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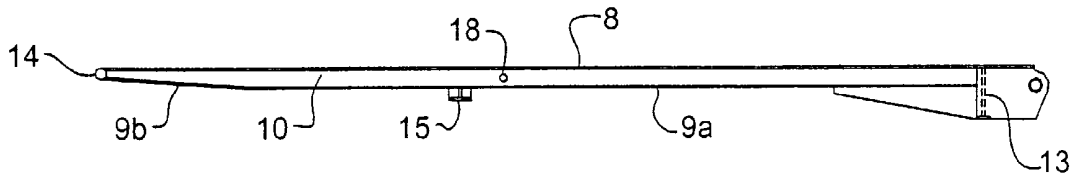
(54) Title: SANDWICH PLATE RAMPS



(57) Abstract: A moveable ramp has a load-bearing deck formed of a sandwich structure comprising upper and lower metal plates and an intermediate layer of plastic bonded to the metal plates so as to transfer shear forces between them.

SANDWICH PLATE RAMPS

The present invention relates to ramps, particularly movable ramps used in vehicle ferries, e.g. to allow vehicle loading and unloading and access between decks.

RoRo and RoPax ferries are in wide scale use around the world for transport of motor vehicles such as cars, vans and lorries, etc. across bodies of water. Such ferries have one or more vehicle decks on which the motor vehicles are carried and are provided with movable ramps which lower drawbridge-style onto the dock to allow the motor vehicles to be driven onto and off the decks. Often, movable ramps will be provided fore and aft in the vessel so that the vehicles can be driven forwardly onto and off the vehicle decks, so avoiding delay in turning the vehicles or reversing them. On multi-deck vessels, moveable ramps may be provided to allow vehicle access between decks and in some cases such moveable ramps may be arranged to be raised and held in a raised position with a vehicle on the ramp.

Moveable ramps of this type must be sufficiently strong to carry the expected vehicle loads, including concentrated wheel loads from fork lifts, cars, lorries, tractors, trailers, etc. which may be up to 150 tons in the case of multiple heavy goods vehicles, and durable in use. In particular the upper surface over which the motor vehicles are driven, which is preferably slip resistant, is subject to substantial wear and must be able to withstand this for a reasonable period without loss of structural strength in the ramp. At the same time, the weight of the ramp and space it occupies by must be minimised to maximise the useful cargo space and tonnage of the vessel.

To date, such ramps have been made of stiffened steel structures but these are quite complex and heavy structures requiring multiple welds which are difficult to protect from corrosive sea air and are often subject to fatigue cracks at or near ramp tips in the wearing plate and over stiffeners.

Accordingly it is an aim of the present invention to provide an improved ramp structure, for example that is lighter, simpler in construction and/or more easily protected from corrosion and eliminates fatigue prone details.

According to the present invention, there is provided a moveable ramp comprising a load-bearing deck mountable at one end to a rotatable hinge, wherein said load-bearing deck comprises a sandwich structure having upper and lower metal plates and an intermediate layer of a plastic material bonded to said metal plates so as to transfer shear forces therebetween.

The sandwich structure plates used in forming the load-bearing deck have increased stiffness as compared to steel plates of comparable thickness and avoid or reduce the need to provide stiffening elements. This results in a considerably simpler structure with fewer welds leading to both simplified manufacture and a reduction in details and areas that are vulnerable to corrosion and fatigue. Further details of sandwich plate structures suitable for use in the present invention can be found in US Patent 5,778,813 and British Patent Application GB-A-2 337 022. The intermediate layer may also be a composite core as described in International Patent Application No. WO 01/32414. These documents are hereby incorporated herein by reference.

The moveable ramp of the present invention preferably has the upper plate, over which vehicles will be driven, thicker than the lower plate. The upper surface of the upper plate may be provided with a surface finish, profiled surface or coating to improve traction of vehicles passing over it.

The upper plate preferably has a thickness in the range of from 4 to 20mm, the lower plate a thickness in the range of from 3 to 20mm and the intermediate layer a thickness in the range of from 20 to 200mm.

Also preferably, the distal end portion (furthest from the hinge) of the load-bearing deck tapers in thickness. Preferably, this taper is accommodated in the intermediate layer, with the outer metal layers having constant thickness. The lower metal layer may indeed have increased thickness in this region to resist wear against the dockside.

The ramp according to the invention can also be used in non-marine, e.g. building and civil engineering, applications.

The present invention will be described further below with reference to the following description of exemplary embodiments and the accompanying schematic drawings, in which:

Figure 1 shows a moveable ramp according to the invention in a vehicle ferry;

Figure 2 is a plan view of the underside of a moveable ramp according to a first embodiment of the present invention;

Figure 3 is side elevation of the moveable ramp of Figure 2;

Figure 4 is a vertical cross-section of the moveable ramp of Figure 2 along the line A-A;

Figure 5 is a vertical cross-section of the moveable ramp of Figure 2 along the line B-B;

Figure 6 is a vertical cross-section of the moveable ramp of Figure 2 along the line C-C;

Figure 7 is an enlarged side view of the hinge end of the moveable ramp of Figure 2;

Figure 8 is a horizontal cross-section of the hinge end of the moveable ramp of Figure 2 along the line D-D in Figure 7;

Figure 9 is a vertical cross-section of the hinge end of the moveable ramp of Figure 2 along the line E-E in Figure 8;

Figure 10 is a plan view of the underside of a moveable ramp according to a first embodiment of the invention;

Figure 11 is a cross-section along F-F of the moveable ramp of Figure 10; and

Figure 12 is a cross-section along G-G of the moveable ramp of Figure 10.

In the various drawings, like parts are denoted by like reference numerals.

Figure 1 shows a vehicle ferry 1, which may be a RoRo or RoPax ferry, which has a moveable ramp 2 at its bow to allow motor vehicles 3 to be driven directly from vehicle deck 4 to the dockside 5. The ramp 2 is hinged at its inboard (proximal) end and may be provided with wires and winches or hydraulic cylinders (not shown) to raise and lower it. The ramp may be formed by several independently hinged adjacent sections so as to minimise lateral stresses in the event that the dockside is not level and to accommodate movement of the vessel at anchor. Some such arrangements are sometimes referred to as bow fingers. Similar ramps may be provided at the stern of the vessel to allow straight through loading and unloading of motor vehicles. The vehicle entrance and exits will commonly be closed by bow and stern doors (not shown) when the vessel is underway, but such may not be necessary in the case of small open deck ferries in sheltered waters. The ramp of the invention may, when raised, form a watertight door.

Figure 2 is plan view of the underside of the moveable ramp 2 according to a first embodiment of the invention which is generally square or rectangular in plan, e.g. about 3 to 4m long by 0.5 to 1m wide. At the inboard (proximal) end side flanges 6 are provided for mounting to a hinge on the vessel and at the outboard (distal) end the ramp has a tapered portion 7 to reduce the step off the end of the ramp to the dockside. These details can also be seen in Figures 3 and 4 which are respectively a side elevation and a vertical cross-section on line A-A in Figure 2.

The upper plate 8 of the ramp 2 may be formed of, e.g., 8mm steel plate provided with appropriate anti-corrosion coatings. The upper surface, over which the vehicles will be driven, is substantially flat and may be provided with a surface treatment to improve traction with vehicle tyres. For example, the upper surface may be provided with a self-draining non-slip raised pattern formed by evenly distributed raised studs, such as that manufactured by Corus Group plc under the trademark "Durbar".

The lower plate 9 is formed in two parts; the main part 9a extending over most of the length of the ramp 2 is made, e.g., of 4mm steel plate whilst the distal end part 9b, farthest from the hinge, is formed of thicker steel plate, e.g. 8mm. This part of the ramp will contact the dockside when the ramp is lowered and the thicker plate is used to accommodate the resulting wear. The distal end part, in which the ramp also tapers, may be about 0.3 to 1m in length.

Side walls 12, e.g. of 10mm steel plate, join the upper and lower plates 8, 9 and one or more longitudinal dividers, e.g. also of 10mm plate, may be provided. The upper and lower plates 8, 9 and side walls 10 thus form a box-like structure which is filled by the intermediate layer 12 which is a plastic or elastomeric material bonded to the upper and lower plates 8,9 so as to transfer shear forces between them. In the main part of the ramp, the upper and lower plates are spaced 60mm apart tapering to about 25-30mm in the end part. Figures 5 and 6, which are vertical cross-sections along the lines B-B and C-C in Figure 2 respectively, show the box structure and taper more clearly. As shown in Figures 5 and 6, the side walls 10 may be inset slightly from the edges of upper and lower plates 8,9 which thus form small lips.

At the hinge end of the ramp, the box-like structure is closed by end plate 13, e.g. of 12mm steel plate, which extends below lower plate 9 and spans between side flanges 6 to reinforce them. At the distal end, the box-like structure is closed by a solid metal, e.g. steel, tip rod 14 of, e.g. 40mm diameter. This is because that end of the ramp will be subject to very substantial wear from vehicles mounting the ramp to board the vessel 1.

A ledge 15 may be provided projecting from the side of the ramp at an appropriate position to engage an adjacent ramp so that a set of ramps can be raised and lowered as a unit.

Details of the hinge structure and inboard end of the ramp are shown in Figures 7, 8 and 9. As can there be seen, the side flanges 6 extend below lower plate 9 and have a main part 6a of relatively thick plate, e.g. 25mm, in which are provided through-holes 16 for mounting on hinge pins (not shown). Bushings, e.g.

of bronze, are provided in the through-holes 16. The main parts 6a extend proximally of the end plate 13 which may be provided with a horizontal flange on its lower edge for additional strength. Extending distally of the end plate 13 are additional plates 6b which are thinner, e.g. 10mm, than the main plates 6a of the side flanges 6 and decrease in depth, terminating about 0.3 to 1m from the end plate 13. An additional reinforcement plate 17, similar in shape to the plates 6b, can be provided extending distally from the end plate 13 in its medial portion.

The presently preferred method of manufacture of the ramp of the invention is weld the side walls 10 and divider 11 to the inner side of the upper plate 8. The two parts 9a, 9b of the lower plate 9 are then welded on to form the box like structure which is then closed by welding in place the end wall 13 and tip rod 16. The intermediate layer 12 is then formed by injecting uncured plastic through injection ports 18 (shown in Figures 2 and 3) with vents 19 (shown in Figures 2 and 3) allowing the escape of air. The plastic can than be allowed to cure or heat cured as necessary. The injection ports can be ground off and sealed, along with the vents, after curing. The side flanges 6 and other fittings can be welded on before or after injection and curing of the elastomer, as convenient. It may be preferred to complete all welding before injection of the elastomer to minimise heat damage to it.

A second embodiment of the present invention is shown in Figures 10, 11 and 12. In this embodiment, the moveable ramp is a single structure, e.g., of about 16m x 16m, rather than being segmented into smaller ramps as in the first embodiment.

The ramp 20 according to the second embodiment comprises a main ramp plate 21 stiffened by transverse beams 22 and longitudinal girders 23. The main ramp plate 21 is a sandwich structure comprised of upper plate 24, intermediate layer, or core, 25 and lower plate 26. Hinge details 27 are provided to connect the ramp to the vessel. The core 25 comprises foam forms occupying, e.g., 50% of the volume of the cavity between upper and lower plates 24, 26 and elastomer ribs occupying the remainder. As an example, the upper plate may have a thickness of

6mm, the core 75mm and the lower plate 7mm. Structurally, the foam contributes negligible strength but the elastomer ribs adhere to the upper and lower plates 24, 26 so as to transfer shear forces therebetween.

The ramp 20 may also form the main door of the vessel and may be provided with independent smaller ramps at its distal end (the left hand end in Figure 10). These independent smaller ramps may be of similar construction to the ramps of the first embodiment. Foundations and other details are provided to take concentrated loads such as those associated with latches, locks, attachments for cables or other actuators, etc..

To construct the ramp 20, the lower plate 26 is positioned upside down and the transverse beams 22 and longitudinal girders welded to the lower surface of lower plate 26. The partial structure is then turned over and spacer bars and side walls welded to the upper surface of lower plate 26. Next, foam forms (blocks) are placed to cover 50% of the area of the plate. Then, the upper plate 24 is welded to the spacer bars and side walls to form airtight cavities. Anti-skid bars and other details can then be welded in place. Finally, the airtight cavities are injected with elastomer which cures to complete the core 25.

An equivalent all-steel structure of conventional design employs a 13mm steel upper plate stiffened by longitudinal bulb flats. It also requires additional transverse beams. Compared to this, the ramp according to the invention is weight neutral whilst the elimination of bulb flats and some beams greatly reduces the amount of welding necessary and generally simplifies construction. There is also a substantial reduction in the area of steel that must be painted and elimination of many points at which moisture might collect.

The upper and lower metal plates, and other metal parts of the ramps of the invention, are preferably structural steel, as mentioned above, though may also be aluminium, stainless steel or other structural alloys in applications where lightness, corrosion resistance or other specific properties are essential. The metal should preferably have a minimum yield strength of 240MPa and an elongation of at least 10%.

The intermediate layer should have a modulus of elasticity, E, of at least 250MPa, preferably 275MPa, at the maximum expected temperature in the environment in which the member is to be used. In ship building applications this may be 100 °C.

The ductility of the elastomer at the lowest operating temperature must be greater than that of the metal layers, which is about 20%. A preferred value for the ductility of the elastomer at lowest operating temperature is 50%. The thermal coefficient of the elastomer must also be sufficiently close to that of the steel so that temperature variation across the expected operating range, and during welding, does not cause delamination. The extent by which the thermal coefficients of the two materials can differ will depend in part on the elasticity of the elastomer but it is believed that the thermal expansion coefficient of the elastomer may be about 10 times that of the metal layers. The coefficient of thermal expansion may be controlled by the addition of fillers to the elastomer.

The bond strength between the elastomer and metal layers must be at least 0.5, preferably 6, MPa over the entire operating range. This is preferably achieved by the inherent adhesiveness of the elastomer to metal but additional bond agents may be provided.

Additional requirements if the ramp is to be used in a ship building application, include that the elastomer must be hydrolytically stable to both sea and fresh water.

The elastomer may therefore essentially comprise a polyol (e.g. polyester or polyether) together with an isocyanate or a di-isocyanate, a chain extender and a filler. The filler is provided, as necessary, to reduce the thermal coefficient of the intermediate layer, reduce its cost and otherwise control the physical properties of the elastomer. Further additives, e.g. to alter mechanical properties or other characteristics (e.g. adhesion and water or oil resistance), and fire retardants may also be included.

Whilst an embodiment of the invention has been described above, it should be appreciated that this is illustrative and not intended to be limitative of the scope of the invention, as defined in the appended claims. In particular, the dimensions given are intended as guides and not to be prescriptive.

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CLAIMS

1. A moveable ramp comprising a load-bearing deck mountable at one end to a rotatable hinge, wherein said load-bearing deck comprises a sandwich structure having upper and lower metal plates and an intermediate layer of a plastic material bonded to said metal plates so as to transfer shear forces therebetween.

2. A moveable ramp according to claim 1 wherein said upper plate is thicker than said lower plate.

3. A moveable ramp according to claim 1 or 2 wherein the upper surface of said upper plate is provided with a surface finish, profiled surface or coating to improve traction of vehicles passing over it.

4. A moveable ramp according to claim 1, 2 or 3 wherein said upper plate has a thickness in the range of from 4 to 20mm, said lower plate has a thickness in the range of from 3 to 20mm and said intermediate layer has a thickness in the range of from 20 to 200mm.

5. A moveable ramp according to any one of the preceding claims wherein the distal end portion of the load-bearing deck tapers in thickness.

6. A moveable ramp according to claim 5 wherein said taper is accommodated in the intermediate layer.

7. A moveable ramp according to claim 6 wherein said lower plate has increased thickness in said distal end portion.

8. A moveable ramp according to any one of the preceding claims wherein said intermediate layer comprises a compact elastomer.

9. A moveable ramp according to any one of claims 1 to 7, wherein said intermediate layer comprises a form and said plastic material, which is located in the spaces between said upper and lower metal plates not occupied by said form.

10. A moveable ramp constructed substantially as hereinbefore described with reference to the accompanying drawings.

11. A vessel having at least one moveable ramp according to any one of the preceding claims.

Fig. 1

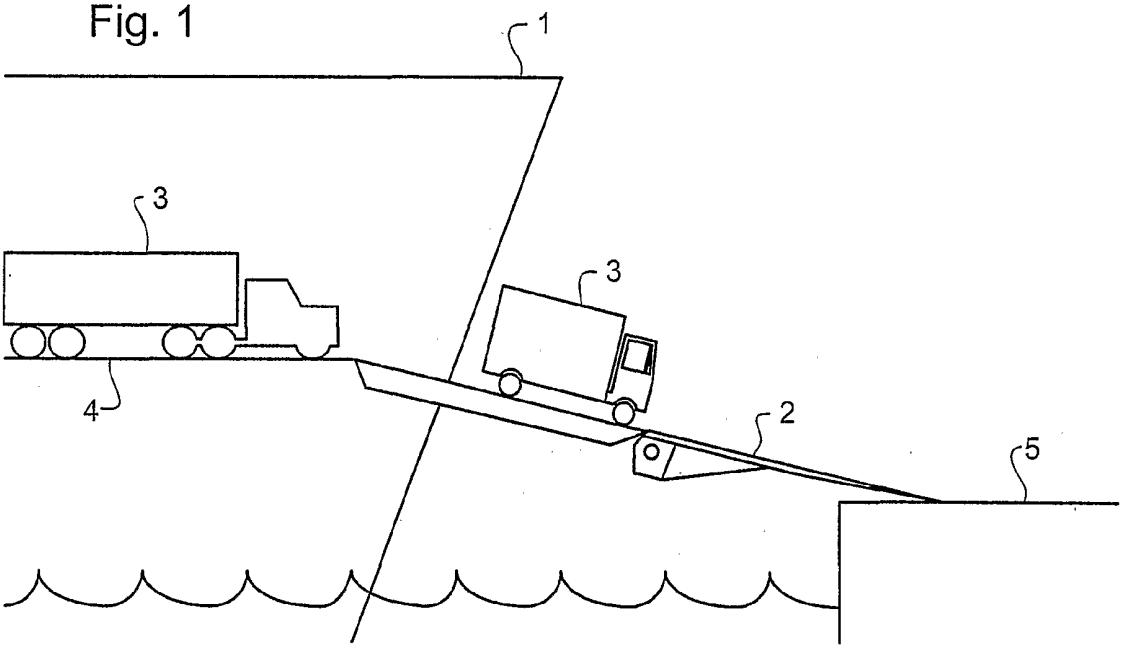


Fig. 2

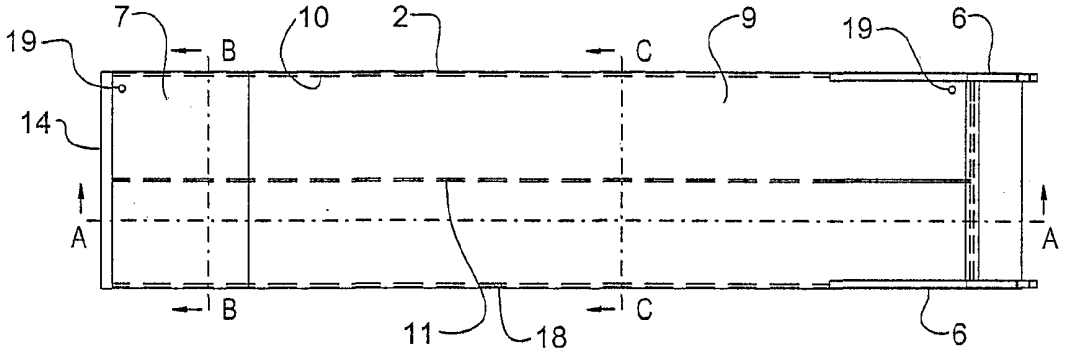


Fig. 3

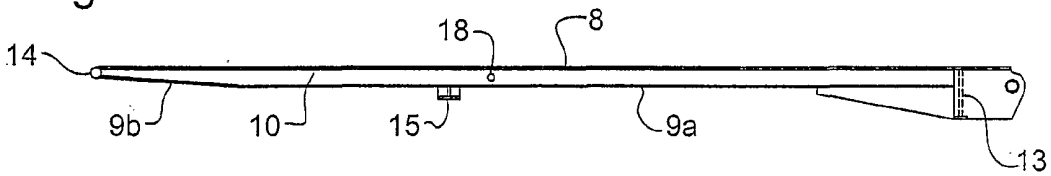


Fig. 4

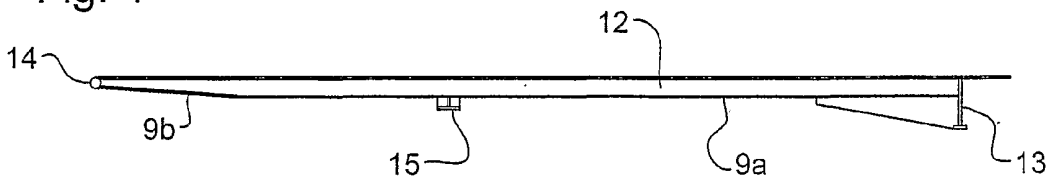


Fig. 5

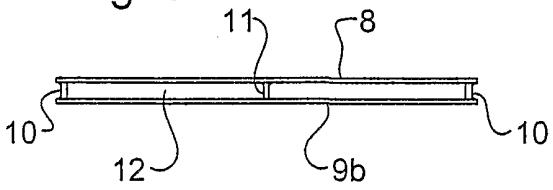


Fig. 6

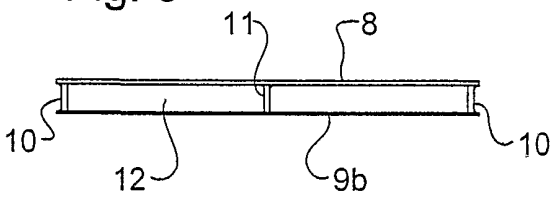


Fig. 7

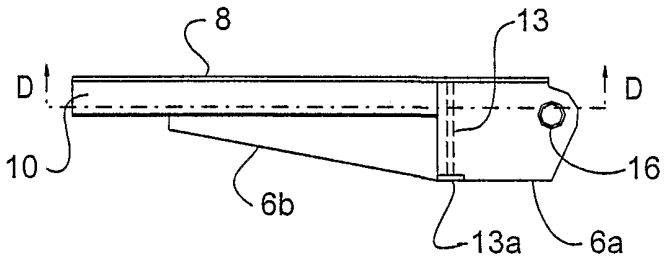


Fig. 8

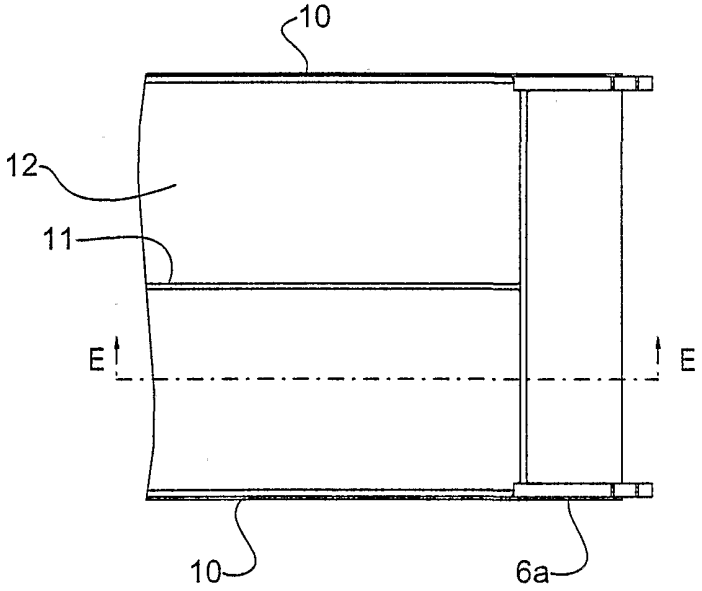
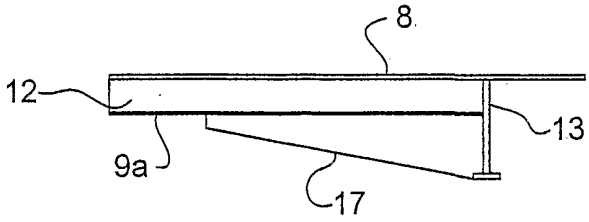


Fig. 9



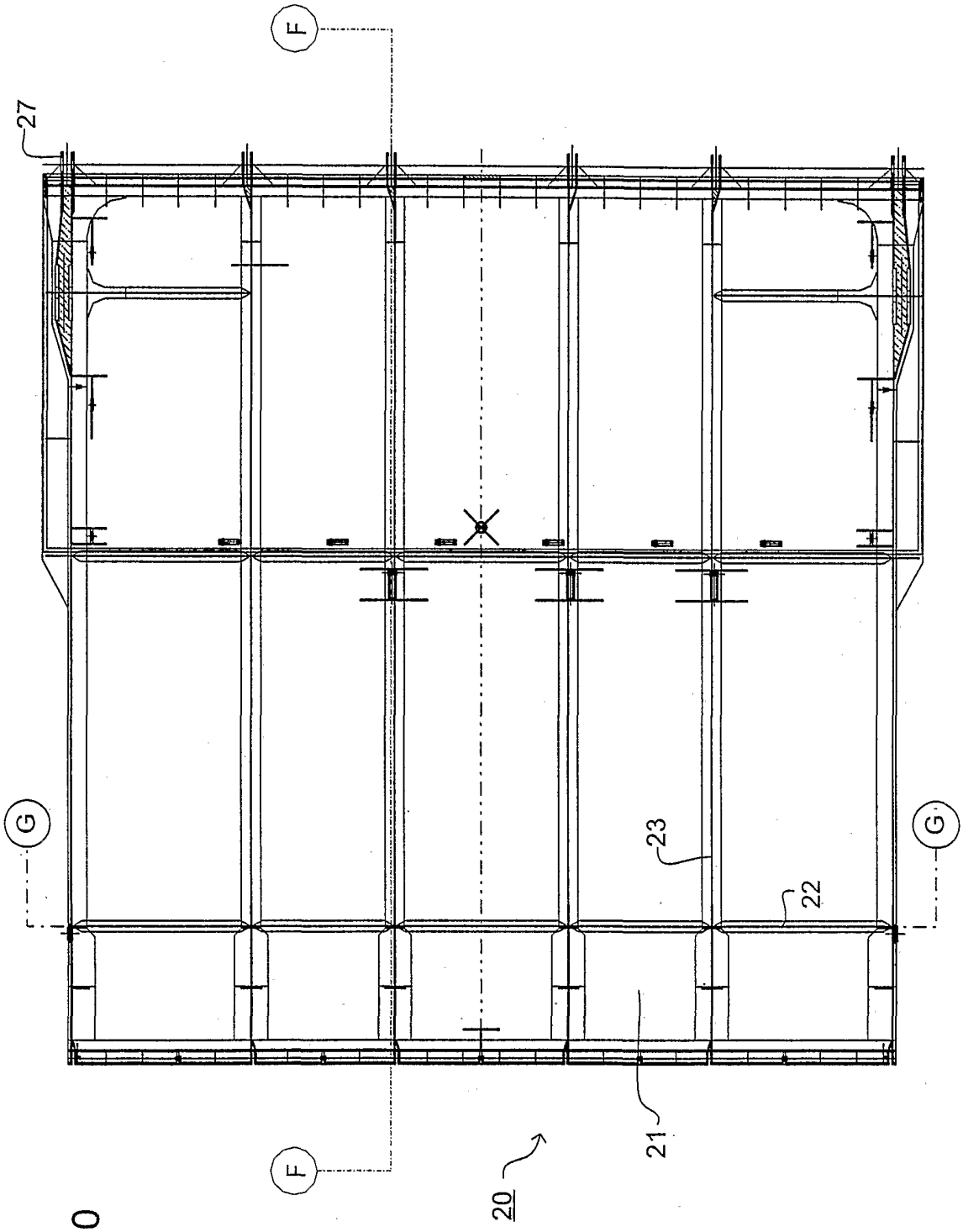


Fig. 10

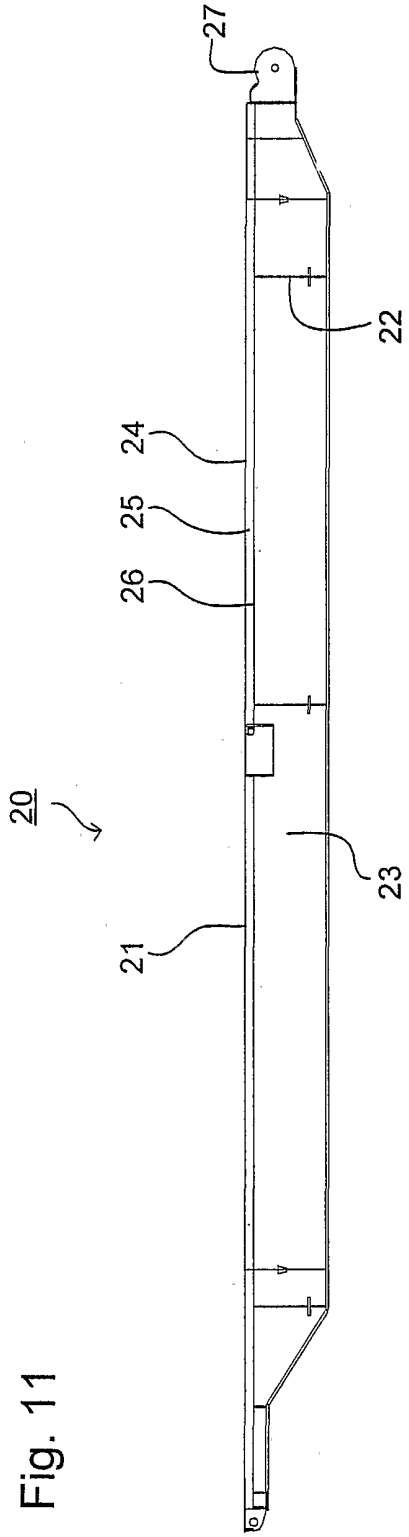


Fig. 11

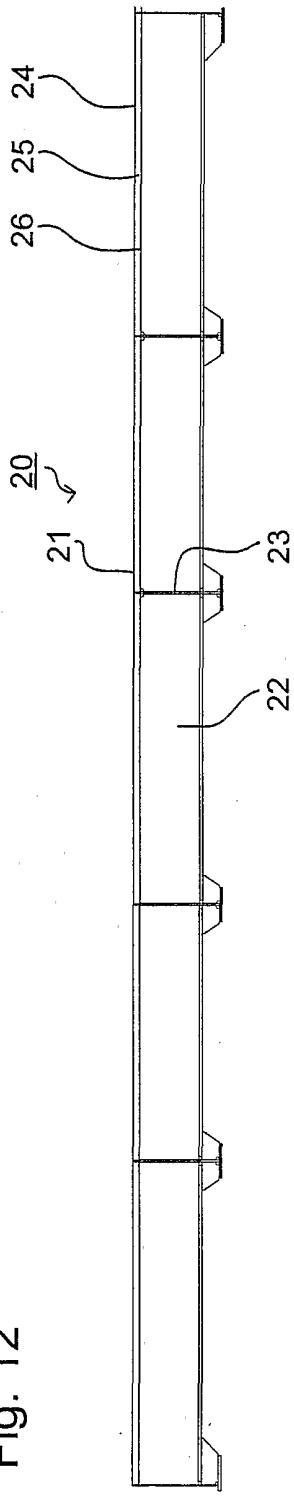


Fig. 12

INTERNATIONAL SEARCH REPORT

Ir tional Application No
PCT/GB 01/03749

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B63B27/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 14235 A (MACGREGOR SWE AB ;CARLBERG GUSTAF (SE)) 17 May 1996 (1996-05-17) abstract; figures	1
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A	US 3 339 326 A (DERR HENRY H ET AL) 5 September 1967 (1967-09-05)	
A	US 4 665 577 A (PARRAMORE THOMAS S) 19 May 1987 (1987-05-19)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2001	19/12/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	De Schepper, H

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Ir ɔnal Application No
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