element is attached to the vehicle body frame by means of an energy absorbing element support device, and upper edge portions of right and left side portions of the rail guard are supported by the vehicle body frame at locations lateral of the energy absorbing element support device.

[0009] As the energy absorbing element, well-known energy absorbing elements with a low peak load and a high mean reaction force, for example, a pipe member that is tubular with rectangular cross-section, may be used.

[0010] On assumption that railway vehicles collide with each other, a length of the crush zone at the front portion of the vehicle body is designed in view of various factors associated with collision. With the above construction, within the crush zone, a rigid member for supporting the rail guard is not provided, and therefore, the rail guard is not rigidly attached to the vehicle body frame. As a result, a peak load in crush within the crush zone is suppressed.

[0011] Since the energy absorbing element with a low peak load and a high mean reaction force is provided behind the front portion of the rail guard to extend in the longitudinal direction of the vehicle, the collision energy is also absorbed by the energy absorbing element. In contrast to the structure without the energy absorbing

element, the ability to absorb the collision energy is higher and impact acting on driver and passengers is relieved. Further, since the energy absorbing element absorbs large part of the collision energy generated in eliminating the obstacles, which is to be absorbed by the rail guard device, impact generated in eliminating the obstacles is relieved.

[0012] Therefore, when large collision energy is applied on the rail guard by moving obstacles off the track during traveling of the vehicle, such collision energy is absorbed by the energy absorbing element and impact applied on the driver and passenger is relieved.

[0013] It is preferable that the upper edge portions of the right and left side portions of the rail guard are attached to the vehicle body frame by means of a rail guard support device at a location forward of a driver's cabin.

[0014] Since the survival zone for the driver and passengers, including the drive's cabin, is located behind the crush zone, crush of the driver's cabin is avoided in collision and the survival zone for the driver and passengers is ensured. More specifically, the collision energy is absorbed by the energy absorbing element within the crush zone located forward of and apart from the driver's cabin. As a result, the survival zone for the driver and passengers is ensured and impact acting on them is relieved.

[0015] It is preferable that the rail guard is obliquely downwardly inclined forwardly or laterally, a block that is of a substantially rectangular parallelepiped shape is attached to a vicinity of an upper edge portion of the front portion of the rail guard, and a lower edge portion of the front portion of the rail guard is located substantially vertically below a front face of the block.

[0016] With this construction, since the block of the substantially rectangular parallelepiped shape is attached to the vicinity of the upper edge portion of the front portion of the rail guard and the lower edge portion of the front portion of the rail guard is located substantially vertically below the front face of the block, the upper-side portion (block) of the rail guard and the lower-side portion of the rail guard collide simultaneously in collision between vehicles. Therefore, the vertical load generated by a rake angle of the rail guard is reduced and crush and deformation of the rail guard occurs in the longitudinal direction of the vehicle.

[0017] The above and further objects and features of the invention will more fully be apparent from the following detailed description with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a side view showing a rail guard support structure of a railway vehicle according to the present invention;

Fig. 2 is a plan view of Fig. 1;

Figs. 3(a) to 3(d) are schematic views showing simulation analysis results of deformation of a rail guard having the structure of the present invention, which deformation is caused by a collision load generated by colliding a rigid body ball of 100kg mass with the center of the rail guard at a speed of 300 km/h;

Fig. 4 is a view showing a reaction force as a function of time of a rail guard device (rail guard) in the direction in which the vehicle travels, which change is caused by colliding the rigid body ball of 100kg mass with the rail guard device having the rail guard support structure of the present invention from its front toward its center;

Figs. 5(a) to 5(c) are schematic views showing a result of simulation analysis of deformation of the rail guard having the structure of the present invention, which deformation is caused by a collision load generated by colliding the rail guard with the rigid body ball of 100kg mass at a speed of 300 km/h deviating from the center of the rail guard;

Figs. 6(a) to 6(d) are views showing a result of simulation analysis of deformation of a vehicle body having the structure of the present invention, which deformation is caused by colliding a rigid wall with the vehicle body;

Fig. 7 is a side view showing the conventional rail guard support structure of a railway vehicle; and

Fig. 8 is a plan view of Fig. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Hereinafter, an embodiment of the present invention will be described with reference to the accompanying drawings.

[0020] Referring now to Figs. 1 and 2, a rail guard 1 for eliminating obstacles on a track during traveling of a vehicle is bent like horseshoe to be entirely curved to project forwardly and is comprised of a front portion 1A and right and left side portions 1B and 1C extending rearwardly from right and left ends of the front portion 1A. The rail guard 1 is suspended from a vehicle body frame 10 by means of a rail guard support device 22 having a plurality of rail guard fitting members 2 and an upper support member 3. That is, the front portion 1A of the rail guard 1 is not directly supported by the vehicle body frame 10. More specifically, behind a crush zone S, upper edge portions of the right and left side portions 1B and 1 C of the rail guard 1 are fixed to the upper support member 3 by means of the plurality of fitting members 2. The upper support member 3 is attached to the vehicle body frame 10. The vehicle body structure within the crush zone S is designed to absorb collision energy by plastic deformation.

[0021] A coupling bracket 4 protrudes rearwardly from the rear side of the front portion 1A of the rail guard 1. The coupling bracket 4 is coupled to a front end portion of an energy absorbing pipe member 5 that is tubular

with rectangular cross-section as an energy absorbing element extending in the longitudinal direction of the vehicle body. Unlike the conventional structure, behind the rail guard 1, there is no impact absorbing plate comprised of a plurality of superposed plate springs and provided so as to conform to the rail guard 1. The energy absorbing pipe member 5 extends along a center axis of the vehicle. The energy absorbing pipe member 5 has a cutout portion 5a formed in an upper surface of the vicinity of a front end thereof to open upwardly and to be laterally symmetric with respect to the center axis of the vehicle. The front end portion of the energy absorbing pipe member 5 provided with the cutout portion 5a functions as a trigger portion that triggers bellows-like deformation of the energy absorbing pipe member 5 to absorb energy. The use of the energy absorbing pipe member 5 that is tubular with rectangular cross-section instead of the conventional impact absorbing plate 5 is advantageous in reducing weight.

[0022] A plurality of energy absorbing pipe members 5 may be provided. In that case, it is preferable that the plurality of pipe members 5 are laterally symmetric with respect to the center axis of the vehicle. This is because, upon impact in the center axis direction of the vehicle acting on the front end portion of the rail guard 1, the load acts on the respective energy absorbing pipe members (energy absorbing elements) properly in balance, and therefore, the energy absorbing pipe members absorb the energy by the bellows-like deformation without turning over.

[0023] A rear end portion of the energy absorbing pipe member 5 is connected to a lower support member 6 extending in the lateral direction of the vehicle body. The lower support member 6 is a closed box-like member. Right and left end portions of the lower support member 6 are connected to lower end portions of the right and left support members 7L and 7R vertically extending. Upper end portions of the right and left support members 7L and 7R are fastened to the vehicle body frame 10 behind the crush zone S. The lower support member 6 is connected to the vehicle body frame 10 by means of right and left inclined support members 8L and 8R located behind the lower support member 6 and extending rearwardly and obliquely upwardly. Thus, the support members 6, 7L, 7R, 8L and 8R constitute an energy absorbing element support device 21 for supporting the rear end portion of the energy absorbing pipe member 5.

[0024] As described above, the upper edge portions of the right and left side portions 1B and 1C of the rail guard 1 are supported by the vehicle body frame 10 by means of the rail guard support device 22 (comprised of the rail guard fitting members 2 and the upper support member 3) at positions lateral of the energy absorbing element support device 21. Therefore, the upper edge portions of the right and left side portions 1B and 1 C of the rail guard 1 are attached to the vehicle body frame 10 by means of the rail guard support device 22 at a location forward of the driver's cabin 13 located behind the crush zone S.

[0025] Since the energy absorbing pipe member 5 is located behind the rail guard 1 and the rear end portion of the pipe member 5 is connected to the energy absorbing element support device 21 (support members 6, 7L, 7R, 8L, and 8R) attached to the vehicle body frame 10, a deformation stroke for absorbing collision energy becomes sufficiently long. In addition, the rail guard 1 is supported by means of the rail guard support device 22 (support members 2 and 3) behind the crush zone S. This eliminates a need for a support device rigidly supporting the rail guard within the crush zone S. That is, the rail guard is not rigidly mounted. As a result, a peak load in collision is suppressed and the crashworthiness of the vehicle is improved.

[0026] In particular, since the survival zone for driver and passengers including the driver's cabin 13 is located behind the crush zone S, crush of the driver's cabin 13 is prevented in collision and the survival zone for the driver and passengers is ensured. Since the collision energy is absorbed by the collision energy absorbing pipe member 5 within the crush zone S located forward of and apart from the driver's cabin 13, the survival zone for the drive and passengers is ensured and impact acting on the driver and passengers is relieved.

[0027] As shown in Fig. 1, the rail guard 1 is obliquely downwardly inclined forwardly or laterally. A block 9 that is of a substantially rectangular parallelepiped shape is attached to a vicinity of the upper edge portion of the front portion of the rail guard 1. A lower edge portion of the front portion of the rail guard 1 is located vertically below a front face of the block 9. The front face of the block 9 is flat within a substantially vertical plane and a rear face thereof is inclined so as to conform to the rail guard 1. With this construction, when vehicles collide with each other, an upper-side portion of the rail guard 1 (front face of the block 9) and a lower-side portion of the rail guard 1 (lower edge portion of the rail guard 1) collide simultaneously. As a result, a vertical load generated by a rake angle (angle with respect to a vertical plane) of the rail guard 1 is reduced, and crush and deformation of the rail guard 1 occurs in the longitudinal direction of the vehicle.

[0028] During traveling of the vehicle, when large collision energy acts on the rail guard 1 by eliminating the obstacles on the track, the rail guard 1 crushes to absorb collision energy and the energy absorbing pipe member 5 is deformed like bellows to absorb the collision energy. Therefore, an effect of absorbing the collision energy is equal to or higher than that of the conventional structure (structure comprising the impact absorbing plate having a plurality of plate springs superposed and provided behind and in conformity to the rail guard).

[0029] Figs. 3(a) to 3(d) show simulation results of deformation of the rail guard having the above-mentioned rail guard support structure, which deformation is caused by a collision load generated when a rigid body ball of 100kg mass collides with the center of the rail

guard at a speed of 300km/h. Fig. 4 shows the resulting reaction force of the rail guard (rail guard device). Figs. 3(a) to 3(d) show deformations occurring when elapse time T after the collision is 0sec, 0.006sec, 0.012sec, and 0.03sec.

[0030] As can be sheen from Figs. 3(a) to 3(d) and Fig. 4, when the rigid body ball of 100 kg mass collides with the rail guard at a speed of 300km/h from its front toward its center, the collision energy is absorbed and reduced by deformation of the rail guard and the bellows-like deformation of the energy absorbing pipe member within the crush zone S for 0.03 second after the collision. As can be seen from the graph in Fig. 4, from T = 0 second to T = 0.03 second, the reaction force of the rail guard (rail guard device) in the direction in which the vehicle travels is smaller than 80tonf and therefore, a peak load in collision is not so large.

[0031] In the same manner, Figs. 5(a) to 5(c) show deformation of the rail guard having the above-mentioned structure when the rigid body ball of 100kg mass collides with the rail guard at a speed of 300km/h at a position deviating from the center of the rail guard (rightwardly offset about 750mm from the center of the vehicle body). Figs. 5(a) to 5(c) show deformations occurring when an elapse time T after the collision is 0sec, 0.015sec, and 0.03sec.

[0032] As shown in Figs. 5(a) to 5(c), when the rigid body ball of 100 kg mass collides with the rail guard at 300km/h at the position deviating from the center, the resulting collision energy is absorbed mainly by deformation of the rail guard and a reaction force for moving the rigid body ball off the track is generated for 0.03 second after the collision, because an attack angle of the rigid body ball with respect to the rail guard is small.

[0033] Further, Figs. 6(a) to 6(e) show a result of simulation analysis of deformation of the vehicle body having the above rail guard support structure, which deformation is caused by a collision load generated by colliding a rigid wall Ob with the vehicle body. Figs. 6(a) to 6(c) show deformations occurring when deformation strokes Ds are 0mm, 250mm, 500mm, 750mm, and 1000mm.

[0034] In this embodiment, while the energy absorbing pipe member that is tubular with rectangular cross-section is used as the energy absorbing element, because this pipe member is easily deformed like bellows to absorb energy and has a reduced weight, other well-known energy absorbing elements may be used.

[0035] Numerous modifications and alternative embodiments of the invention will be apparent to those skilled in the art in view of the foregoing description. Accordingly, the description is to be construed as illustrative only, and is provided for the purpose of teaching those skilled in the art the best mode of carrying out the invention. The details of the structure and/or function may be varied substantially without departing from the spirit of the invention and all modifications which come within the scope of the appended claims are reserved.

Claims

1. A rail guard support structure of a railway vehicle by which a rail guard for eliminating an obstacle on a track during traveling of the vehicle is supported by a vehicle body frame, **characterized in that**

   an energy absorbing element is provided behind a front portion of the rail guard to extend in a longitudinal direction of the vehicle, and a rear end portion of the energy absorbing element is attached to the vehicle body frame by means of an energy absorbing element support device, and

   upper edge portions of right and left side portions of the rail guard are supported by the vehicle body frame at locations lateral of the energy absorbing element support device.

2. The rail guard support structure of a railway vehicle according to Claim 1, wherein the upper edge portions of the right and left side portions of the rail guard are attached to the vehicle body frame by means of a rail guard support device at a location forward of a driver's cabin.

3. The rail guard support structure of a railway vehicle according to Claim 1, wherein the rail guard is obliquely downwardly inclined forwardly or laterally, a block that is of a substantially rectangular parallelepiped shape is attached to a vicinity of an upper edge portion of the front portion of the rail guard, and a lower edge portion of the front portion of the rail guard is located substantially vertically below a front face of the block.

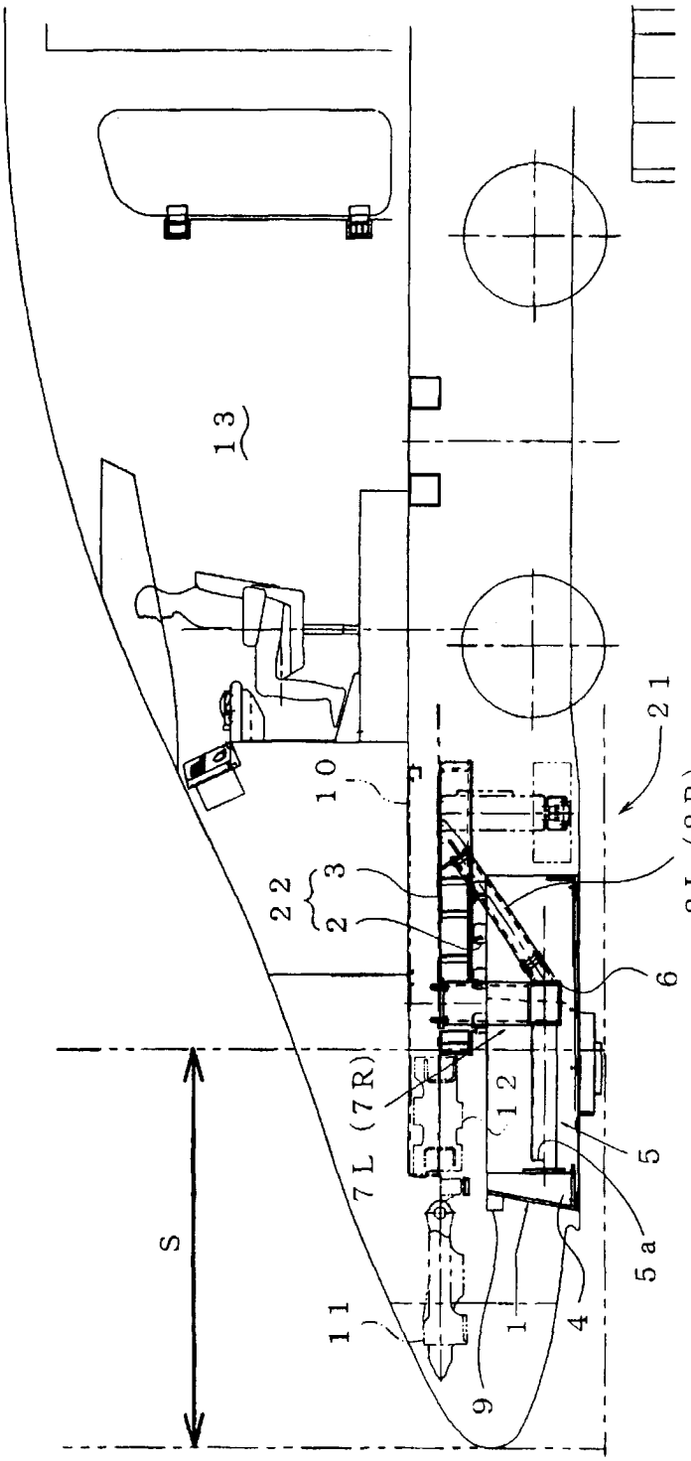

Fig. 1

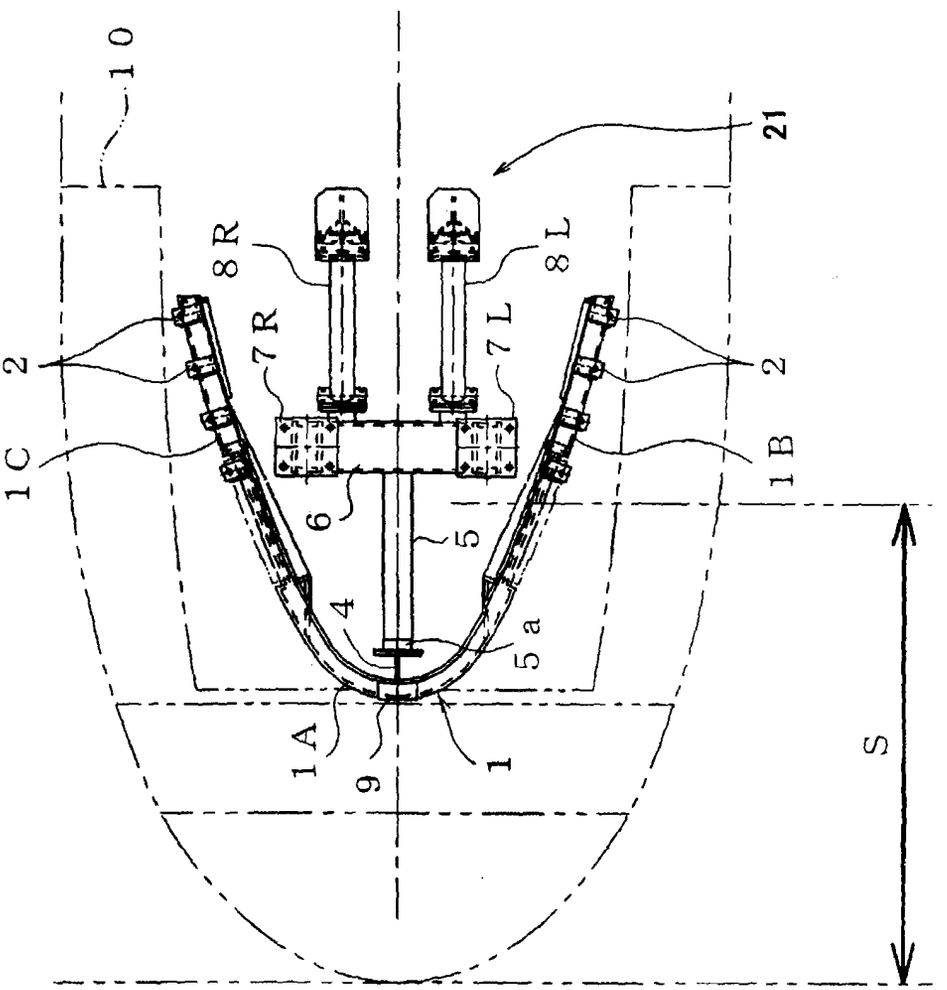

Fig. 2

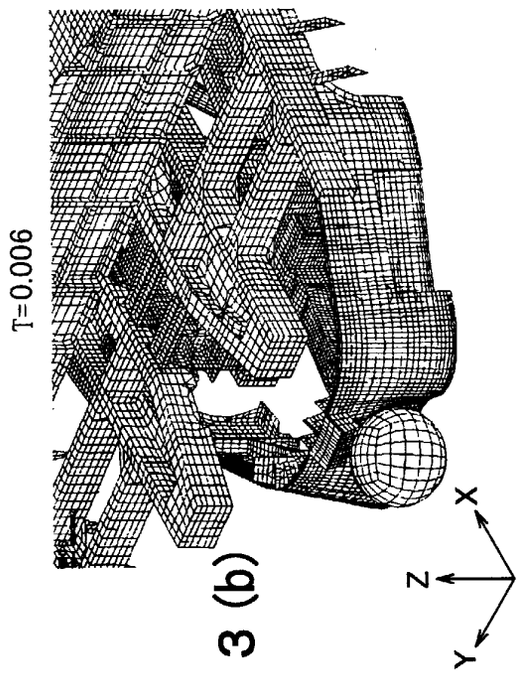

Fig. 3 (b)

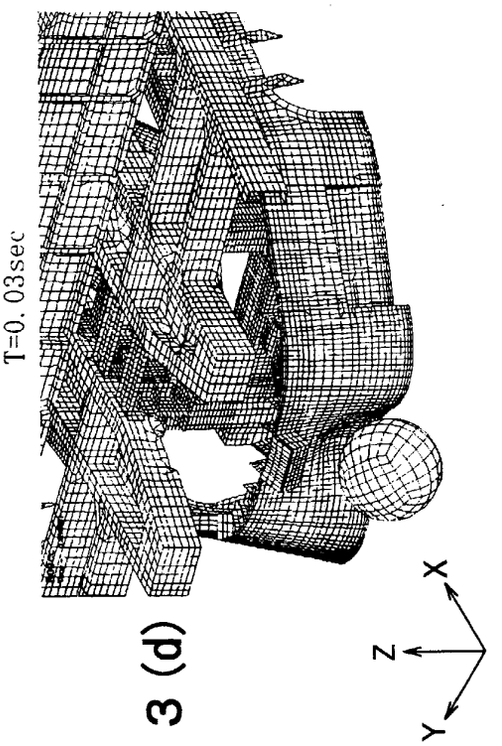

Fig. 3 (d)

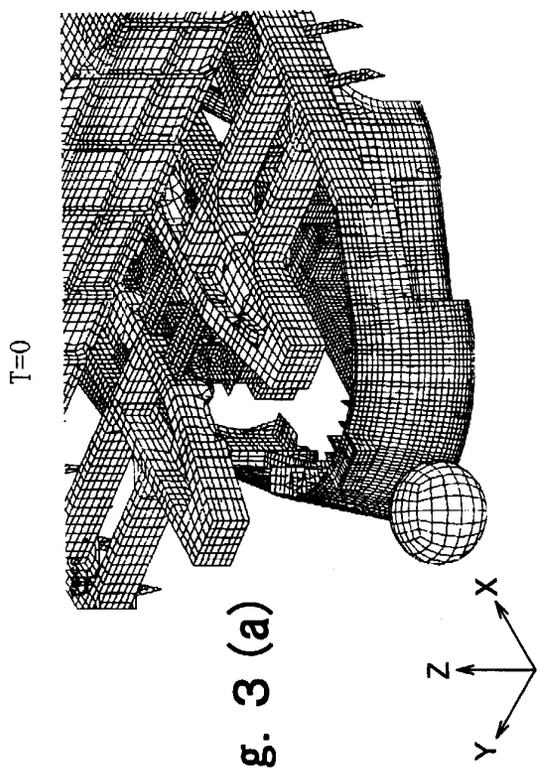

Fig. 3 (a)

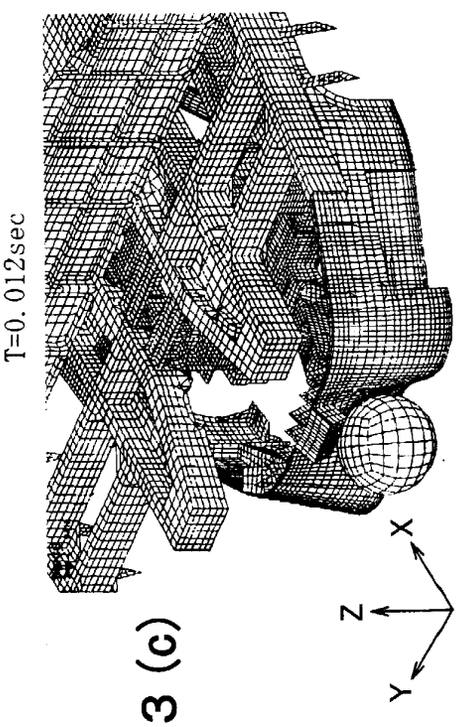

Fig. 3 (c)

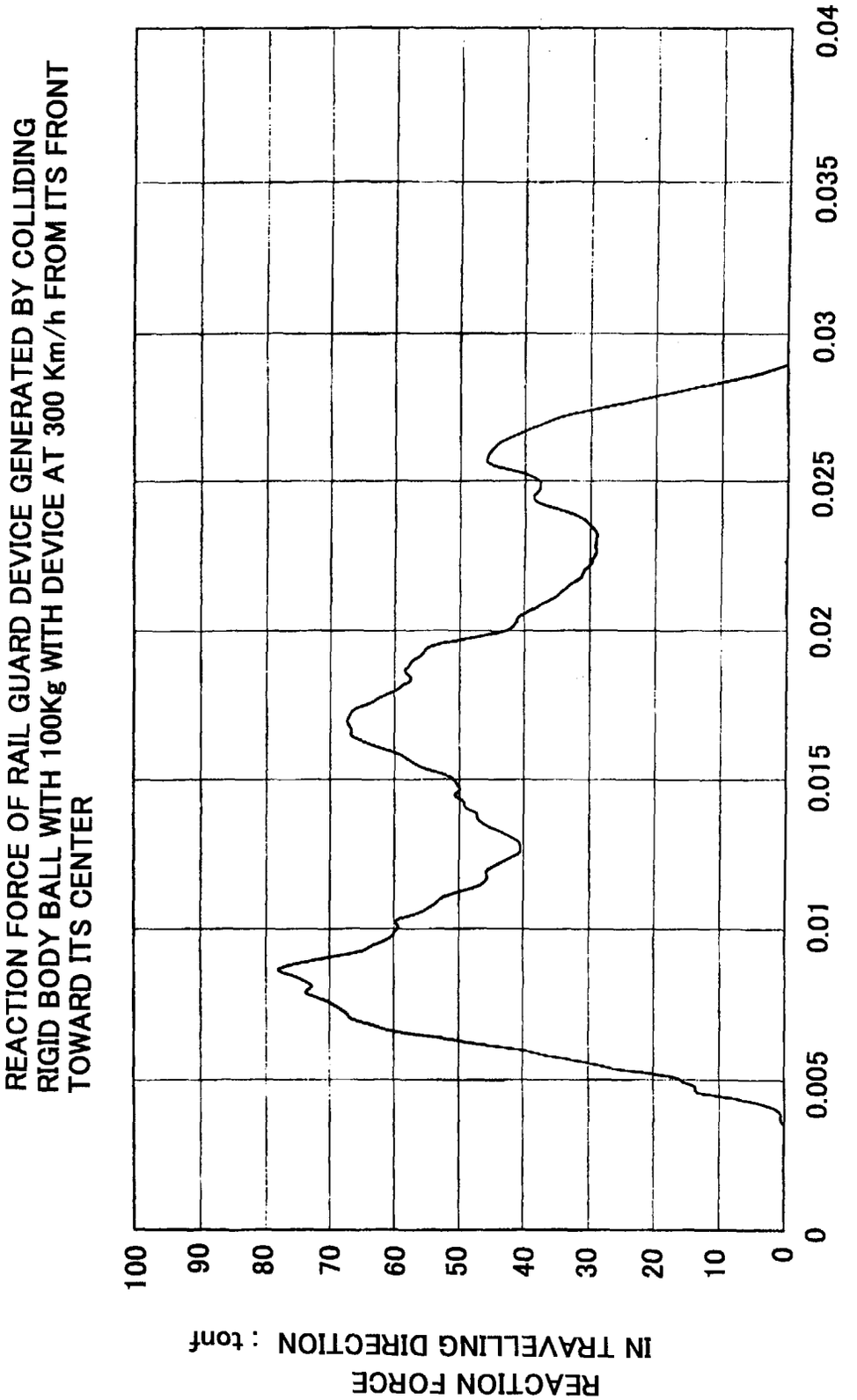
REACTION FORCE OF RAIL GUARD DEVICE GENERATED BY COLLIDING RIGID BODY BALL WITH 100Kg WITH DEVICE AT 300 Km/h FROM ITS FRONT TOWARD ITS CENTER
REACTION FORCE IN TRAVELLING DIRECTION : tonf
100
90
80
70
60
50
40
30
20
10
0
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
TIME : sec

Fig. 4

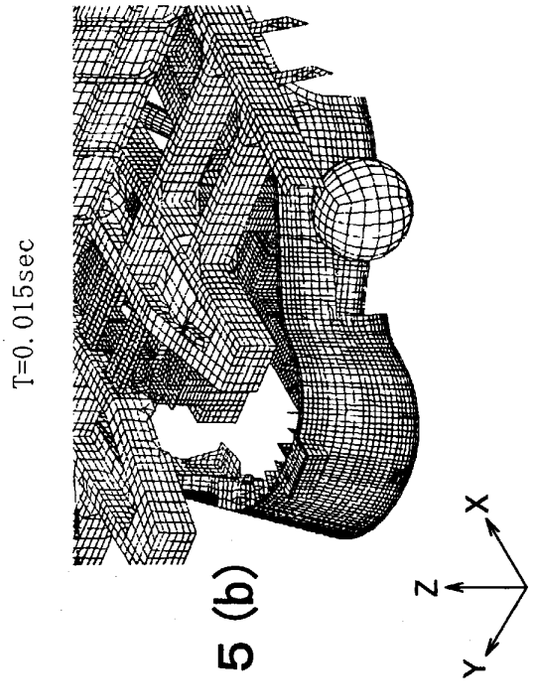

Fig. 5 (b)

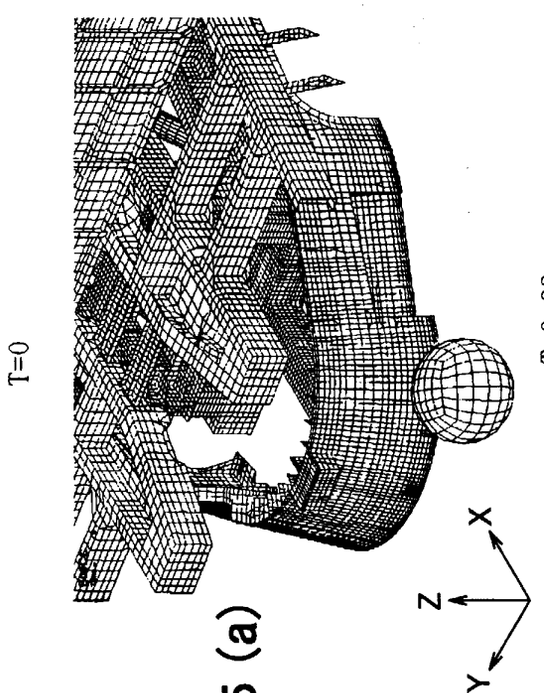

Fig. 5 (a)

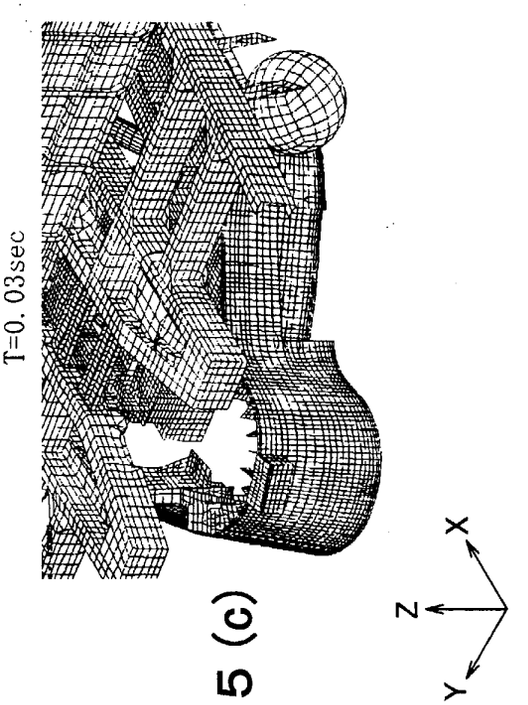

Fig. 5 (c)

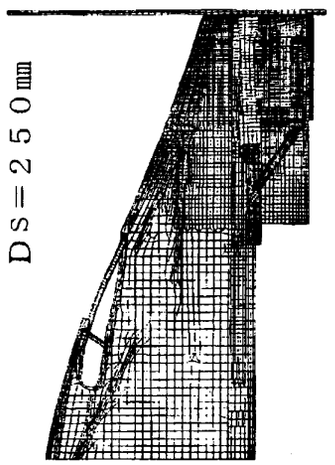

Fig. 6 (b)

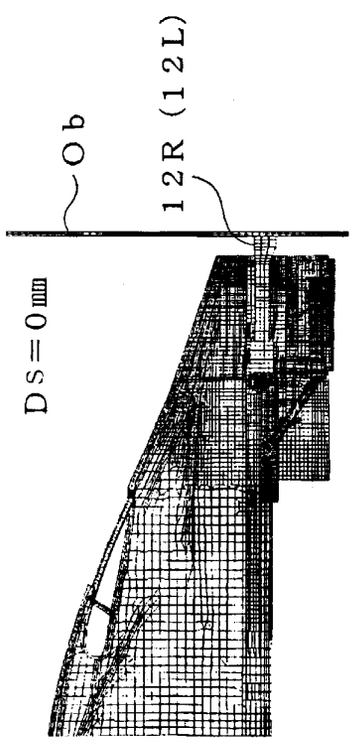

Fig. 6 (a)

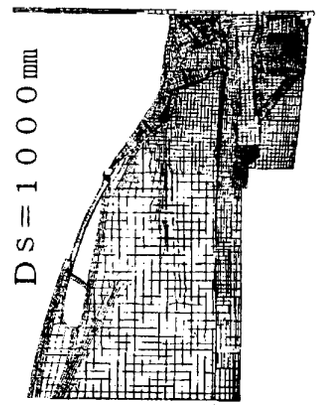

Fig. 6 (e)

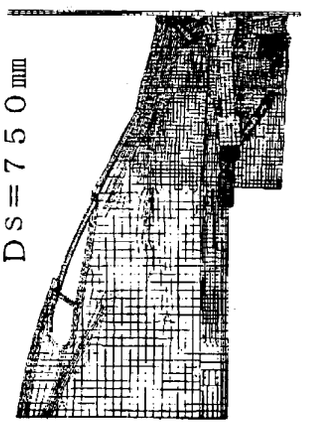

Fig. 6 (d)

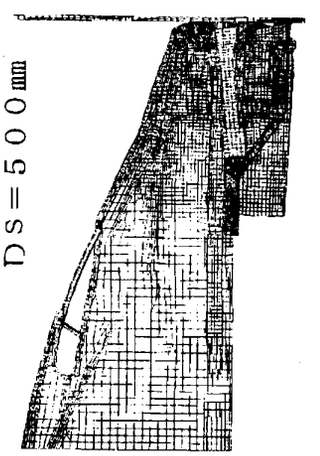

Fig. 6 (c)

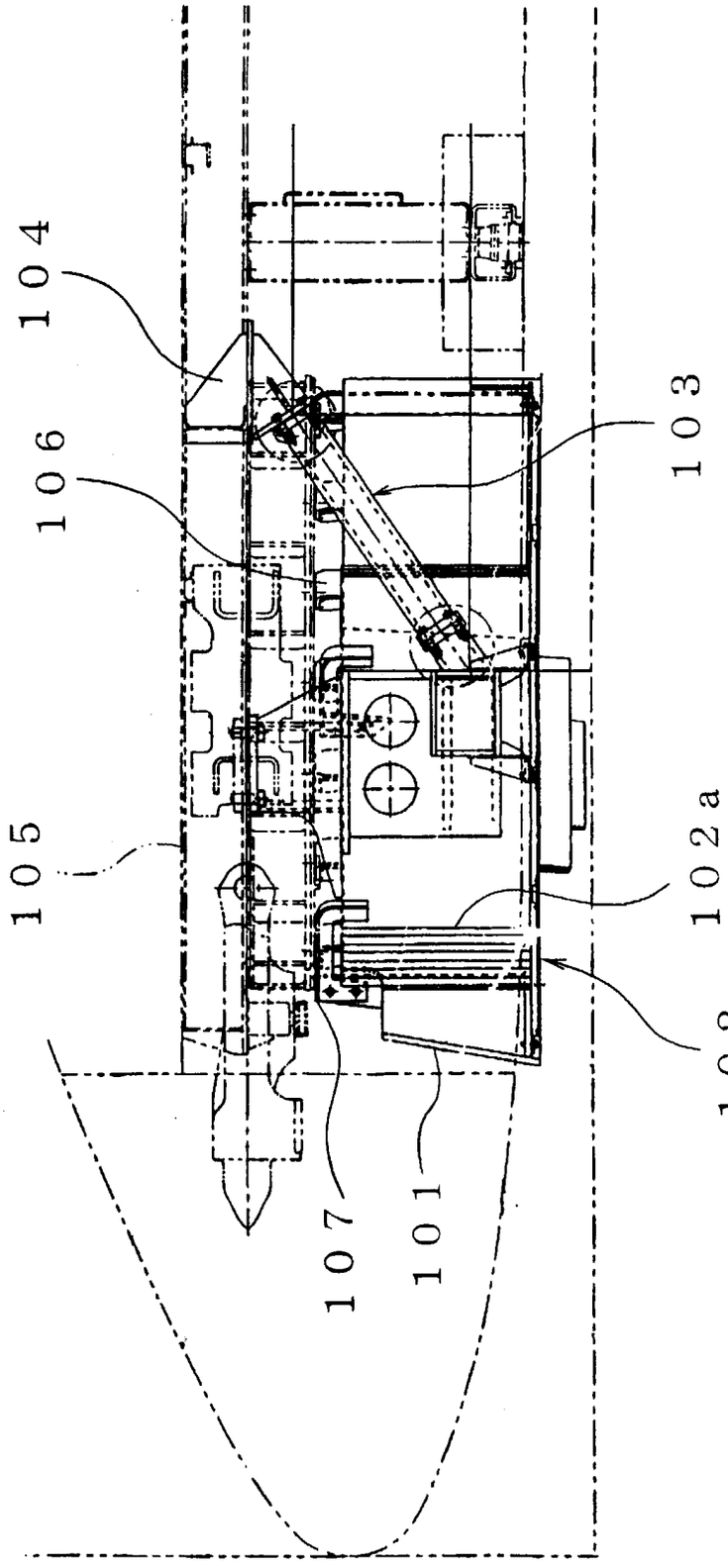

Fig. 7

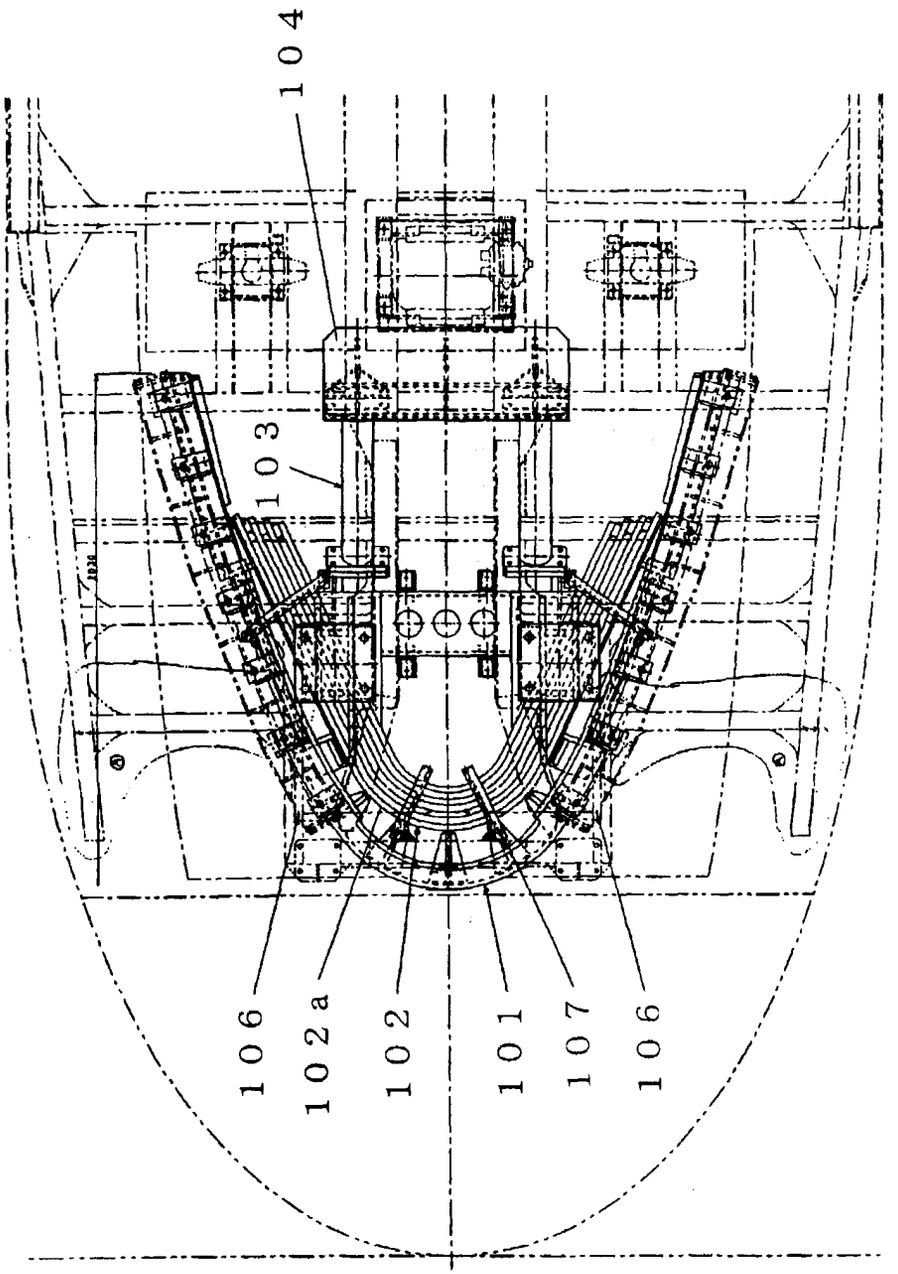

Fig. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 00 9097

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	EP 1 251 054 A (KAWASAKI HEAVY IND LTD) 23 October 2002 (2002-10-23) * paragraphs [0017]-[0020],[0044]-[0046],[0056]; figures 15,16 *	1 2	B61D15/06
Y A	WO 98 51555 A (ABB DAIMLER BENZ TRANSP ;HUBER MAX (DE); WERNER FRIEDRICH (DE)) 19 November 1998 (1998-11-19) * page 5-6; figures *	2 1	
A,D	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 19, 5 June 2001 (2001-06-05) & JP 2001 055141 A (CENTRAL JAPAN RAILWAY CO;NIPPON SHARYO SEIZO KAISHA LTD), 27 February 2001 (2001-02-27) * abstract *	1	
A	DE 635 018 C (CURT STEDEFELD DIPL ING;FRANZ KRUCKENBERG DIPL ING) 14 September 1936 (1936-09-14) * the whole document *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B61F B62D
A	EP 0 655 565 A (GEC ALSTHOM TRANSPORT SA) 31 May 1995 (1995-05-31) * abstract *	1	B61D
A	NL 8 900 633 A (SICOMMERCE AG) 1 October 1990 (1990-10-01)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	20 October 2003	Ferranti, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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