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(71) Applicant: **Rubrica Ingeniería Y Arquitectura, S.L.**
12003 Castellón de la Plana (Castellón) (ES)

(72) Inventor: **TICHELL FORTEA, Enrique**
12003 Castellón (ES)

(74) Representative: **Urizar Anasagasti, Jesus Maria**
IPAMARK, S.L.
Paseo de la Castellana 72 1°
28046 Madrid (ES)

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(54) **COLLAPSIBLE FORMWORK FOR A BRIDGE DECK AND METHOD FOR ADVANCING THE FORMWORK**

(57) The formwork comprises interior formwork (1) and exterior formwork (2), wherein the interior formwork comprises a central section (3) and two lateral sections (4), such that the lateral sections (4) define the two wing sections of the deck and comprise at least one lateral panel (5) affixed to at least one angular panel (6) and connected by means of at least one swivel joint (9) to at least one side-wall panel (7), and the central section (3) comprises at least one removable upper panel (8); the

side-wall panels (7) have a rotary movement about the swivel joints (9) and each lateral section (4) of the interior formwork (1) rests on at least two beams (10) affixed to at least one cantilever (11), which in turn rests on at least two beams (10) affixed to at least one cantilever (11), which in turn rests on at least one advance structure (12) by means of at least a first hydraulic cylinder (13). The application also relates to a method for advancing the lower formwork (1).

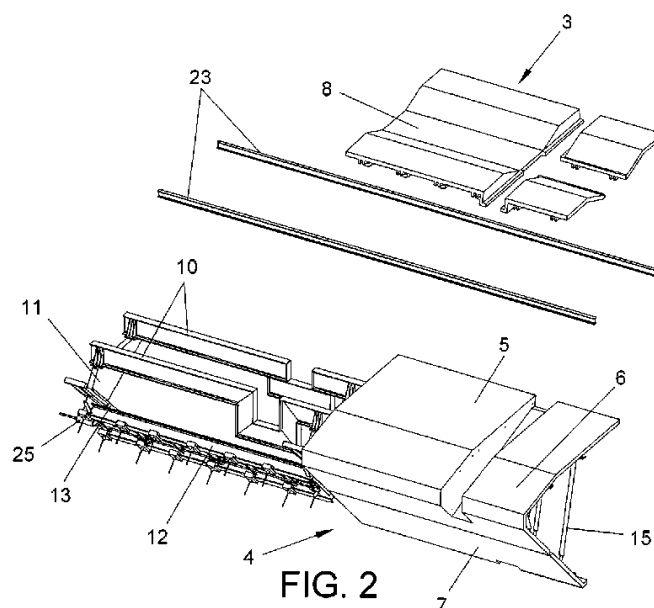


FIG. 2

Description

Object of the invention

[0001] The present invention relates to a collapsible formwork for a bridge deck that significantly facilitates the work of moving from one concrete post to the next, by collapsing portions of the formwork and the automatic advance of the formwork, which means that the invention also relates to the method for advancing the formwork. The formwork, object of the invention, is applicable to civil engineering works, specifically to bridge building.

Technical problem to be solved and background of the invention

[0002] When the bridge deck is being carried out, the use of a formwork in which to pour the concrete that shapes the bridge deck is necessary.

[0003] The formwork on which the concrete is poured is a very large installation that requires high level of accuracy so that the support it constitutes is useful for building the aforementioned bridge deck.

[0004] The bridge decks are built in phases, that is to say, a complete section of the structure of the deck is built and the formwork rests on this built section to advance and locate it in a position for a new post where the concrete that configures the following section is poured.

[0005] Normally, the advance operation of the formwork entails lowering the formwork which entails moving large pieces and high technical complexity since the dimensions of the structure mean that the movement is slow and a complex process that must be repeated on multiple occasions throughout the construction work.

Description of the invention

[0006] The invention described discloses a system for collapsing pieces of a formwork of a bridge box.

[0007] A collapsible formwork for a bridge deck comprising an interior formwork that defines an interior section of a box of the deck and an exterior formwork that defines a lower section of the box and at least two wing sections of the deck wherein the interior formwork comprises a central section and two lateral sections.

[0008] The two lateral sections define the two wing sections of the deck and the lateral sections comprise at least one lateral panel affixed to at least one angular panel and connected by means of at least one swivel joint to at least one side-wall panel, and the central section comprises at least one removable upper panel, wherein the side-wall panels have a rotary movement about the swivel joints and wherein each lateral section of the interior formwork rests on at least two beams affixed to at least one cantilever, which in turn rests on at least one advance structure by means of at least a first hydraulic cylinder, such that the lateral sections of the interior formwork have a movement in the interior section of the box

by means of the first hydraulic cylinder.

[0009] The collapsible interior formwork for a bridge deck comprises second hydraulic cylinders that connect the side-wall panels to a beam such that a movement of the second hydraulic cylinders makes the side-wall panels have a rotary movement about the swivel joints.

[0010] The interior formwork of the collapsible formwork for a bridge deck comprises first advance hydraulic cylinders that rest at one end on a section of concreted box and at another end on the advance structure.

[0011] The collapsible interior formwork for a bridge deck further comprises first tensioners that connect the upper panels to the side-wall panels, second tensioners that connect the lateral panels to the side-wall panels and third tensioners that connect ends of the side-wall panels to each other, similarly the upper panels of the central section rest on first advance tracks.

[0012] The exterior formwork of the collapsible formwork for a bridge deck comprises a central portion and two lateral portions, wherein each lateral portion comprises at least three wing sections with a straight configuration that are connected to each other by means of articulated joints.

[0013] The exterior formwork of the collapsible formwork for a bridge deck rests on a carriage that comprises ribs such that the wing sections of the exterior formwork rest on the ribs.

[0014] Fourth tensioners, fifth tensioners, sixth tensioners and third hydraulic cylinders are located between the wing sections and the ribs in the collapsible formwork for a bridge deck, object of the invention.

[0015] The carriage rests on second advance tracks by means of runners linked to second hydraulic advance cylinders that provide the carriage with an advance movement.

[0016] The interior formwork of the collapsible formwork for a bridge deck, object of the invention, has a method for advancing between different concrete posts that comprises the following stages:

- remove the first tensioners and the second tensioners
- lower the upper panel on the first advance tracks
- fold the second hydraulic cylinders rotating the side-wall panels about the swivel joints.
- fold the first hydraulic cylinders lowering the lateral sections that slide over the advance structures.
- unfold the first advance hydraulic cylinders advancing the advance structures, and therefore the lateral sections.
- unfold the first hydraulic cylinders lifting the lateral sections that slide over the advance structures.
- unfold the second hydraulic cylinders rotating the side-wall panels about the swivel joints.
- advance the central section.
- lift the upper panel until it is level with the lateral panels of the lateral sections, and
- place the first tensioners and the second tensioners.

Description of the figures

[0017] To complete the description, and for the purpose of helping to make the characteristics of the invention more readily understandable, the present specification is accompanied by a set of figures constituting an integral part of the same, which by way of illustration and not limitation represent the following:

Figure 1 is a perspective view of the interior formwork of the formwork, object of the invention.

Figure 2 is a perspective view of the interior formwork with the lateral section and the central section separated.

Figure 3 is a cross sectional view of the interior formwork of the formwork, object of the invention.

Figure 4 is a perspective view of the carriage and the exterior formwork of the formwork, object of the invention.

Figure 5 is a side view of the carriage and the formwork of figure 4.

Figure 6 is a front view of a lateral portion of the exterior formwork of the formwork, object of the invention, with the wing sections in a concreting position.

Figure 7 is a front view similar to figure 6 with the wing sections in a carriage movement position.

Figure 8 is a figure in which the phases of the method for advancing the interior formwork shown in figures 1 to 3 are shown.

[0018] The various numerical references found in the figures correspond to the following elements:

- 1. - interior formwork
- 2. - exterior formwork
- 3. - central section
- 4. - lateral section
- 5. - lateral panel
- 6. - angular panel
- 7. - side-wall panel
- 8. - upper panel
- 9. - swivel joint
- 10. - beam
- 11. - cantilever
- 12. - advance structure
- 13. - first hydraulic cylinder
- 14. - first tensioners
- 15. - second tensioners
- 16. - wing section
- 17. - rib
- 18. - fourth tensioners
- 19. - fifth tensioners
- 20. - sixth tensioners
- 21. - third hydraulic tensioners
- 22. - carriage
- 23. - first advance tracks
- 24. - second hydraulic cylinders

- 25. - first advance hydraulic cylinders
- 26. - second advance hydraulic cylinders
- 27. - runner
- 28. - second advance tracks
- 29. - third tensioners

Preferred embodiment of the invention

[0019] As stated above and may be seen in the figures, the object of the invention is a formwork for bridge decks with a configuration and elements that facilitate the advance operation of the formwork by means of collapsing some elements of the formwork, which reduces the complexity of the operations necessary for advancing the formwork, thus increasing the efficiency in carrying out the bridge deck.

[0020] A bridge deck is a structure with a section comprising an omega-shaped cross section with a central box and wings, thus meaning that any formwork used for the concreting of a deck must comprise two different parts, an interior portion for the formwork of the central box and an exterior portion corresponding to the interior portion and to the wings of the deck.

[0021] The section of the central box is a hollow section that comprises an upper wall and a lower wall that are approximately parallel to each other and inclined lateral walls that connect the upper wall and the lower wall, the lateral walls are inclined because the lower wall is small than the upper wall.

[0022] The formwork, object of the invention, comprises two portions: an interior formwork (1) and an exterior formwork (2).

[0023] The interior formwork (1) comprises a central section (3) and two lateral sections (4) and is symmetrical with respect to a plane that passes through the centre of the central section (3) and is longitudinal to the central section (3).

[0024] The two lateral sections (4) of the interior formwork (1) comprise at least one lateral panel (5), at least one angular panel (6) and at least one side-wall panel (7). The central section (3) of the interior formwork (1) comprises at least one upper panel (8).

[0025] As such, the section of the central box is defined by the elements of the interior formwork (1) in the following manner:

- The lateral panels (5) of a first lateral section (4) along with the upper panels (8) of the central section (3) and along with the lateral panels (5) of a second lateral section (4) define a portion of the upper wall of the section of the box;
- The angular panels (6) define the transition between the upper wall and the lateral walls of the section of the box, the angular panels (6) are affixed on one side to the lateral panels (5) and on another to the side-wall panels (7).
- The side-wall panels (7) define the lateral walls up to the contact with the lower wall of the section of

the central box, and are affixed to the angular panels (6) by means of swivel joints (9) that enable a collapsing movement between the side-wall panels (7) and the angular panels (6).

[0026] Each lateral section (4) of the interior formwork (1) rests on two beams (10) located under the lateral panels (5), with said beams (10) in a parallel position and affixed to at least two cantilevers (11) that rest on an advance structure (12) by means of first hydraulic cylinders (13), the advance structure (12) being located on the lateral walls of the section of the box and such that the lateral section (4) of the interior formwork (1) may move with respect to the position of the advance structure (11) by means of first hydraulic cylinders (13).

[0027] As mentioned above, the formwork, object of the invention, has been developed to be able to have an advance movement without the need to disassemble large pieces, thus speeding up the movements that the formwork makes for the different concrete posts in the construction of the box of the bridge. Therefore, two configurations of the formwork, object of the invention, may be differentiated, a first configuration in which the formwork is prepared to receive the concrete and a second configuration in which the formwork carries out a movement between two different posts.

[0028] When the interior formwork of the formwork, object of the invention, is prepared to receive the concrete, the upper panel (8) of the central section (3) is connected to the side-wall panels (7) the two lateral sections (4) by means of first tensioners (14) that on each side of the formwork, object of the invention, connect one end of the upper panel (8) to the side-wall panel (7) at the end closest to the lower wall of the section of the central box. Likewise, the lateral panels (5) are connected to the side-wall panels (7) by means of second tensioners (15) between an intermediate point of the lateral panels (5) and an intermediate point of the side-wall panels (7), said side-wall panels (7) connect to a beam (10) by means of second hydraulic cylinders (24). Lastly, third tensioners (29) connect two ends of the panels (7) to each other.

[0029] Similarly to the first hydraulic cylinders (13), they are in an unfolded position such that the angular panels (6) are in the position in which they shape the contact between the lateral walls and the upper wall of the section of the central box, the lateral walls (5) along with the upper panels (8) provide support to the upper wall of the section of the central box and the side-wall panels (7) shape the upper portion of the lateral walls of the section of the central box.

[0030] This entire configuration is to shape the section of the central box through the inside thereof. To shape the central section of the box on the exterior and the wings of the section of the bridge deck, the exterior formwork (2) is used.

[0031] As such, the interior formwork (1) in the second configuration, that in which the formwork carries out a movement between two different posts, is defined:

- In the central section (3), the upper panels (8) are removed, which are located on first advance tracks (23) on the lower wall of the section of the box:
- In the lateral sections (4), the first tensioners (14) and the second tensioners (15) are removed, in addition the side-wall panels (7) rotate about the swivel joints (9) and bring the free end of the side-wall panels (7) closer to the upper panel (8), for this rotation, the second hydraulic cylinders (24) contract causing the aforementioned rotation of the side-wall panels (7). Additionally, the first hydraulic cylinders (13) also contract, separating the interior formwork (1) from the upper wall, sliding on the advance structure (12). Lastly, first advance hydraulic cylinders (25), which push the advance structure (12) and with the advance structure (12) the interior formwork (1), are located in the advance structure (12), resting on a section of built box.

[0032] The exterior formwork (2) comprises a central portion and two lateral portions. Each lateral portion of the exterior formwork (2) comprises three wing sections (16) that serve to support the concrete when the wings of the bridge deck are carried out. The three wing sections (16) are straight and are connected to each other by means of articulated joints (24) that enable a relative rotary movement between adjacent wing sections (16), and enable the alignment between the three wing sections (16) to have bends. The three wing sections (16) rest on ribs (17) by means of fourth tensioners (18), fifth tensioners (19), sixth tensioners (20) and third hydraulic cylinders (21). The ribs (17) on which both the three wing sections (16) and the central portion of the exterior formwork (2) are placed and rest, form part of a carriage (22) that advances resting on second advance tracks (28) that are placed on a section of concreted deck.

[0033] When the exterior formwork (2) of the formwork, object of the invention, is prepared to receive the concrete, the third tensioners (18), the fourth tensioners (19) and the fifth tensioners (20) are in a position such that the three wing sections (16) are in a position at a distance from the ribs (17) and the third hydraulic cylinders (21) are in an extended position, such that the wing sections (15) along with the central portion of the exterior formwork (2) give the omega-shaped cross section to the lower portion of the bridge deck.

[0034] On the contrary, when the concreting has been carried out, the exterior formwork collapses, freeing the position of the third tensioners (18) and of the fourth tensioners (19), and folding the third hydraulic cylinders (21), such that the three wing sections (16) have relative rotations between each other and rotate about the third hydraulic cylinders (21) and about the fifth tensioners (20), the lateral portions being in a retracted position with the between the ribs (17) of the carriage.

[0035] With the lateral portions of the exterior formwork between the ribs (17), the advance of the carriage (22) is caused by means of second advance hydraulic cylinders

ders (26) that move on the second advance tracks (28) by means of runners (27) linked to the aforementioned carriage (22).

[0036] The formwork, object of the invention, as it has been explained, enables a movement between a concrete post and the following by means of simple steps, which speeds up the concreting work with respect to the formworks known to date.

[0037] The method for moving the interior formwork (1) comprises the following phases:

- remove the first tensioners (14) and the second tensioners (15), lower the upper panel (8) on the first advance tracks (23),
- fold the second hydraulic cylinders (24) rotating the side-wall panels (7) about the swivel joints (9),
- fold the first hydraulic cylinders (13) lowering the lateral sections (4) that slide over the advance structures (12),
- unfold the first advance hydraulic cylinders (23) advancing the advance structures (12), and therefore the lateral sections (4),
- unfold the first hydraulic cylinders (13) lifting the lateral sections (4) that slide over the advance structures (12),
- unfold the second hydraulic cylinders (24) rotating the side-wall panels (7) about the swivel joints (9), advance the central section (3),
- lift the upper panel (8) until it is level with the lateral panels (8) of the lateral sections (4), and
- place the first tensioners (14) and the second tensioners (15).

[0038] The invention should not be limited to the particular embodiment described in this document.

[0039] A person skilled in the art may develop other embodiments in light of the description made herein. As such, the scope of the invention is defined by the following claims.

Claims

1. A collapsible formwork for a bridge deck comprising an interior formwork

(1) that defines an interior section of a box of the deck and an exterior formwork
 (2) that defines a lower section of the box and at least two wing sections of the deck wherein the interior formwork of the box comprises a central section (3) and two lateral sections (4), **characterised in that** the lateral sections (4) define the two wing sections of the deck and the lateral sections (4) comprise at least one lateral panel (5) affixed to at least one angular panel (6) and connected by means of at least one swivel joint (9) to at least one side-wall panel (7), and the

central section (3) comprises at least one removable upper panel (8), wherein the side-wall panels (7) have a rotary movement about the swivel joints (9) and wherein each lateral section (4) of the interior formwork (1) rests on at least two beams (10) affixed to at least one cantilever (11), which in turn rests on at least one advance structure (12) by means of at least one first hydraulic cylinder (13) such that the lateral sections (4) of the interior formwork (1) have a movement in the interior section of the box by means of the first hydraulic cylinder.

2. The collapsible formwork for a bridge deck according to claim 1 **characterised in that** the interior formwork (1) comprises second hydraulic cylinders (24) that connect the side-wall panels (7) to a beam (10), such that a movement of the second hydraulic cylinders (24) make the side-wall panels (7) have a rotary movement about the swivel joints (9).

3. The collapsible formwork for a bridge deck according to claim 1 **characterised in that** the interior formwork (1) comprises first advance hydraulic cylinders (25) that rest at one end on a section of concreted box and at another end on the advance structure (12).

4. The collapsible formwork for a bridge deck according to the preceding claims **characterised in that** the interior formwork (1) comprises:
 - first tensioners (14) that connect the upper panels (8) to the side-wall panels (7),
 - second tensioners (15) that connect the lateral panels (4) to the side-wall panels (7),
 - third tensioners (29) that connect the ends of the side-wall panels (7) to each other.

5. The collapsible formwork for a bridge deck according to the preceding claims **characterised in that** the upper panels (8) of the central section (3) rest on first advance tracks (23).

6. The collapsible formwork for a bridge deck according to the preceding claims **characterised in that** the front formwork (2) comprises a central portion and two lateral portions, wherein each lateral portion comprises at least three wing sections (16) with a straight configuration that are connected to each other by means of articulated joints (24).

7. The collapsible formwork for a bridge deck according to claim 6 **characterised in that** the exterior formwork (2) rests on a carriage (22) comprising ribs (17) such that the wing sections (16) of the exterior formwork (2) rests on the ribs (17).

8. The collapsible formwork for a bridge deck according to claim 6 **characterised in that** fourth tensioners (18), fifth tensioners (19) and sixth tensioners (20) and third hydraulic cylinders (21) are located between the wing sections (16) and the ribs (17). 5
9. The collapsible formwork for a bridge deck according to claim 7 **characterised in that** the carriage (22) rests on second advance tracks (28) by means of runners (27) linked to second advance hydraulic cylinders (26) that provide the carriage with an advance movement (22). 10
10. The method for advancing the interior formwork (1) of the formwork defined in the preceding claims **characterised in that** it comprises the following stages: 15
- remove the first tensioners (14) and the second tensioners (15), 20
 - lower the upper panel (8) on the first advance tracks (23),
 - fold the second hydraulic cylinders (24) rotating the side-wall panels about the swivel joints (9),
 - fold the first hydraulic cylinders (13) lowering the lateral sections (4) that slide over the advance structures (12), 25
 - unfold the first advance hydraulic cylinders (23) advancing the advance structures (12), and therefore the lateral sections (4), 30
 - unfold the first hydraulic cylinders (13) lifting the lateral sections (4) that slide over the advance structures (12),
 - unfold the second hydraulic cylinders (24) rotating the side-wall panels (7) about the swivel joints (9), advance the central section (3), 35
 - lift the upper panel (8) until it is level with the lateral panels (8) of the lateral sections (4), and
 - place the first tensioners (14) and the second tensioners (15). 40

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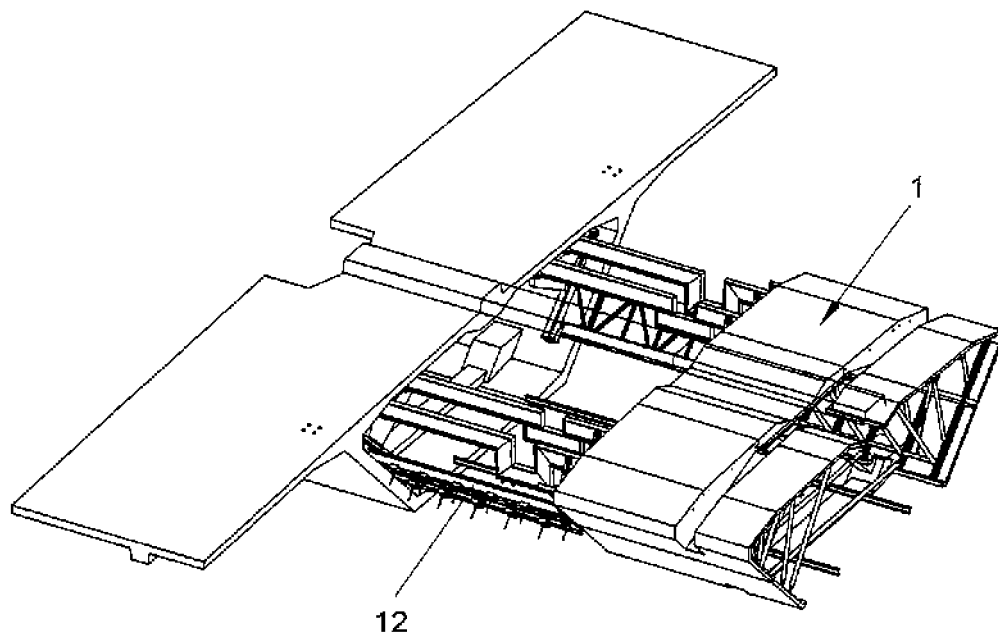


FIG. 1

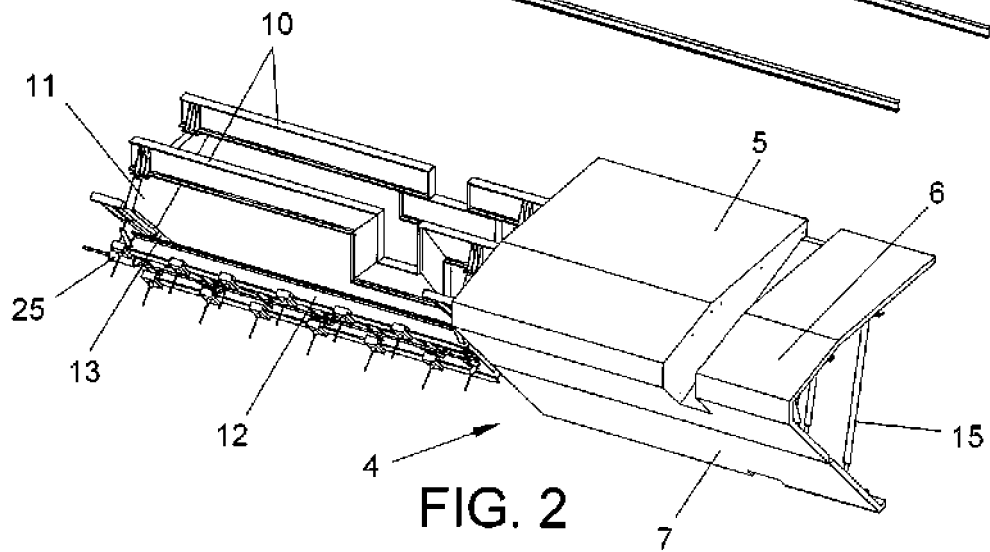
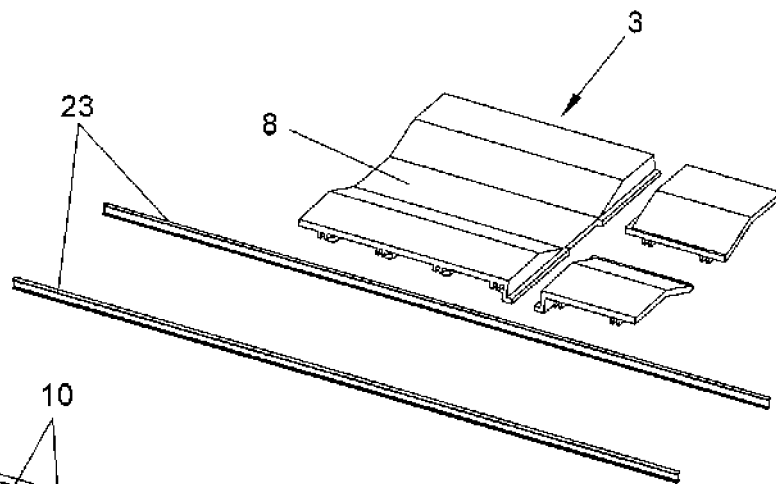


FIG. 2

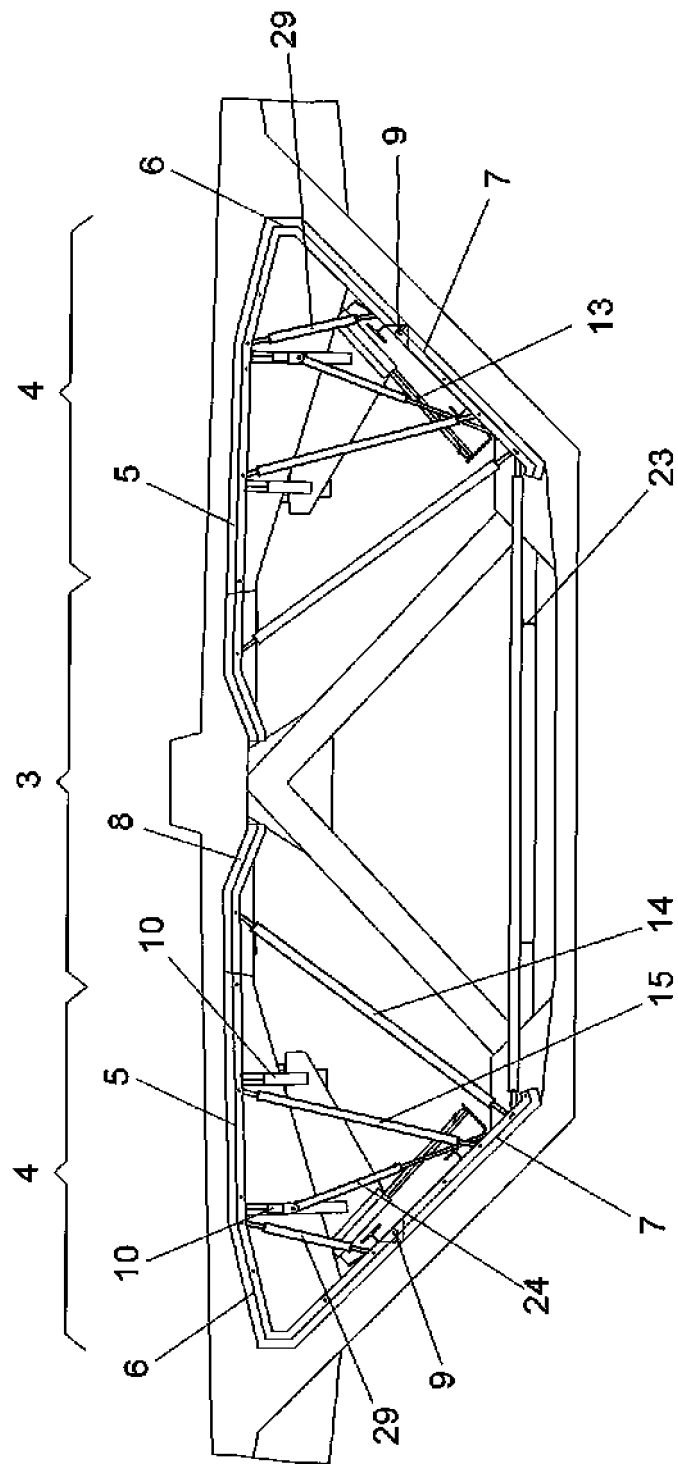


FIG. 3

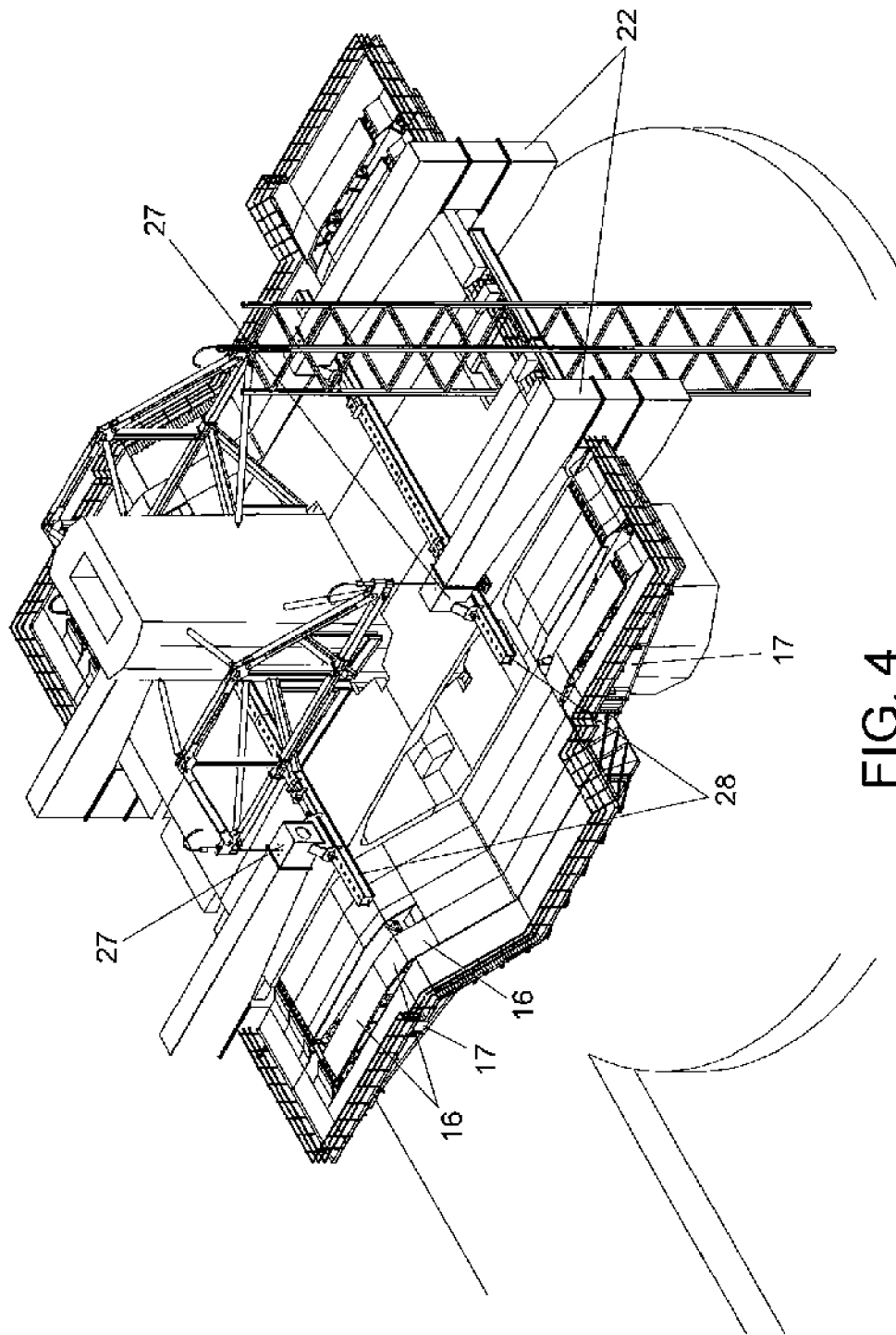


FIG. 4

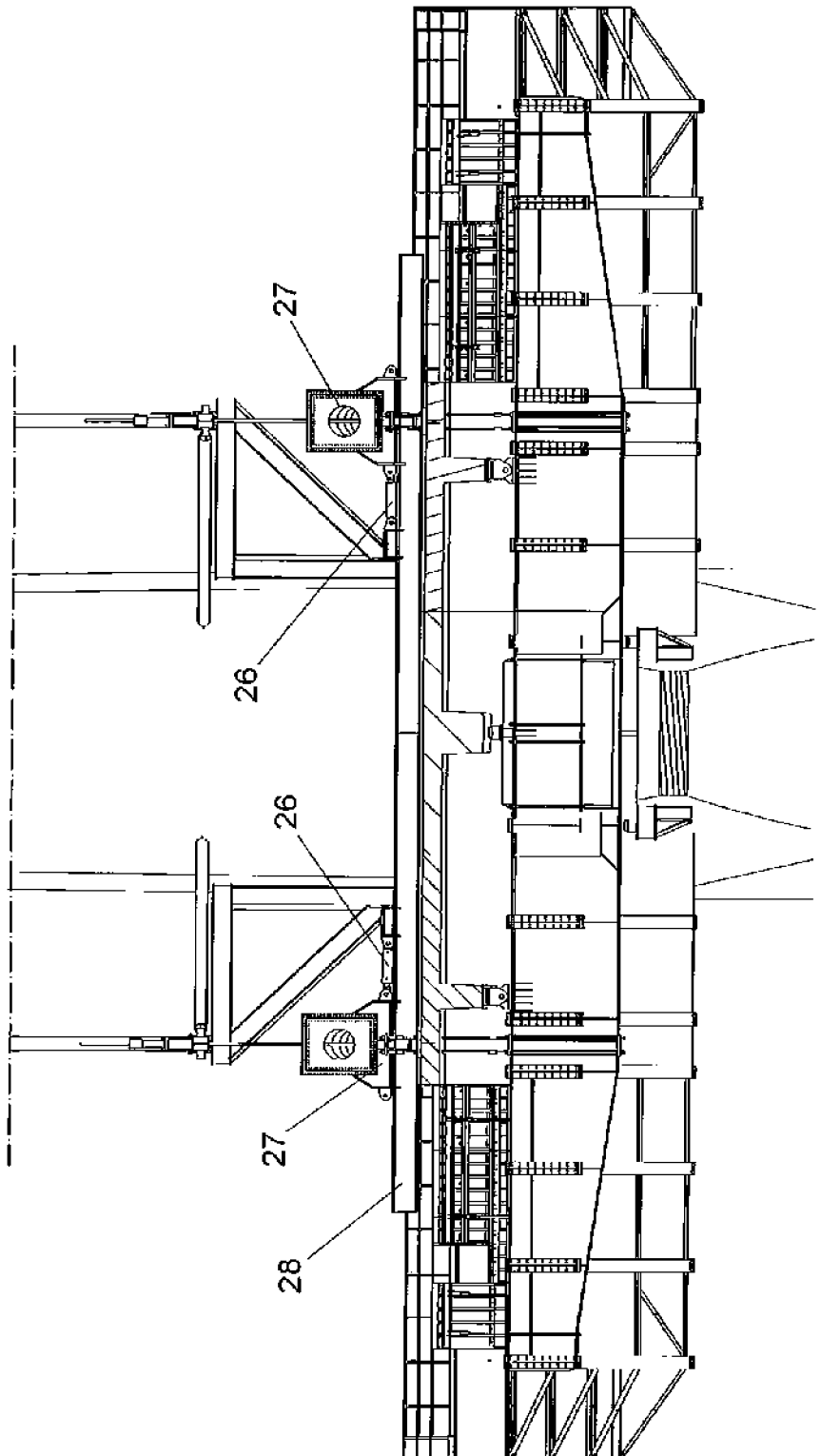


FIG. 5

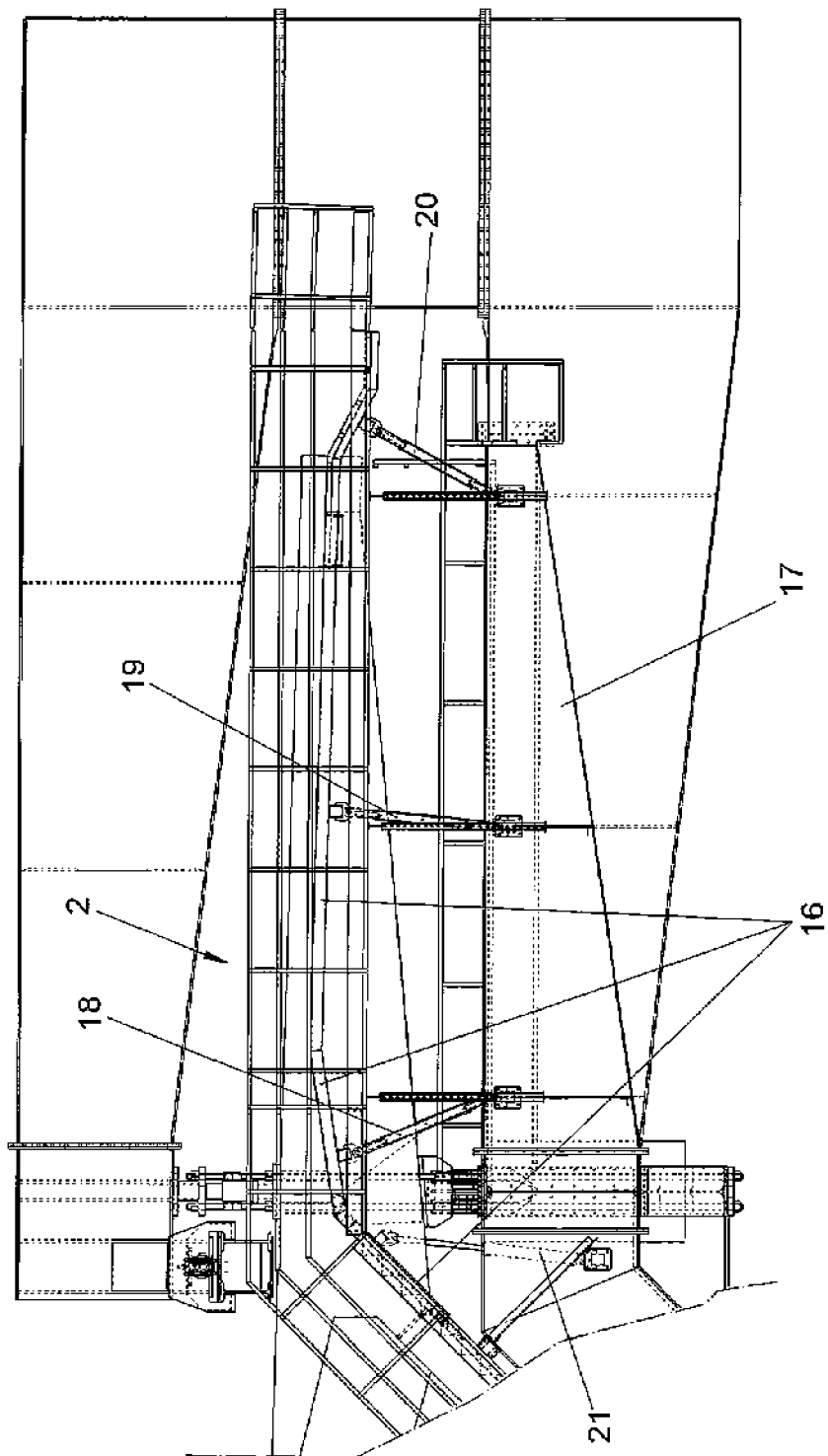


FIG. 6

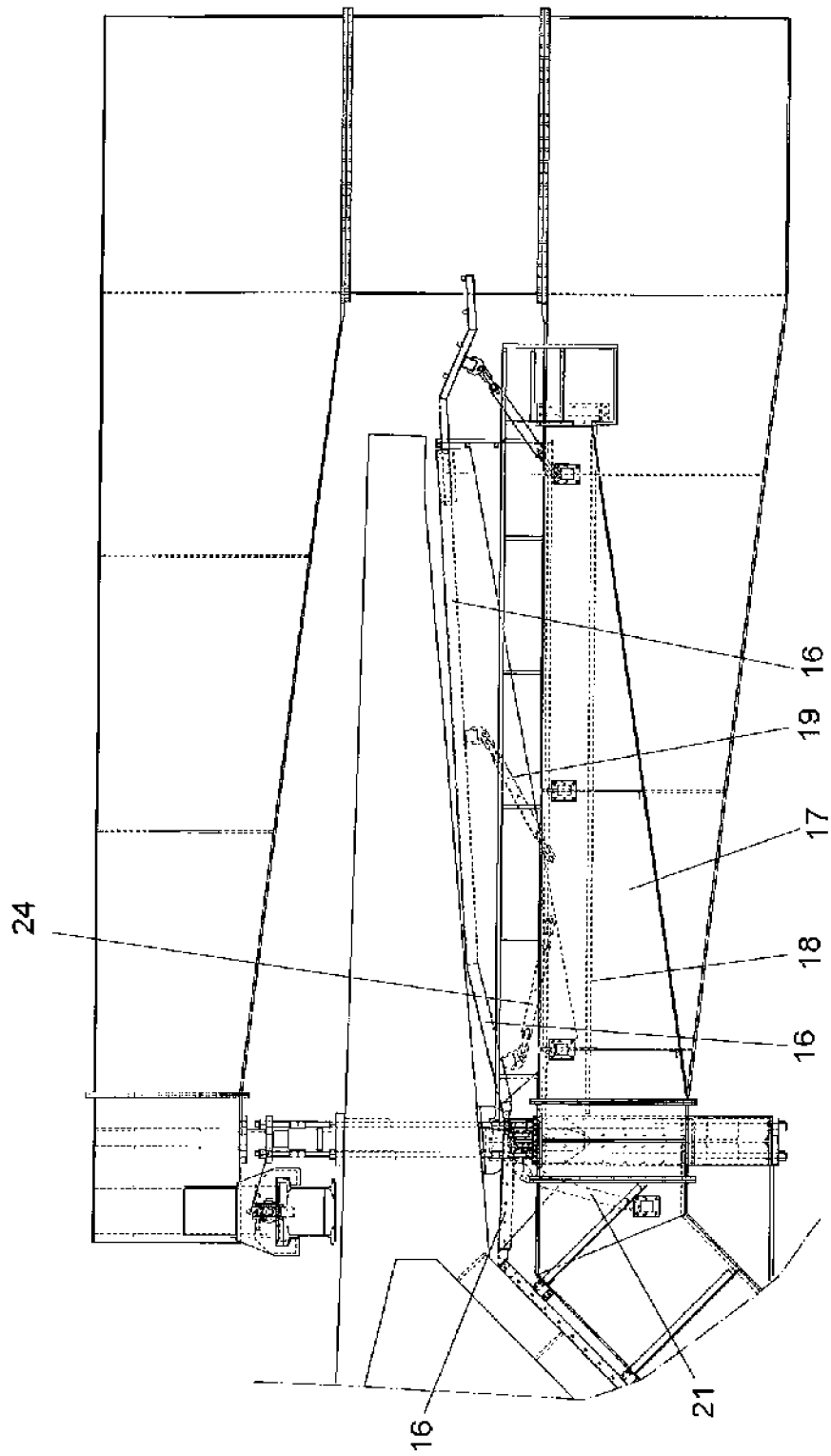


FIG. 7

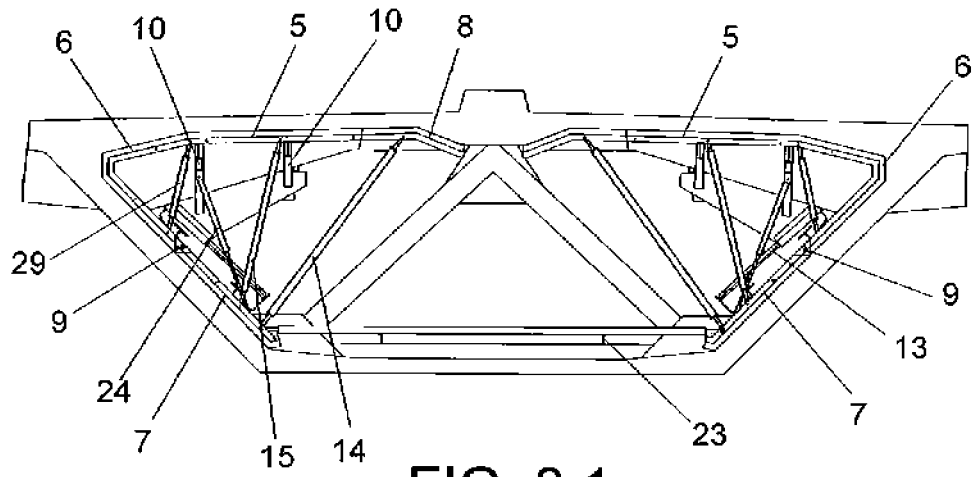


FIG. 8.1

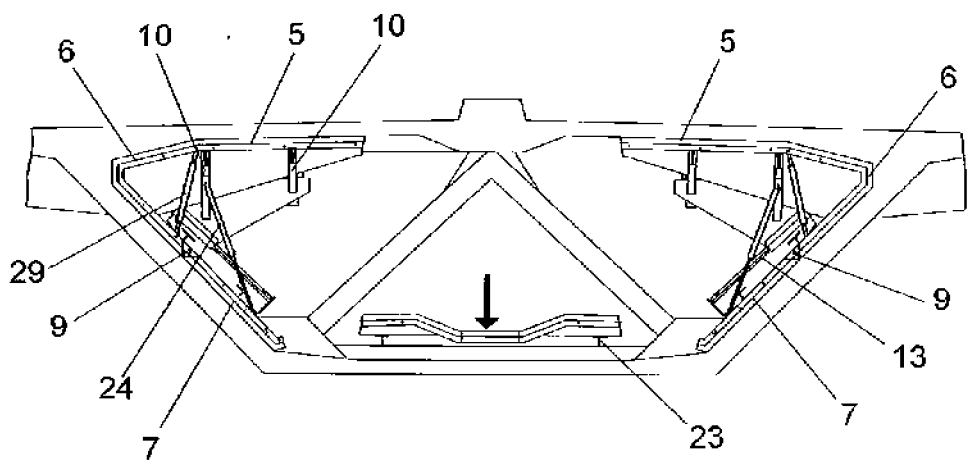


FIG. 8.2

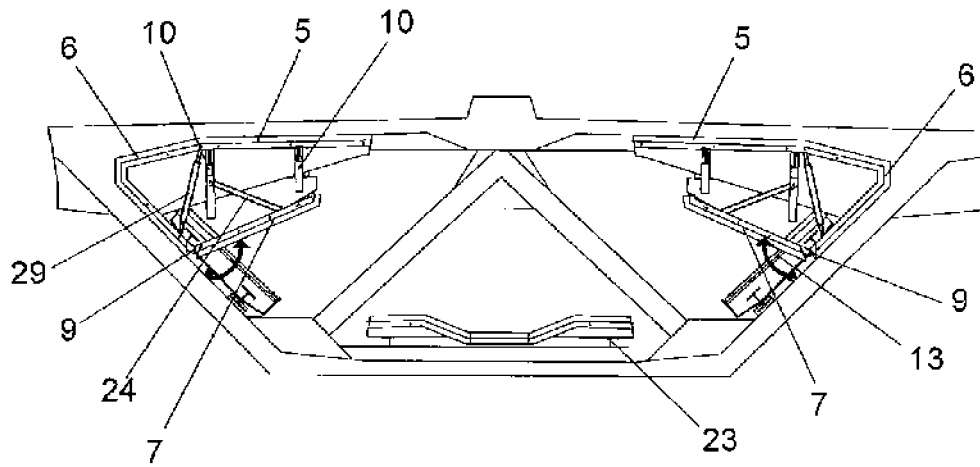


FIG. 8.3

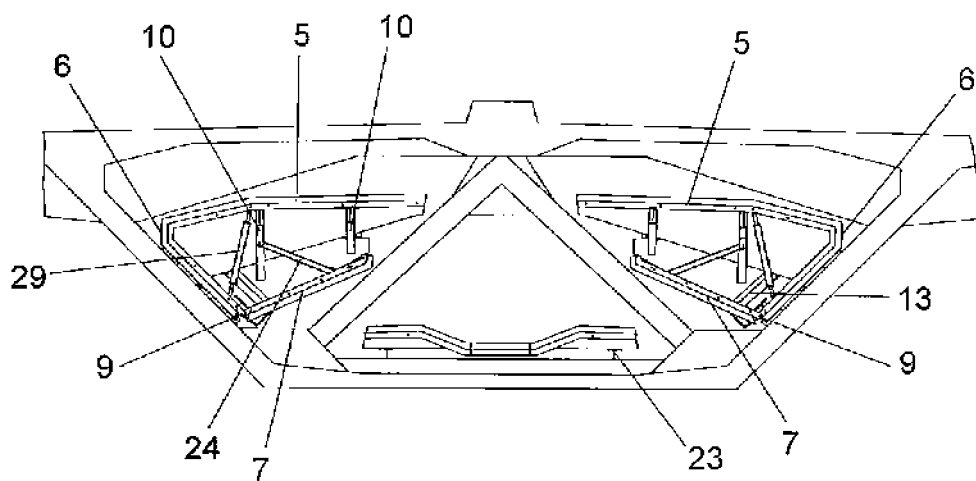


FIG. 8.4

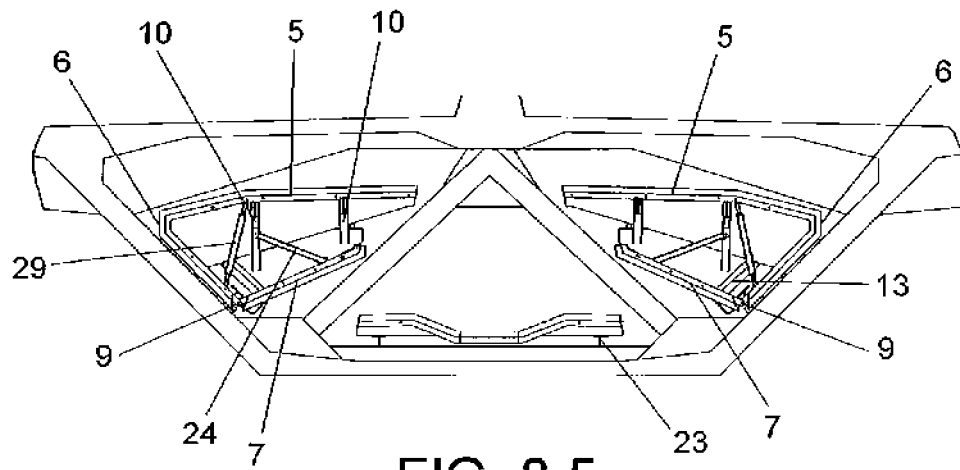


FIG. 8.5

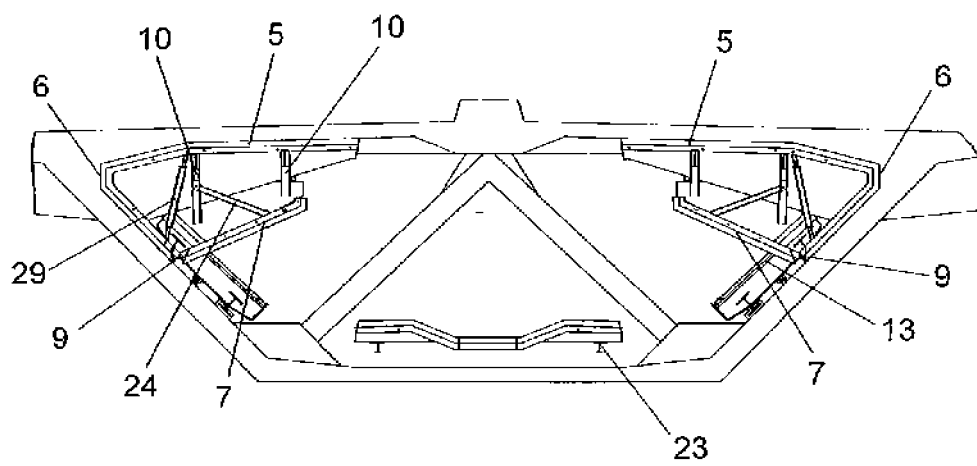


FIG. 8.6

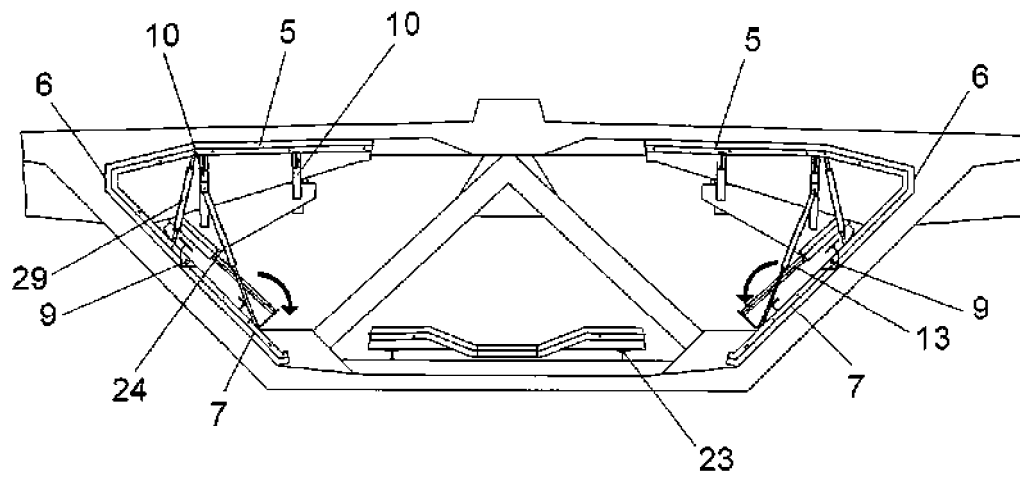


FIG. 8.7

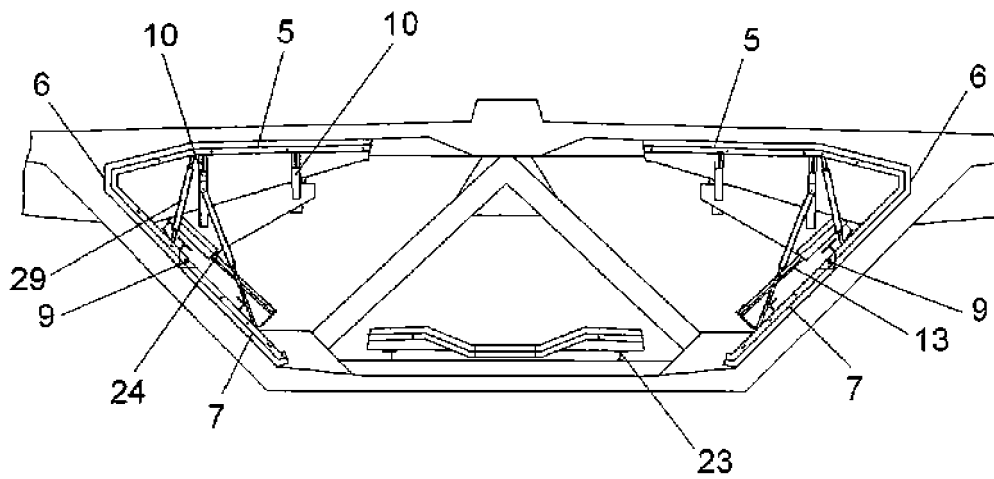


FIG. 8.8

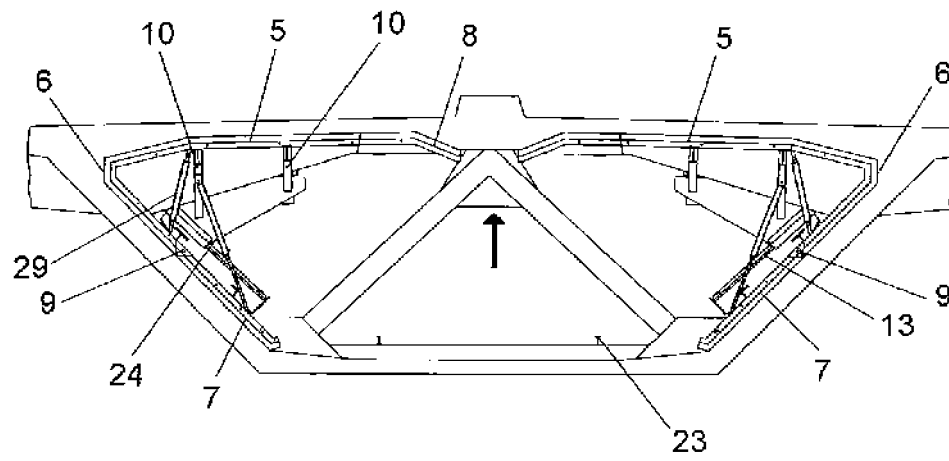


FIG. 8.9

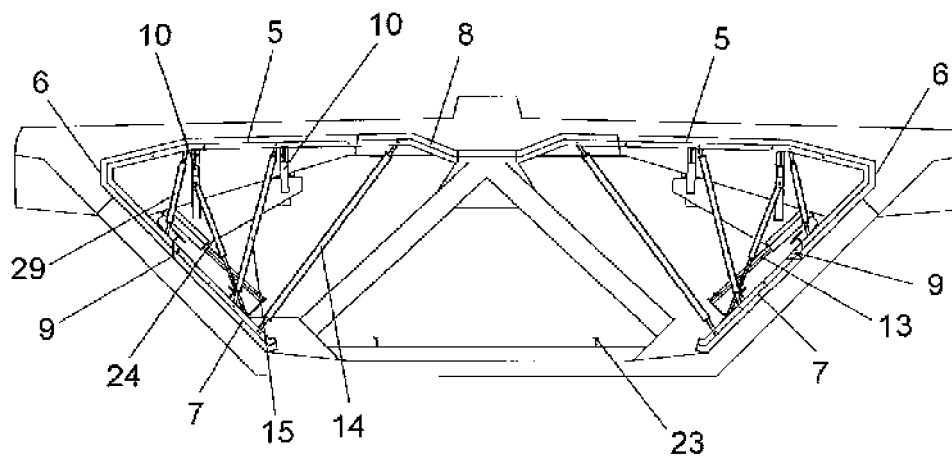


FIG. 8.10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2015/070562

A. CLASSIFICATION OF SUBJECT MATTER

E01D1/00 (2006.01)

E01D21/00 (2006.01)

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)

E01D

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 practicable, search terms used)

EPODOC, INVENES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3985480 A (FINSTERWALDER KLEMENS) 12/10/1976, column 2, line 17 - column 7, line 26; figures.	1-10
A	CN 201065511Y Y (GUANGDONG CHANGDA HIGHWAY ENGI) 28/05/2008, figures & Abstract of the DataBase WPI. Retrieved from EPOQUE; AN 2008-H49309.	1-10
A	CN 201245818Y Y (CHINA MAJOR BRIDGE ENG CO LTD) 27/05/2009, figures & Abstract from DataBase WPI. Retrieved from EPOQUE; AN 2009-K03195 .	1-10
A	KR 20020035038 A (DONGDO IND CO LTD) 09/05/2002, figures & Abstract from DataBase WPI. Retrieved from EPOQUE; AN 2002-679684 .	1-10

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents, such combination being obvious to a person skilled in the art

"&"

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Date of the actual completion of the international search
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Name and mailing address of the ISA/

OFICINA ESPAÑOLA DE PATENTES Y MARCAS
Paseo de la Castellana, 75 - 28071 Madrid (España)
Facsimile No.: 91 349 53 04Authorized officer
M. Castañón Chicharro

Telephone No. 91 3493261

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