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(54) Prefabricated article of manufacture made of reinforced concrete for tunnel

(57) A prefabricated article of manufacture made of reinforced concrete for tunnel construction, in particular for underground ducts and cables, comprising at least two panels (2) each consisting of a concrete body and iron reinforcement elements, and hinging means (6) interposed between the panels and adapted to enable rotation of said panels between a substantially aligned position and an operating position arranged at an angle.

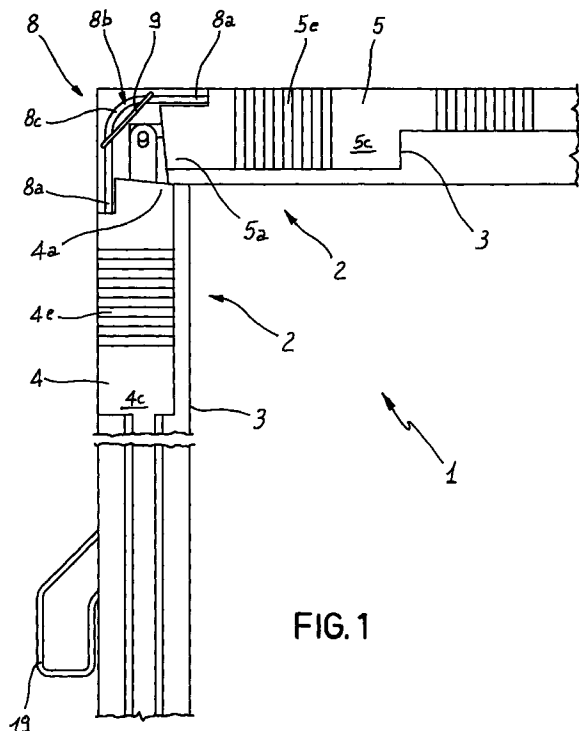


FIG. 1

EP 0 875 662 A1

Description

The present invention relates to a prefabricated article of manufacture made of reinforced concrete for tunnel construction, in particular for underground ducts and cables

It is known that tunnel and underground passage constructions made of reinforced concrete intended to house cables and ducts for facilities of different types generally also requiring to be inspected, involves heavy expenses and execution times that are sometimes very long above all in an urban environment.

Under this situation, the technical task underlying the present invention is to devise a prefabricated article of manufacture made of reinforced concrete not only enabling the construction costs for these tunnels to be reduced, but above all appearing particularly useful in restraining time required for carrying out said tunnels to the greatest extent, taking into account the fact that during this time an excavation is to be maintained opened.

The technical task mentioned is substantially achieved by a prefabricated article of manufacture made of reinforced concrete for making tunnels, in particular for underground ducts and cables, which is characterized in that it comprises at least two panels each consisting of a concrete body and iron reinforcement elements, and hinging means interposed between said panels and adapted to enable the panel rotation about a hinge axis between a substantially aligned position and an operating position arranged at an angle.

Description of a preferred but non-exclusive embodiment of a prefabricated article of manufacture made of reinforced concrete for making tunnels in accordance with the invention is now given hereinafter, by way of non-limiting example, with reference to the accompanying drawings, in which:

- Fig. 1 is a fragmentary front view of an article of manufacture in accordance with the invention disposed in an operating position;
- Fig. 2 is a side view of end portions of two articles of manufacture arranged in succession to form a tunnel;
- Fig. 3 is a section taken along line III-III in Fig. 2;
- Fig. 4 is a fragmentary side view of the article of manufacture shown in Fig. 1, having a pair of panels disposed in mutual alignment;
- Fig. 5 is a side view of a first plate-like element of a hinge assembly of the article of manufacture shown in Fig. 1;
- Fig. 6 is a diagrammatic side view of a second plate-like element of a hinge assembly of the article of manufacture shown in Fig. 1;
- Fig. 7 is a top view of the plate-like elements seen in Figs. 6 and 7 in an assembled condition to form said hinge assembly;
- Fig. 8 shows a mounting step of the article of manufacture; and

- Fig. 9 highlights some articles of manufacture at an aligned position for transportation on lorries.

With reference to the drawings, the article of manufacture in accordance with the invention is generally identified by reference numeral 1.

It preferably comprises three prefabricated flat panels 2, each consisting of a concrete body 3 and iron reinforcement elements suitably shaped and disposed within said body.

Panels 2, in turn, comprise two side panels 4 and a centre panel 5 adapted to define, in an operating position, two uprights and a crosspiece element. Each upright has two eyebolts or lifting rings on its extrados, to be used in handling and mounting operations, whereas the crosspiece element has four eyebolts.

Interposed between uprights 4 and the crosspiece element 5 is hinging means 6 adapted to enable rotation of the former about a hinge axis 7 (see Fig. 7) between a substantially aligned position, shown in Figs. 4 and 9, corresponding to the manufacture and transportation condition of the article of manufacture, and an operating position bent at a right angle (see Fig. 1).

The reinforcement elements of panels 2 comprise connecting elements 8 between the panels themselves, each of which has anchoring portions 8a fitted into bodies 3 and an outer connecting portion 8b between each upright 4 and the crosspiece element 5 partly bendable during rotation of said upright 4.

More particularly, the outer connecting portion 8b comprises a curved centre portion 8c substantially in the form of an arc of a circle of a value in compliance with law requirements and having its centre on the side involving the hinge axis 7 and two substantially curved side portions 8d in said aligned position (see Fig. 4) having the respective centres on the side facing away from the hinge axis 7. Also provided is stiffening means 9 adapted to keep the shape of the centre portion 8c substantially unchanged during said rotation and means 10 for controlling deformation of the side portions 8d, and adapted to determine a rectilinear conformation of said side portions in the operating position of the article of manufacture.

Practically, the stiffening means 9 is defined by a tie-rod element fastened to the ends of the centre portion 8c and the extension of which follows the chord of the arc of a circle formed by said centre portion. The deformation control means 10 is defined by flat locating areas against which abutment of the side portions 8d occurs, which portions are in the form of recesses disposed on first end portions 4a of uprights 4 and on end portions 5a of the crosspiece element 5.

The first end portions 4a of uprights 4 further have each an abutment area 4b transverse to the vertical extension direction of uprights 4, that is oriented horizontally in said operating position, adapted to define a support surface for end rest areas 5b of the crosspiece element 5.

Practically, due to rotation allowed by the hinging means 6, the abutment areas 4b are brought to abut against the rest areas 5b thereby causing, in said operating position, a stable arrangement substantially at a right angle between uprights 4 and the crosspiece element 5.

The hinging means 6 comprises two hinge assemblies 11 (Fig. 7) interposed between each upright 4 and the crosspiece element 5. In turn, each hinge assembly 11 comprises a first plate-like element 12 internally anchored to the crosspiece element 5 also by a horizontal expansion 12a and a vertical expansion 12b and a second plate-like element 13 anchored internally of the corresponding upright 4 also by means of a tab 13a vertically aligned in said operating position.

The first plate-like element 12 is provided at its end with a first through seating 14 adapted to house a pivot pin 15 defining the hinge axis 7. The pivot pin 15 is also housed in a second through seating 16 formed at the end of the second plate-like element 13 and shaped in the form of an elongated hole adapted to define a vertically-oriented backlash for the pivot pin itself 15 when upright 4 is disposed at a right angle relative to the crosspiece element 5. In this way the crosspiece element load exclusively bears on the abutment areas 4b of uprights 4 and not on the pivot pin 15 and related plate-like elements 12 and 13.

Both the side uprights 4 and the crosspiece element 5 comprise respective end faces 4c and 5c for pairing with corresponding end faces of other articles of manufacture provided with hollows 4d and 5d that altogether form empty areas adapted to house concrete castings defining connecting joints between adjacent articles of manufacture.

Preferably, the vertical joints between next adjacent uprights are also obtained by making use of flexible connecting sheets 17 to be inserted in hollows 4d and defining partial-holding envelopes for the concrete castings intended to form said joints.

These connecting elements 17 avoid any concrete escape into the hollow spaces 18 between adjacent panels (see Fig. 3) and therefore allow said panels to be maintained surface-clean so that they can be optionally submitted to another sealing of the traditional type by a cementing material.

In addition, the end faces 4c and 5c of uprights 4 and crosspiece element 5 have respective indented areas 4e and 5e of an extension transverse to the major extension direction of said faces. These indented areas on which castings of the connecting joints grip enable transmission of shearing actions between subsequent articles of manufacture and therefore give rise to a tube-like behaviour of the structural assembly consisting of the articles of manufacture coupled in sequence.

Finally, each upright 4 comprises a second end portion 4f intended to define a support foot or base at which the reinforcement elements are provided with fitting elements 19 having outwardly projecting portions adapted

to constitute unidirectional fittings external to the section formed by the article of manufacture in an operating position (see Fig. 2).

Mounting of a prefabricated article of manufacture made of reinforced concrete described above mainly as regards structure is as follows.

For handling of each article of manufacture a rigid plate or equalizer device is used which is provided, at the lower part thereof, with four hooks to be engaged with the respective eyebolts or lifting rings disposed on the panel extradoses. This enables the panels to be maintained in an aligned position (see Fig. 9).

On assembling, the equalizer device engages the article of manufacture by means of the four hooks of the crosspiece element, so as to enable rotation of the two side panels upon their own weight during the same lifting operation (see Fig. 8).

The stable arrangement at a perfect right angle of the uprights is completed close to the means of transport by the use of an iron straightening apparatus or template having a safety adjustment function. The particular position of the hinge assemblies 11 causes the automatic abutment of the rest areas 5b of the crosspiece element 5 against the abutment areas 4b of uprights 4 as soon as the latter take a vertical position.

The connecting elements 8 during rotation of uprights 4 are bent and keep the arc of the centre portion 8c substantially undeformed by virtue of the stiffening means 9, bringing the side portions 8d against the flat locating areas 10 so that they take a rectilinear conformation.

When the adjustment step has been completed, which step may have a duration of about ten minutes, the article of manufacture does no longer require any prop, and once the article has been installed, uprights are to be put perpendicularly by acting on the braces of the temporary template.

A foundation strip obtained by casting of special strata engages the fitting element 19 to the upright base.

By appropriate concrete materials of small particle size sealings are carried out at the upper corners between the uprights and crosspiece element. Before carrying out junction operations between the end faces 4c of adjacent uprights 4 belonging to two next adjacent articles of manufacture, the flexible sheets 17 are inserted in hollows 4d so as to avoid any material escape to the hollow spaces 18. Subsequently, a further optional sealing of said hollow spaces by means of a cementing material may be performed.

By way of example, accomplishment of a complete mounting, starting from foundation, of twelve articles of manufacture corresponding to a 30 metre tunnel in total may be conceived, during two work days only.

The invention achieves important advantages.

First of all, the article of manufacture in accordance with the invention has the essential features of resistance to deformation and absence of crackings under

even very high vertical loads possibly of the asymmetric type too, as can be ascertained in the case in which laying underground takes place at one side only.

In addition, the article of manufacture can be produced in a flat condition in the appropriate sizes for making rectangular tunnels of any section, the only constraint being that of the panel width that must not exceed 2.5 metres for transportation requirements, and can be easily transferred to the place of use together with other units maintained in an aligned position and disposed in a stacked relationship on the loading platform of a motor-vehicle (Fig. 9).

It is to point out that an important role is played in the invention by the structure and arrangement of elements 8 and end portions 4a and 5a ensuring a hinge-like behaviour of means 6, when panels pass from a coplanar configuration to an operating configuration, and at the same time causing locking by fitting of means 6 when the desired tunnel configuration is reached. In addition, element 8 due to its own arc-shaped conformation and its arrangement relative to the centre of curvature, when the article of manufacture reaches the tunnel configuration, is advantageously already capable by itself of bearing horizontal loads, even if asymmetric.

It is to note that means 9 and surfaces 10 contribute in an essential manner to the assurance of an appropriate deformation of element 8. The latter, in addition, once uprights are in a vertical position, is already in the correct position for defining an appropriate reinforcement for the casting to be poured into the hinging area between the crosspiece and uprights.

It will be finally recognized that the article of manufacture is particularly adapted to make technological underground ducts under the urban road network, thereby enabling an important reduction in construction times and costs for urbanization works and a consequent reduction in management costs for facilities placed therein.

Claims

1. A prefabricated article of manufacture made of reinforced concrete for tunnel construction, in particular for underground ducts and cables, characterized in that it comprises:
 - at least two panels (2), each consisting of a concrete body (3) and iron reinforcement elements, and
 - hinging means (6) interposed between said panels and adapted to enable the panel rotation about a hinge axis (7) between a substantially aligned position and an operating position arranged at an angle.
2. An article of manufacture as claimed in claim 1, characterized in that said reinforcement elements comprise connecting elements (8) between said panels (2), and in that each of said connecting elements (8) has at least two anchoring portions (8a) fitted in said panels and at least one outer connecting portion (8b) partly bendable during said rotation.
3. An article of manufacture as claimed in claim 2, characterized in that said outer portion (8b) of said connecting element (8) comprises a curved centre portion (8c) substantially in the form of an arc of a circle having a centre disposed on the side involving said hinge axes (7) and two substantially curved side portions (8d) in said aligned position and the respective centres on the opposite side relative to said hinge axis (7), and in that it comprises stiffening means (9) adapted to substantially keep the shape of said centre portion (8c) unchanged during said rotation and means (10) for controlling the deformation of said portions and adapted to determine a rectilinear conformation of the latter in said operating position.
4. An article of manufacture as claimed in claim 3, characterized in that said stiffening means (9) is defined by a tie-rod element fastened to the end of said centre portion (8).
5. An article of manufacture as claimed in claim 3, characterized in that said means for controlling the deformation of said side portions (8d) comprises flat locating areas (10) formed on said adjacent end portions (4a, 5a) of said panels (4, 5), said side portions (8d) abutting against said locating areas (10) in said operating position.
6. An article of manufacture as claimed in claim 1, characterized in that each of said panels (2) has a substantially flat conformation.
7. An article of manufacture as claimed in claim 6, characterized in that provision is made for three panels (2) comprising two side panels (4) and a centre panel (5) adapted to define two uprights and a crosspiece element in said operating position.
8. An article of manufacture as claimed in claim 7, characterized in that each of said uprights (4) comprises a first end portion (4a) close to said crosspiece element (5) and having an abutment area (4b) for a corresponding end rest area (5b) of the crosspiece element (5), said abutment area (4b) and rest area (5b) being adapted to determine, in said operating position, a stable arrangement at a substantially right angle between said upright (4) and crosspiece element (5).
9. An article of manufacture as claimed in claim 8, characterized in that said hinging means (6) com-

prises at least two hinge assemblies (11) interposed between each upright (4) and said crosspiece element (5) and in that each said hinge assembly (11) comprises a first plate-like element (12) anchored to said crosspiece element (5), a
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second plate-like element (13) anchored to one said upright (4) and a pivot pin (15) defining said hinge axis (7) and housed in through seatings (14, 16) formed in said plate-like elements (12, 13).

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10. An article of manufacture as claimed in claim 9, characterized in that the through seatings (16) of said second plate-like elements (13) are shaped in the form of an elongated hole adapted to define a vertically oriented backlash for said pivot pin (15) in
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said stable arrangement substantially at a right angle.

11. An article of manufacture as claimed in claim 1, characterized in that said panels (2) comprise end
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faces (4c, 5c) pairing with corresponding end faces (4c, 5c) of other articles of manufacture having hollows (4d, 5d) adapted to house concrete castings defining connecting joints between adjacent articles of manufacture.
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12. An article of manufacture as claimed in claim 11, characterized in that said end faces (4c, 5c) have indented areas (4e, 5e) having an extension transverse to the major extension direction of the end
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faces themselves.

13. An article of manufacture as claimed in claim 12, characterized in that it comprises flexible sheets (17) to be inserted in said hollows (4d) and defining envelopes for partial holding of concrete castings
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intended to form said connecting joints.

14. An article of manufacture as claimed in claim 8, characterized in that each of said uprights (4) comprises a second end portion (4f) intended to define a support base, and in that said reinforcement elements comprise fitting elements (19) having outwardly projecting portions at said support base and
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adapted to define unidirectional fittings external to the section formed by the article of manufacture in said operating position.
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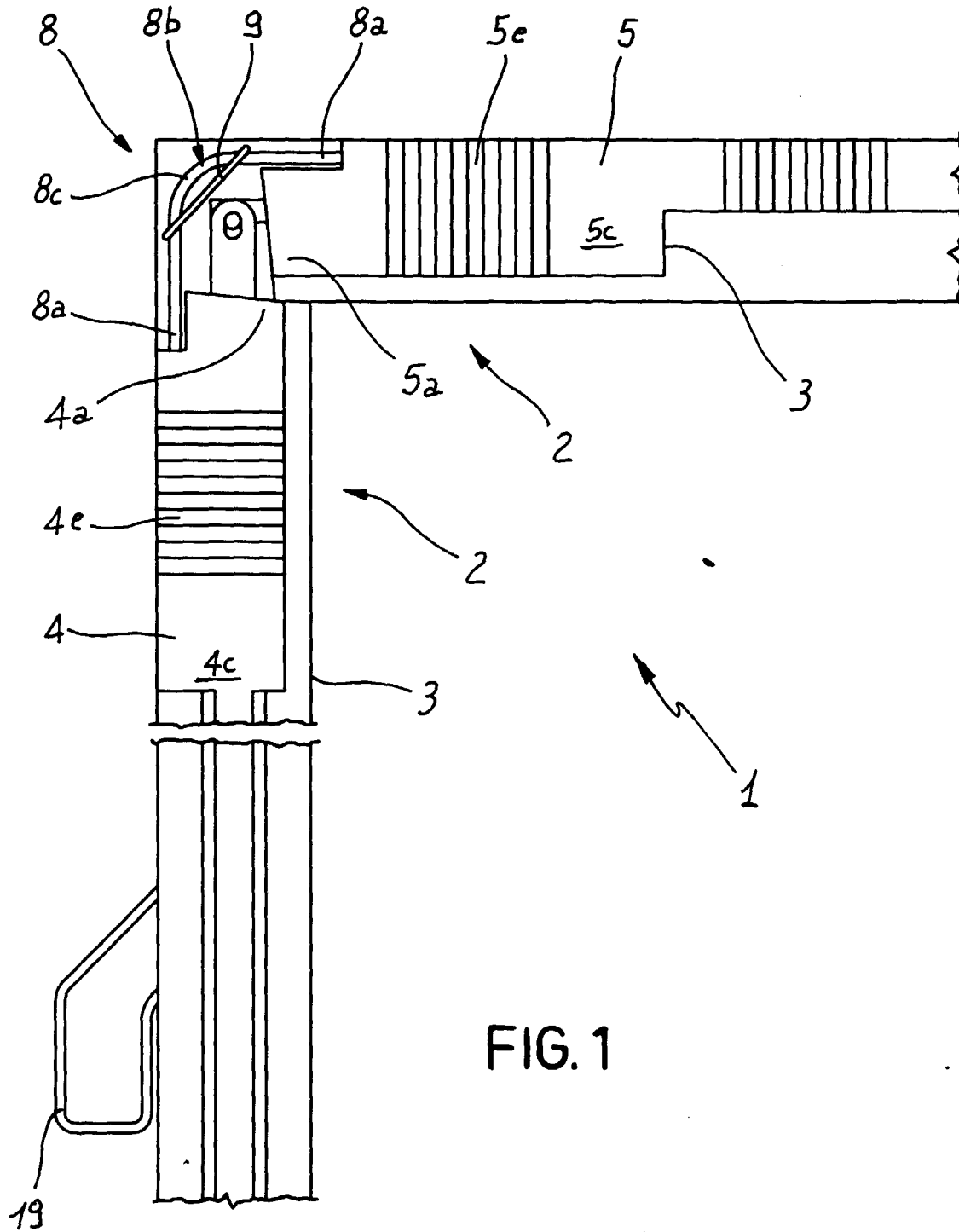
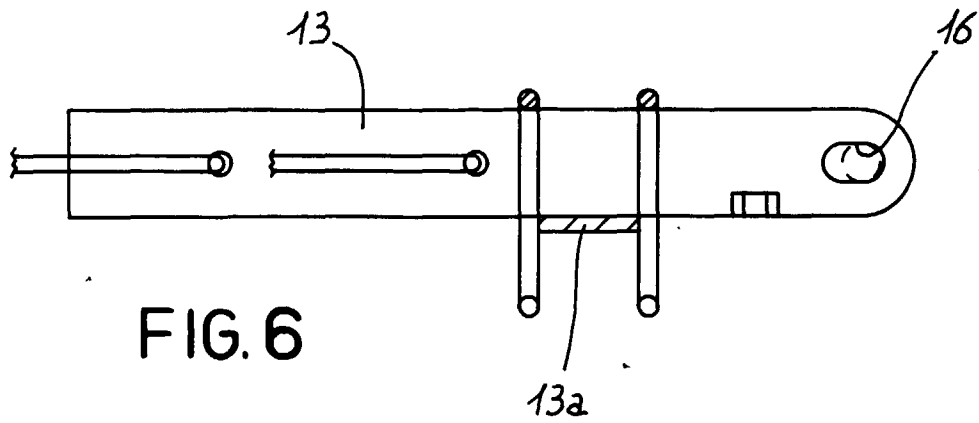
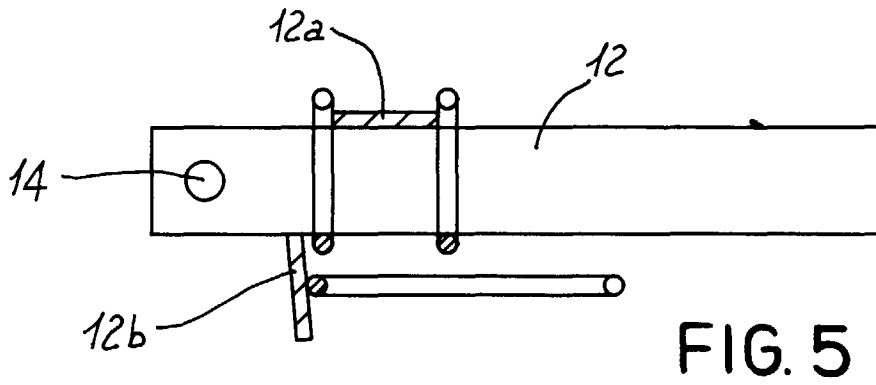
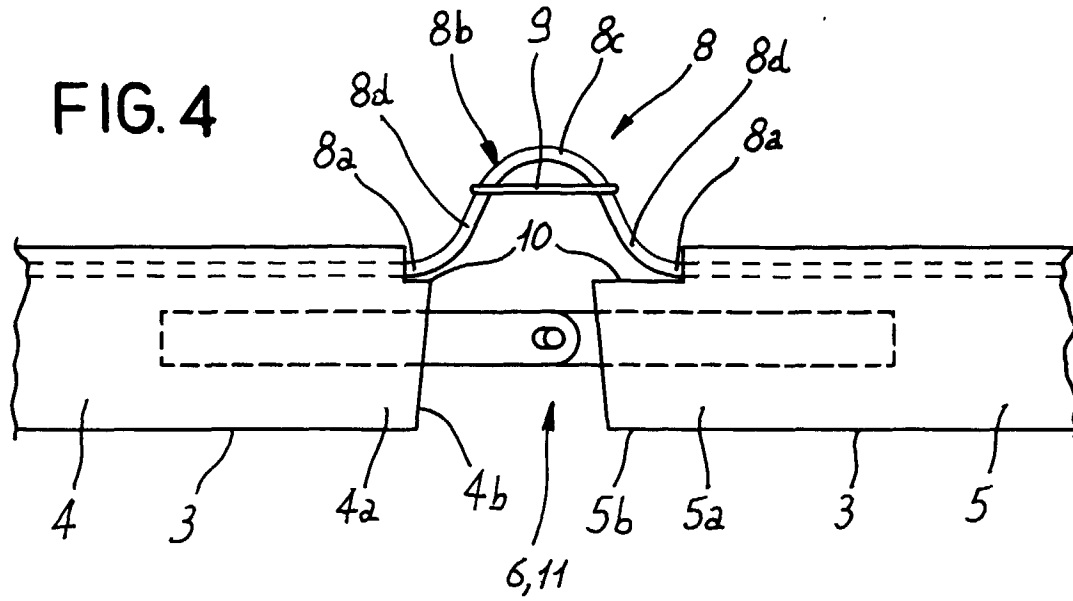


FIG. 1



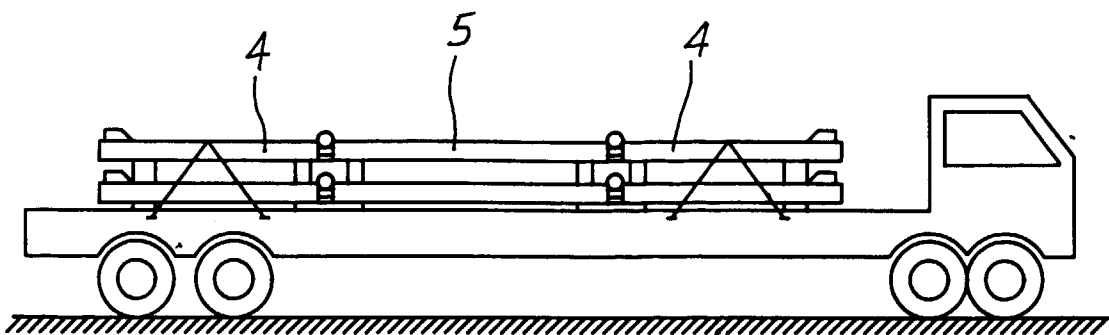
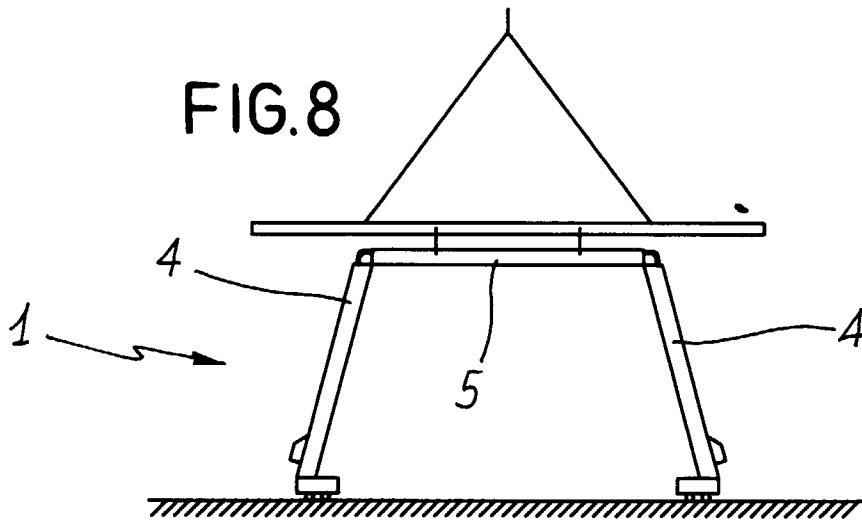
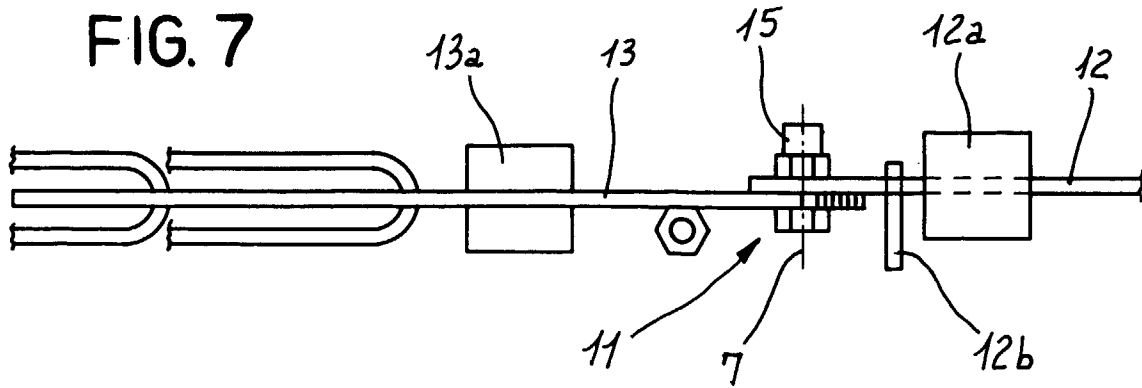


FIG. 9



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 83 0207

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.6)
X	US 4 693 634 A (CHIAVES) * column 2, line 41 - column 4, line 5; figures 1-13 * ---	1,2,6,11	E21D1/00 E02D29/05 E04B1/04
X	DE 29 05 165 A (SEITZ) * page 8, line 8 - page 12, line 4; figures 1-7 * ---	1,6-11	
A	DE 32 24 307 A (SIEMENS) * page 4, line 36 - page 6, line 15; figures 1-5 * -----	1-3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E02D E04B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		15 September 1997	Kergueno, J
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