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(11) EP 0 754 821 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:  
22.01.1997 Bulletin 1997/04

(51) Int. Cl.<sup>6</sup>: E04H 3/14, E04B 7/14

(21) Application number: 95304964.0

(22) Date of filing: 17.07.1995

(84) Designated Contracting States:  
DE FR GB IT

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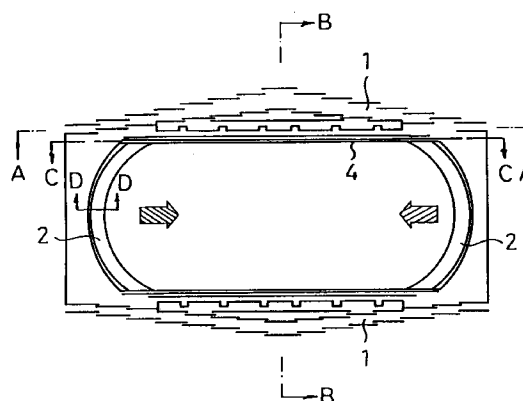
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(54) Structure of multipurpose suspended roof arena capable of changing space volume and construction method thereof

(57) The arena has a movable stand (2) capable of changing the usable space in accordance with the type and scale of an event. The rectangular suspended-roof arena comprises a pair of outward convex-shaped stands (2) provided between both long sides of the rectangle to be movable along the long side of the rectangle. A stand (1) at the long side of the rectangle decreases in width stepwise towards the ends. The suspended roof comprises suspending members (15) extending between columns (12) whose bases are connected to a foundation (18) which bears the tension and vertical load of each suspending member (15). Each suspending member (15) comprises steel (16) which bears tension and laminated lumber (17) which surrounds the steel (16) and bears bending moment.

FIG. 1



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## Description

This invention relates to an arena composed of a movable stand and a suspended roof in order to make it possible to select a space volume suitable for the scale of an event and form a realistic space.

To use an existing arena for various purposes, a variable driving unit such as a movable stand has been used. However, the unit has not harmonized with a construction plan, and the value added according to the synergistic effect between the unit and the construction plan has not been considered. Moreover, the existing arena has been constituted to take on upward convex shape and had a large unnecessary load space because it has used an air film structure, a parasol-dome tension film structure, or a hybrid film structure. Furthermore, an existing suspended roof could not be suspended only by a suspending member. Therefore, the shape of the roof has been kept using a cable vertical to the suspending member so as to press the cable from the top of the suspending member. Thus, the shape of the roof has been limited to the saddle type and thereby the labor has been doubled because the pressing cable must be set on the suspending member.

The value added according to the synergistic effect between the variable driving unit such as a movable stand and the construction plan represents that not only the variable driving unit can correspond to various items and types of events but also it is possible to meet requests for the whole arena by minimizing the number of equipments for various functions of a large space and making most use of the functions.

Various functions of an existing arena such as sound, illumination, and air conditioning have depended on heavy equipment including a movable stand in order to correspond to various items and types of events. To improve the arena profitableness which may not often pay, it is necessary not only to cut the initial cost and the running cost of various functions but also find various good ideas. Therefore, it is necessary to attract more events, improve the serviceability ratio and the spectator collection capacity, and improve the profitableness by setting a realistic seat arrangement correspondingly to various scales of events, systematically securing the comfortableness including sound, illumination, and air conditioning and the producibility, and shortening the setting time of these items for each event.

Therefore, the present invention provides an arena, which includes a movable stand harmonizing with a construction plan so that the number of equipments for various functions of the arena is minimized, the initial cost and running cost are decreased, and the profitableness is improved, and which secures the comfortableness including sound, illumination, and air conditioning and the producibility by using a suspended roof to decrease the load space of the arena.

That is, a roof composed of a suspending member keeps its shape by the fact that tension is added to the suspending member. However, when the suspending

member is set under a catenary state, it is impossible to add tension to the suspending member. Therefore, because tension is normally added to the suspending member by setting a pressing cable on the suspending member so that it vertically intersects the suspending member to take an upward convex shape, the shape of an existing roof composed of a suspending member and a pressing cable has been limited to the saddle type. Thus, the labor has been doubled because the pressing cable must be set onto the suspending member.

There are the following two methods for the construction of a suspended roof.

(a) Method of roughly constructing a roof before lifting the same by a crane

(b) Method of constructing a roof on an integrated scaffold assembled under the roof

The method (a) has a problem in the progress of construction under a windy state because a suspended roof has only a small rigidity and the method (b) is not preferable because temporary construction requires a lot of time and cost. Therefore, the present invention solves the above problems and moreover provides a construction method for saving a construction period and construction cost while securing the safety.

It is an object of the present invention to provide a rectangular flat suspended-roof arena having a function for changing a space volume, comprising a pair of outward convex-shaped means provided between both long sides of a rectangle to be movable along the long side of the rectangle, wherein a stand at the long side of the rectangle is formed by making use of a plane whose width decreases stepwise according as a plane portion is closer to an end of the long side, and a vertical cross section, in which the ceiling lowers stepwise, and the vertical cross section of the short side of the rectangle serves as a suspended roof.

The suspended-roof arena comprises a suspended roof including columns stood in a row in one direction and faced each other at intervals, a suspending member set between the columns faced each other and forming the roof, and a foundation to which a column base is connected and which is secured to the ground and bears the tension and vertical load of the suspending member, wherein the suspending member includes a steel material which bears tension, and laminated lumber which surrounds the steel material and bears a bending moment,

The suspended-roof construction method of constructing a suspended roof includes the steps of constructing part of a suspended roof constituted by arranging suspending members each including a steel material, which bears tension, and laminated lumber, which surrounds the steel material and bears a bending moment, in a row in one direction as a unit on the ground, and thereafter lifting and setting the unit between previously-constructed columns faced each

other at intervals. The method comprises the steps of erecting temporary columns at intervals movably in the direction in which the suspending members are arranged in a row at the suspended roof side where the columns are faced each other on the plane, constructing a lift between the parallel temporary columns to be movable vertically with respect to the temporary columns, stretching a wire from the lift to the ground through the top of the temporary columns to connect one end of the wire to the lift and the other end thereof to a winder, thereafter constructing the unit on the lift facing to the direction in which the temporary columns are faced each other, raising the lift while adding tension to each suspending member of the unit to connect an end of each suspending member to the top of each column, thereafter lowering the lift while moving the temporary columns by a certain distance, and further repeating the procedure from construction of the unit on the lift to moving of the temporary columns to set each suspending member between the columns.

The present invention makes it possible to secure the adaptability for the type and scale of an event, the comfortableness, the producibility, the decrease of setting time, and the reduction of maintenance easily and inexpensively at a high quality, on the assumption that a space volume is made variable.

That is, the present invention makes it possible to improve the cost performance of illumination, sound, and air conditioning in view of the initial and running costs by changing the space volume. For example, when fully using a space, an arena can be set as shown in Fig. 4. Moreover, it is possible to correspond to a high-ceiling and small-scale event performed by moving a movable stand to the central portion as shown in Fig. 5 or a low-ceiling and small-scale event performed by moving the movable stand to one side of the arena as shown in Fig. 6. Furthermore, in the case of a small-space, low-ceiling and small-scale event, it is possible to secure the comfortableness and the producibility at an adequate quality level with the equipments for a small space, instead of using the equipments for the entire large space in combination with a partition as shown in Fig. 7. Furthermore, it is possible to further improve the quality for multipurpose and expand the range for multipurpose by operating the movable stand in combination with a previously-prepared movable floor system, a partition system and a traveling burton system including a suspending object system, and sound and illumination equipments such as to vary the positions of these systems in accordance with the scale of an event and the position of a stage.

Moreover, it is possible to collect natural light together with a large opening at the gable side by using a terraced portion with stepwise cross section so as to uniformly secure indirect light up to the center of an arena as shown in Fig. 2(a). Furthermore, as shown in Fig. 2(b), it is possible to simplify the maintenance in a high ceiling space by securing natural ventilation and effectively using natural energy to save energy so as to

secure the comfortableness of the internal environment, while concentrating various equipments for illumination, sound, suspending point and so on by using the terraced portion as a maintenance passage.

Furthermore, as shown in Fig. 3, it is possible to decrease a space volume serving as a load and save energy by forming the cross section of the short side into a suspended roof structure composed of a suspending member so as to take a suspended shape with a curve opposite to that of a normal dome, while economically realizing a frame with the maximum span. At the same time, a downward convex-shaped ceiling contributes to the improvement of acoustic clarity without forming a sound focus and makes it possible to more effectively secure the comfortableness and the producibility.

Furthermore, as shown in Fig. 17, the suspending member comprises a steel material and laminated lumber surrounding the steel material, and has flexural rigidity due to the tension borne by the steel material and the bending moment borne by the laminated lumber. The suspending member independently has a shape-keeping ability. The laminated lumber bears a local bending moment due to snow load and wind load, and moreover it has a function for protecting the steel material from rusting by covering the steel material with the laminated lumber and makes it possible to decrease the total weight of a roof.

Concerning the suspended roof construction method, because the suspending member keeps its shape with no tension, the catenary of the roof directly forms the shape of the roof as shown in Fig. 15 and the shape of the roof in the ridge direction is changed by the fact that the columns in the direction of standing in a row vary in height.

Because the suspending member unit can be lifted without being influenced by wind, it is possible to shorten construction period and decrease construction cost. Moreover, construction can continuously be progressed because the temporary column and lift necessary for lifting the suspending members are moved in the direction in which the suspending members are arranged in a row whenever the unit is installed.

The foregoing and other objects and features of the invention will become apparent from the following description of preferred embodiments of the invention with reference to the accompanying drawings, in which:

Fig. 1 is a top view of a suspended-roof arena of the present invention having a function for changing a space volume;

Fig. 2(a) is a sectional view taken along a line A-A of Fig. 1 and showing the state of natural lighting;

Fig. 2(b) is a sectional view taken along a line A-A of Fig. 1 and showing the state of natural ventilation;

Fig. 3 is an elevation of the section taken along a line B-B of Fig. 1;

Fig. 4 is a layout view in case of using the whole

arena;

Fig. 5 is a layout view in case of using the central portion of a high-ceiling and small-space arena;

Fig. 6 is a layout view in case of using an end of a low-ceiling and small-space arena;

Fig. 7 is a layout view showing a case in which a plurality of events are performed by setting a partition at the both ends of an arena;

Fig. 8 is a sectional view taken along a line C-C of Fig. 1 and showing right and left movable stands with respective driving sections;

Fig. 9 is a sectional view showing a guide roller and a guide rail mounted on a movable stand;

Fig. 10 is a detail view of a movable-stand driving section;

Fig. 11 is a sectional view taken along a line D-D of Fig. 1 and showing a movable stand supported by a driving tire and an outrigger;

Fig. 12 is a side view of a driving tire;

Fig. 13 is a front sectional view of a driving tire, in case that a movable stand is provided with a plurality of driving tires and a plurality of outriggers;

Fig. 14 is a sectional view showing the relation between a guide rail and an outrigger;

Fig. 15 is an elevation showing the outline of a suspended-roof arena and the flow of load;

Fig. 16 is a perspective view showing the framework of a suspended-roof arena;

Fig. 17 is a sectional view showing a suspending member in the axial direction;

Fig. 18 is an elevation showing a suspended-roof construction procedure;

Fig. 19 is a top view showing part of Fig. 18;

Fig. 20 is a partially enlarged view of Fig. 19;

Fig. 21 is a sectional view of Fig. 19;

Fig. 22 is a perspective view showing the state of a constructed unit;

Fig. 23 is a perspective view showing a unit being lifted; and

Fig. 24 is a perspective view showing a completely lifted unit.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a top view of an arena having a rectangular plane. Figs. 2(a) and 2(b) are sectional views taken along a line A-A of Fig. 1, which are elevations of a long-side stand. For a pair of long-side stands 1, as shown in these drawings, it is found that the width decreases stepwise according as a plane portion is closer to an end from the center in view of plane and also the ceiling lowers stepwise in view of the elevation. Fig. 3 is an elevation of the sectional view taken along a line B-B of Fig. 1. A pair of outward convex-shaped movable stands 2 are set between the pair of long-side stands 1 to form an arena. Therefore, the movable stand 2 is moved along the long side according to the purpose, and a using space is determined by freely varying the plane area

and the cross-section height.

The constitution of the movable stand 2 will be described below.

A guide rail 4 is set along the both long sides of the rectangular plane in Fig. 1, and a guide roller 5 mounted on a leg extended from the stand controls the moving direction of the movable stand. Fig. 8 is the sectional view taken along a line C-C of Fig. 1 and showing that the right and left movable stands 2 have a driving section respectively. Fig. 9 is a sectional view showing the guide roller 5 and the guide rail 4, which are mounted on the movable stand 2. Fig. 10 shows a movable-stand driving section, which is a detail view of the portion A in Fig. 8. A rope 6 is stretched in the guide rail 4 and wound on a driving sheave 8 set between two tension sheaves 7. The driving sheave 8 is connected with a driving motor 9. When the driving motor 9 is operated, the rope 6 moves the movable stand 2, which entirely covers the driving unit, in the long-side direction because the rope 8 is stretched with tension. This type of the wire-traction-system driving unit is set at four corners of the circular-arc movable stand 2. Fig. 11 is the sectional view taken along a line D-D of Fig. 1 and showing that the movable stand 2 is supported by a driving tire 10 and an outrigger 11. Fig. 12 is a side view of the driving tire 10 and Fig. 13 is a front sectional view of the driving tire in case that the movable stand 2 is provided with a plurality of driving tires 10 and a plurality of outriggers 11.

The procedure for operating the movable stand 2 will be described below. First, obstacles are removed from the traveling route of the movable stand 2 and a pit cover is removed from the guide rail 4. The outrigger 11 is released. In the case of manual operation, an operator turns on/off the switch of a remote controller to move the movable stand 2 up to a predetermined position in the long-side direction and performs fine adjustment to stop the stand. The operator puts the pit cover on the guide rail 4 and sets the outrigger 11 to complete the operation. Fig. 14 is an illustration showing the relation between the guide rail 4 and the outrigger 11,

In this manner, it is possible to correspond to a not only large-space event using the whole space of an arena as shown in Fig. 4, but also a high-ceiling and small-scale event performed by moving the movable stand 2 to the central portion of the arena as shown in Fig. 5, and a low-ceiling and small-scale event performed by moving the movable stand 2 to one end of the arena as shown in Fig. 6. Moreover, it is possible to perform various types of events at the same time by dividing a large space into several small spaces with a partition 3 and using the equipments for each small space, instead of using the equipments for the large space. That is, it is possible to always secure a realistic easy-to-see visual focus by moving stand seats to a desirable place so as to quickly correspond to the type and scale of an event.

An embodiment of a suspended-roof arena will be described below by referring to the accompanying draw-

ings.

Fig. 15 is an elevation showing the outline of the suspended-roof arena and the flow of load, and Fig. 16 is a perspective view of the framework of the suspended-roof arena. The suspended-roof arena of the present invention, as shown in Figs. 15 and 16, comprises columns 12 arranged in a row in one direction and faced each other at intervals, suspending members 15 constructed between the columns 12 faced each other to constitute a roof, and a foundation 18 to which the base of each column 12 is connected and which is secured to the ground and bears the tension and vertical load of each suspending member 15.

The column 12, as shown in Fig. 15, bears the compressive force due to the vertical load of the suspending members 15 at the indoor side and bears the tensile force due to the tension of the suspending members 15 at the outdoor side to transmit the compressive force and the tensile force to the foundation 18. In the embodiment, the upper structure 13 of the column 12 is constituted with steel frame construction and the lower structure thereof is constituted with reinforced concrete construction in view of the junction with the foundation 18. However, the structure of the column 12 is not restricted.

The foundation 18 is composed of a mat slab 19 connected with the column 12 at the indoor side to transmit the compressive force added from the column at the indoor side to the ground, and an anchor 20 connected with the column 12 at the outdoor side to withstand the tensile force added from the column at the outdoor side. The foundation 18 is secured to the ground.

Fig. 17 is the sectional view of the suspending member 15 in the axial direction.

The suspending member 15, as shown in Fig. 17, is composed of a steel material 16 and laminated lumber 17 surrounding the steel material 16, and has flexural rigidity due to the tension borne by the steel material 16 and due to the bending moment borne by the laminated lumber 17. The suspending member has a shape-keeping ability independently. The laminated lumber 17 bears a local bending moment due to snow load and wind load. Besides, the laminated lumber has a function for protecting the steel material 16 from rusting by covering the steel material with the laminated lumber and makes it possible to decrease the total weight of a roof. Because the suspending member 15 keeps its shape with no tension, the catenary of the roof directly forms the shape of the roof as shown in Fig. 15, and the shape of the roof in the ridge direction is changed by the fact that the columns 12 change in the direction of standing in a row vary in height.

A structural plywood 21 is laid on the laminated lumber 17 to connect and the laminated lumbars 17 arranged in a row with each other. A roofing material 23 is laid on the structural plywood 21 through a waterproof layer 22 and moreover, an air layer 24 is set between the adjacent laminated lumbars 17 for heat insulation. A

heat insulating material 25 is set across the adjacent laminated lumbars.

A method for constructing a suspended-roof arena will be described below.

According to the method, part of a suspended roof 26 constituted by arranging the suspending members 15 in a row in one direction is constructed as a unit 27 on the ground and thereafter, the unit 27 is lifted and set between the previously-constructed columns 12 faced each other at intervals.

The suspending member 15, as shown in Fig. 17, is composed of the steel material 16 which bears the tension, and the laminated lumber 17 which surrounds the steel material 16 and bears the bending moment. The suspending member has a resistance force against a planar external force due to the tension added to the steel material 16. Further, the suspending member has a shape-keeping ability due to the flexural rigidity of the laminated lumber 17 after lifting the unit 27.

Fig. 18 shows the procedure for lifting the suspended roof 26, and Fig. 19 shows a partial plane of the roof. As shown in Figs. 18 and 19, temporary columns 28 are erected at intervals on the inside of the columns 12 faced each other such as to be movable in the direction in which the suspending members 15 are arranged in a row. Each temporary column 28 is moved along a rail 29 laid in the direction in which the columns 12 are arranged in a row, whenever lifting of the unit 27 is completed.

A lift 30 is vertically movably set to the temporary columns 28 arranged in a row, and a wire 31 is stretched from the lift 30 to the ground through a pulley 33 connected to the top of each temporary column 28 and having one end connected to the lift 30 and the other end connected to a winder 32 set on the ground. The lift 30 is vertically moved along the rail 34 laid on each temporary column 28.

As shown in Fig. 20 as the detail view of Fig. 19 and Fig. 21 as the sectional view of Fig. 20, lifting is performed every unit 27 composed of a plurality of suspending members 15. The unit 27 is constructed by using a ground construction frame 35 constructed above the lift facing in the direction in which the columns 12 are faced each other, and the adjacent suspending members 15 are connected with each other at intervals and secured by connection hardware 36. The position of each suspending member 15 is adjusted by adjusting the position of a pedestal 38, on which the suspending members 15 are directly mounted, by jacks 37 at the both ends. After the unit 27 is constructed, tension is added to the steel material 16 of each suspending member 15 due to the own weight (gravity), and lifting is performed while the tension is added to the suspending members 15.

After the unit 27 shown in Fig. 22 is constructed, the lift 30 is raised by winding the wire 31 using the winder 32 (Fig. 23). When the end of each suspending member 15 is lifted up to the top of the column 12, the end of each suspending member 15 is connected to the top of

the column 12 (Fig. 24) to complete the setting of the unit 27.

Thereafter, the lift 30 is lowered, and the temporary column 28 is moved by a certain distance. Then, the procedure from construction of the unit 27 on the lift 30 shown in Fig. 22 to lifting of the unit 27 and connection of the suspending member 15 to the column 12 shown in Figs. 23 and 24 is repeated to set all units 27 between the columns 12. Thereby, setting of the suspended roof 26 is completed.

Though the temporary column 28 is removed after completely setting the suspended roof 26, the column 12 keeps the balance with the suspending member 15 because the columns bear the compressive force at the side of the suspended roof 26 and bears the tensile force at the outside of the roof 26 against the tension of the suspending member 15.

Advantages of the present invention will be described below.

It is possible to secure the adaptability to the type and scale of an event, the comfortableness, the producibility, the shortening of setting time, and the reduction of maintenance easily and inexpensively at a high quality by assuming that the space volume can be changed.

That is, the present invention makes it possible to improve the cost performance of illumination, sound, and air conditioning in view of the initial and running costs by changing the space volume. For example, when fully using a space, an arena can be set so as to fully use the large space. Moreover, it is possible to correspond to a high-ceiling and small-scale event performed by moving the movable stand to the central portion or a low-ceiling and small-scale event performed by moving the movable stand to one side of the arena. Furthermore, in the case of a small-space, low-ceiling and small-scale event using only the end of the space in combination with the partition, it is possible to secure the comfortableness and the producibility at an adequate quality level with the equipments for a small space, instead of using the equipment for the entire large space. Furthermore, it is possible to further improve the quality for multipurpose and expand the range for multipurpose by operating the movable stand in combination with a previously-prepared movable floor system, a partition system, a traveling burton system including a suspending object system, and sound and illumination equipments so as to vary the positions of these systems in accordance with the scale of an event and the position of a stage.

Moreover, it is possible to collect natural light together with a large opening at the gable side by using a terraced portion with stepwise cross section to uniformly secure indirect light up to the center of an arena. Furthermore, it is possible to simplify the maintenance in a high ceiling space by securing natural ventilation, and effectively using natural energy to save energy so as to secure the comfortableness of the internal environment, while concentrating various equipments for illumination, sound, suspending point and so on by

using the terraced portion as a maintenance passage.

Furthermore, it is possible to decrease a space volume serving as a load and save energy by forming the cross section of the shot side into the suspended roof structure composed of the suspending members to take a suspended shape with a curve opposite to that of a normal dome, while economically realizing a frame with the maximum span. At the same time, a downward convex-shaped ceiling contributes to the improvement of acoustic clarity without forming a sound focus, and makes it possible to more effectively secure the comfortableness and the producibility.

Furthermore, the suspending member is composed of the steel material and the laminated lumber surrounding the steel material. The suspending member has the flexural rigidity due to the tension borne by the steel material and the bending moment borne by the laminated lumber go as to independently have a shape-keeping ability. The laminated lumber bears a local bending moment due to snow load and wind load. Besides, the laminated lumber has a function for protecting the steel material from rusting by covering the steel material with the laminated lumber and makes it possible to decrease the total weight of a roof.

Concerning the suspended roof construction method, because the suspending member keeps its shape with no tension, the catenary of the roof directly forms the shape of the roof, and the shape of the roof in the ridge direction is charged by the fact that the columns in the direction of standing in a row vary in height.

Because the suspending member unit can be lifted without being influenced by wind, it is possible to shorten a construction period and decrease a construction cost. Moreover, construction can continuously be progressed because the temporary column and the lift necessary for lifting the suspending members are moved in the direction in which the suspending members are arranged in a row, whenever the unit is installed.

## Claims

1. A structure of a multipurpose rectangular flat suspended-roof arena capable of changing a space volume, comprising:

a pair of movable stand surrounded by both long sides of a rectangle and having outward convex-shaped means provided between both long sides of the rectangle to be movable along the long side said the rectangle;

wherein a stand at the long side of the rectangle is formed by making use of a plane whose width decreases stepwise according as a plane portion is closer to an end of the long side, and a vertical cross section in which the ceiling lowers stepwise, and the vertical cross section of the short side of said rectangle serves as a suspended roof.

2. A structure of a multipurpose suspended-roof arena capable of changing a space volume according to claim 1, wherein the suspended roof includes columns arranged in a row in one direction and faced each other at intervals, suspending members set between the columns faced each other for constituting the roof, and a foundation to which the base of each column is connected and which is secured to the ground and bears the tension and vertical load of each suspending member, and each suspending member includes a steel material which bears tension, and laminated lumber which surrounds the steel material and bears bending moment.

3. A method for constructing a suspended roof of a multipurpose suspended-roof arena capable of changing a space volume, including the steps of constructing part of a suspended roof constituted by arranging suspending members each including a steel material which bears tension, and laminated lumber which surrounds the steel material and bears bending movement, in a row in one direction as a unit on the ground, and thereafter lifting and setting the unit between previously-constructed columns faced each other at intervals, comprising the steps of:

erecting temporary columns at an interval movably in the direction, in which the suspending members are arranged in a row, on the inside of the columns faced each other on the plane; vertically movably setting a lift between the temporary columns arranged in a row; stretching a wire from the lift to the ground through the top of each temporary column such as to connect one end of the wire to the lift and the other end thereof to a winder; thereafter constructing the unit on the lift facing to the direction in which the columns are faced each other; raising the lift while adding tension to each suspending member of the unit to connect the end of each suspending member to the top of the column; moving each temporary column by a certain distance; and moreover repeating the procedure from construction of the unit on the lift to moving of the temporary columns to set the suspending members between the columns.

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FIG. 1

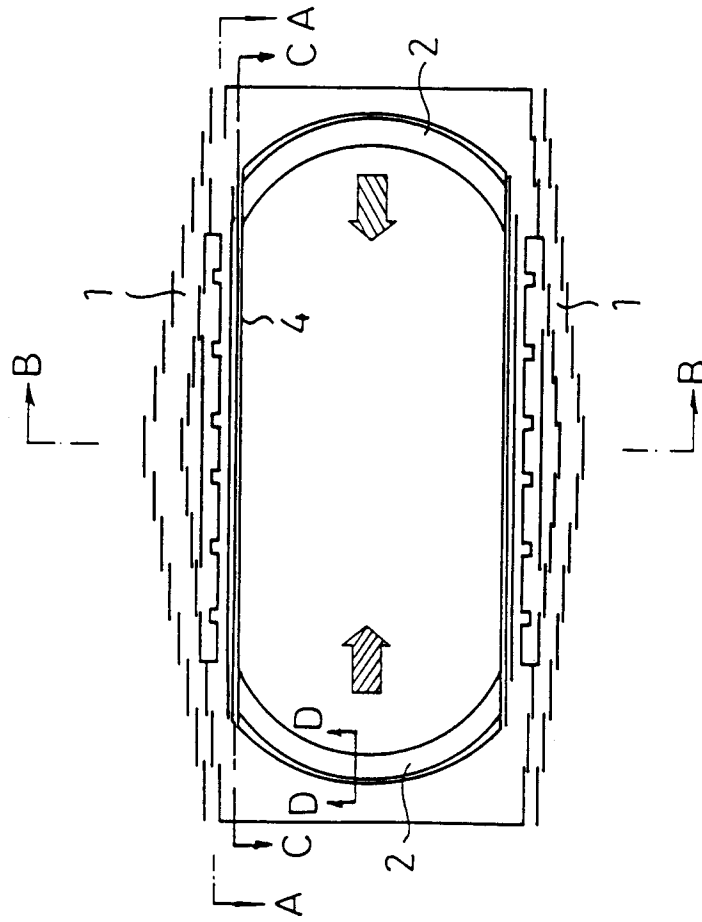


FIG. 2(a)

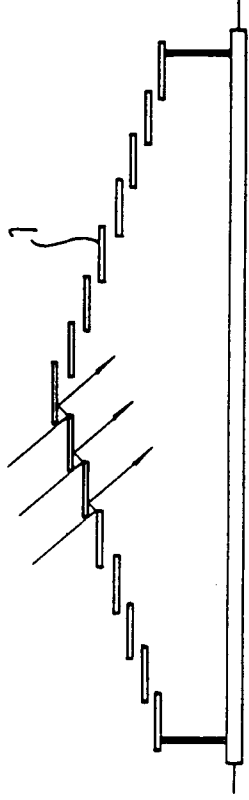


FIG. 2(b)

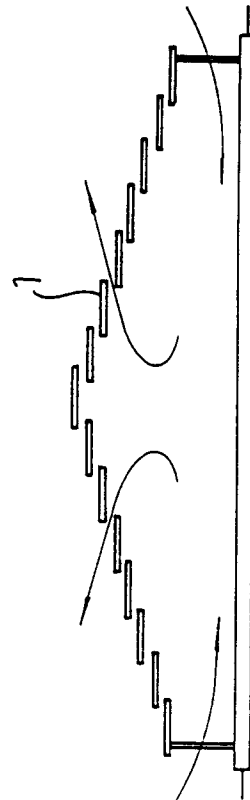




FIG. 3

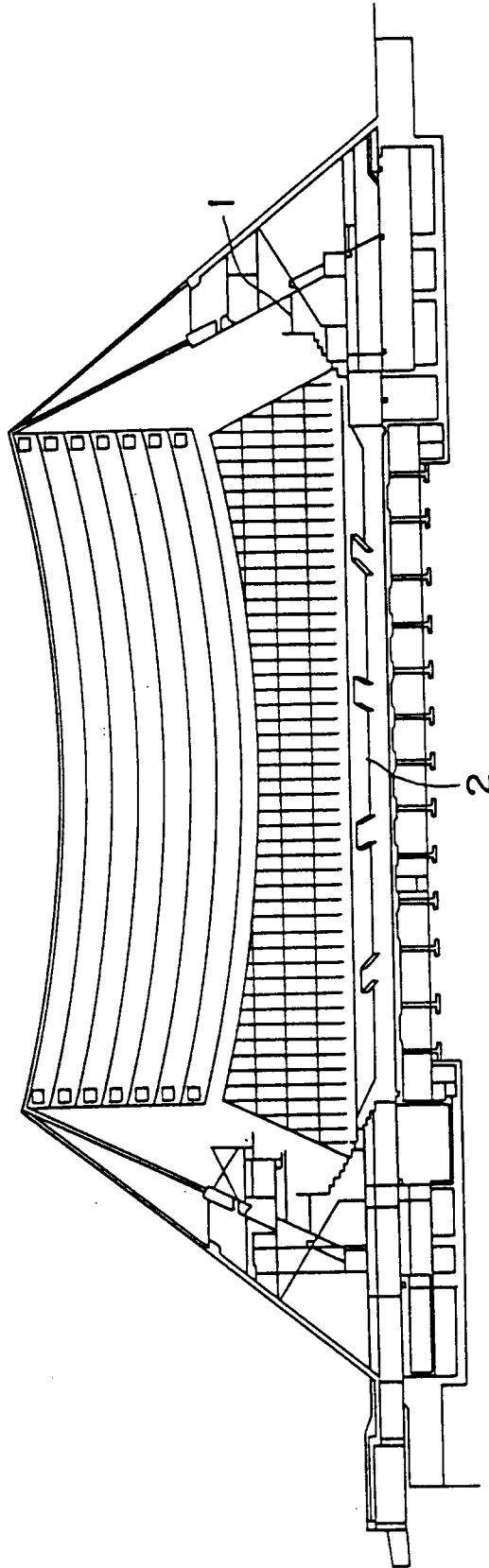


FIG. 4

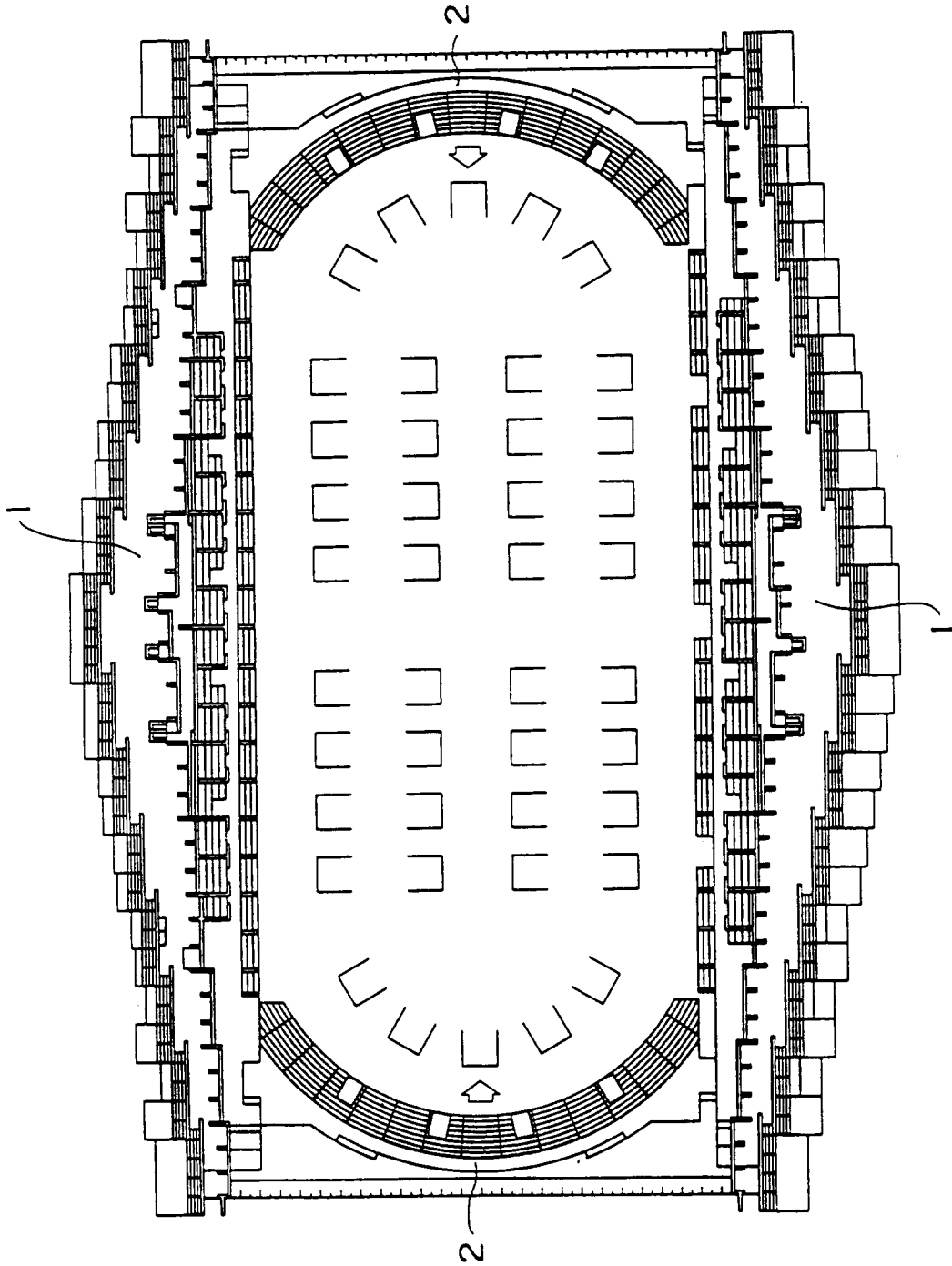


FIG. 5

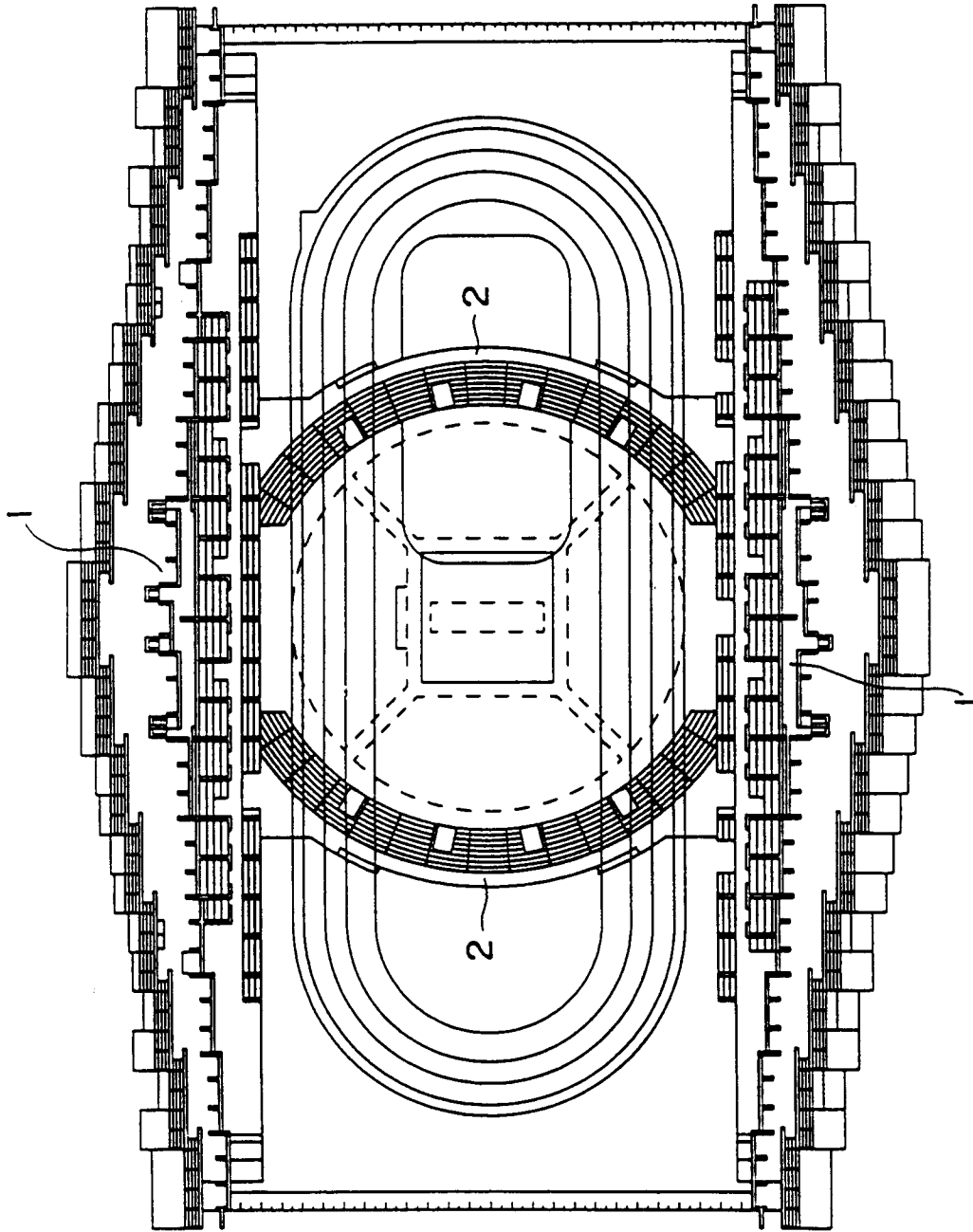


FIG. 6

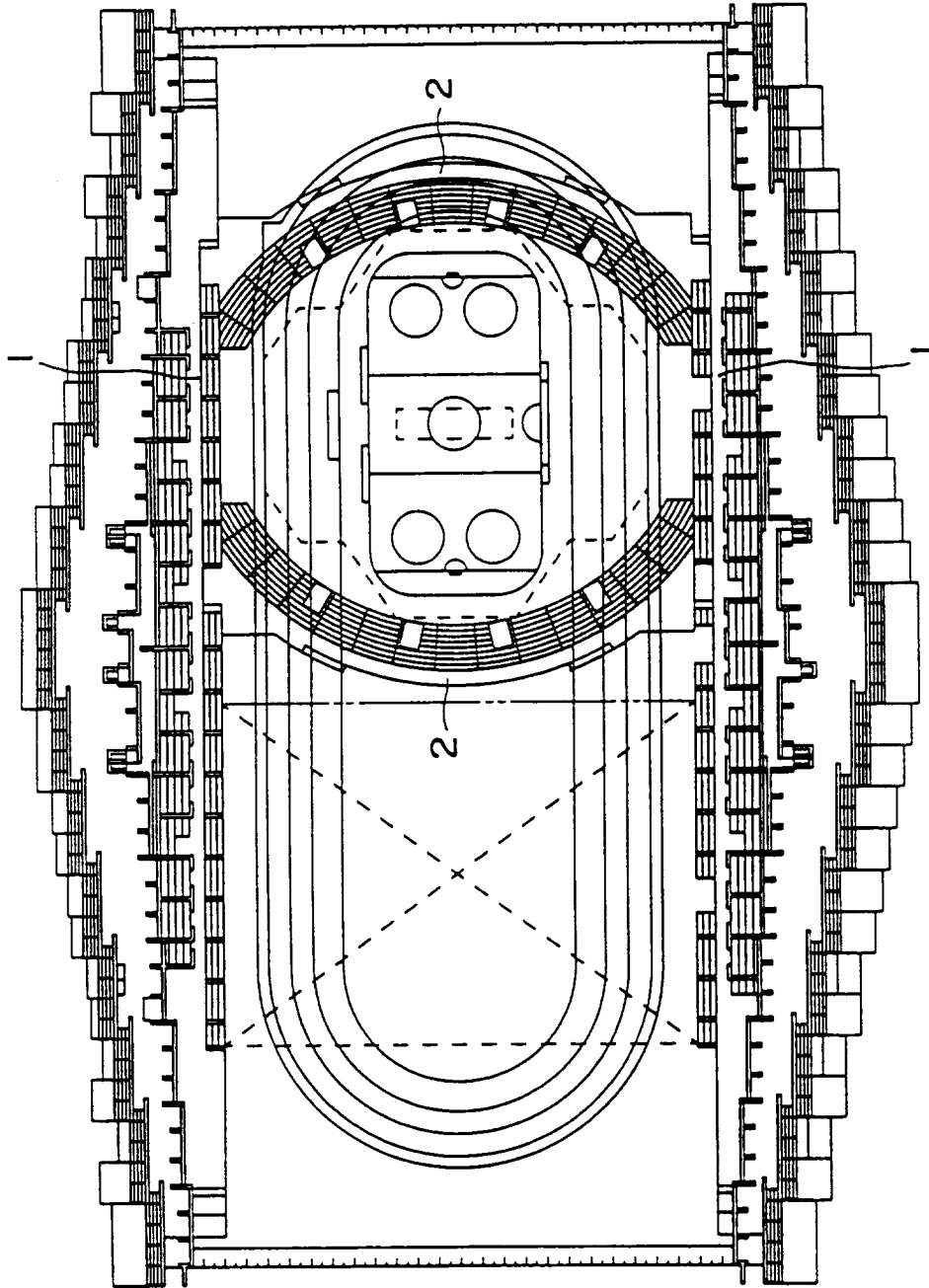


FIG. 7

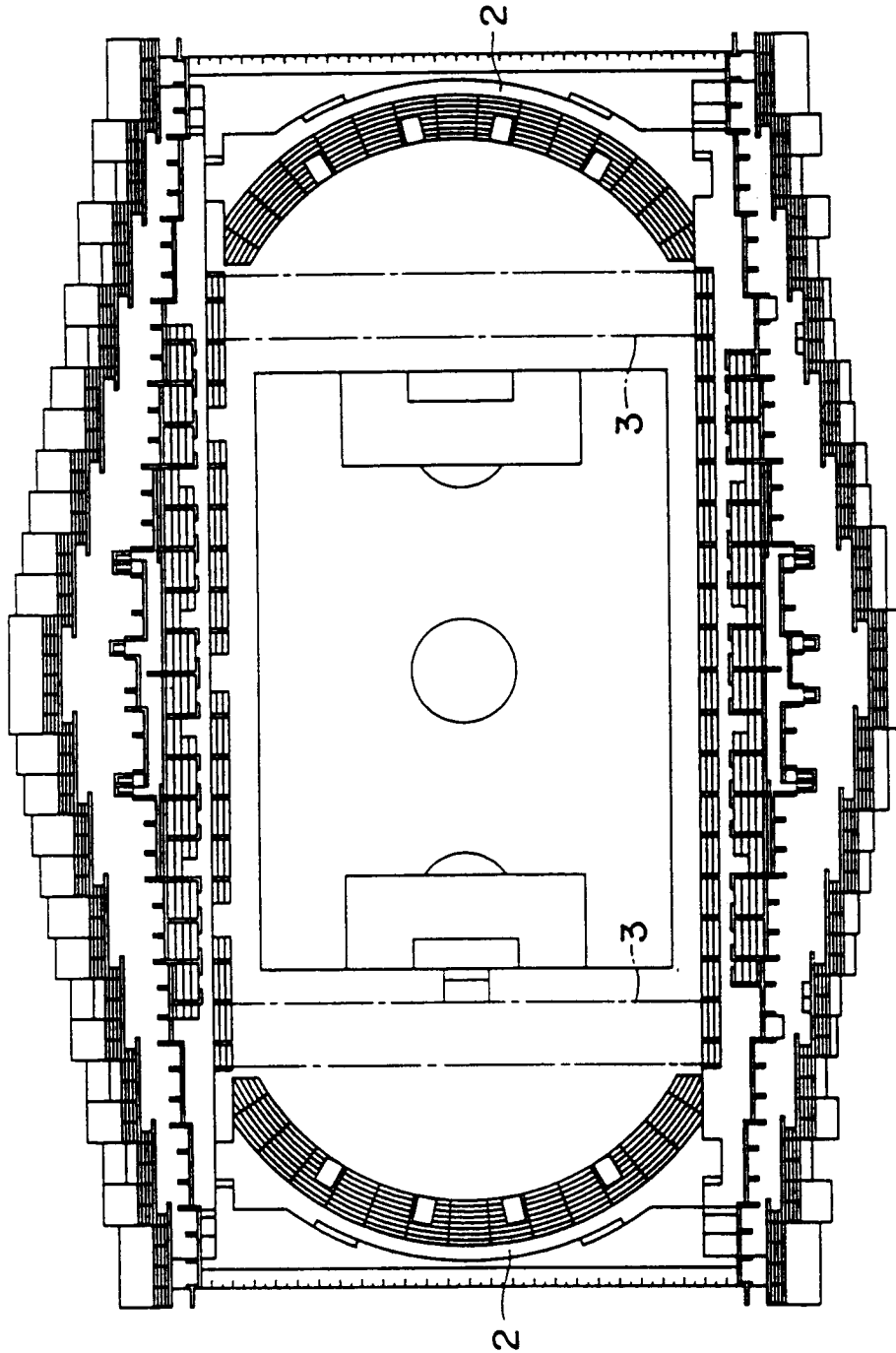


FIG. 8

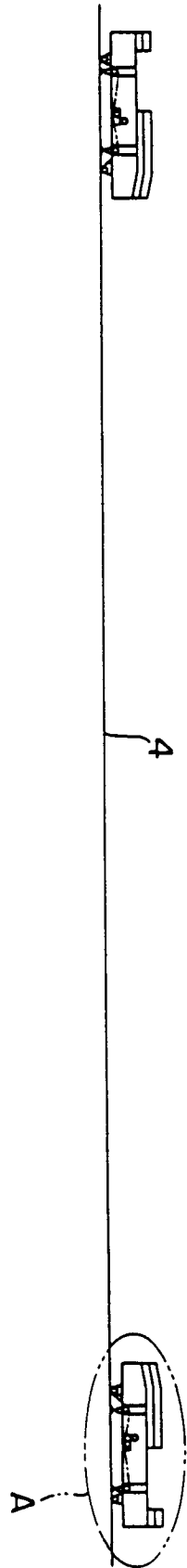


FIG. 9

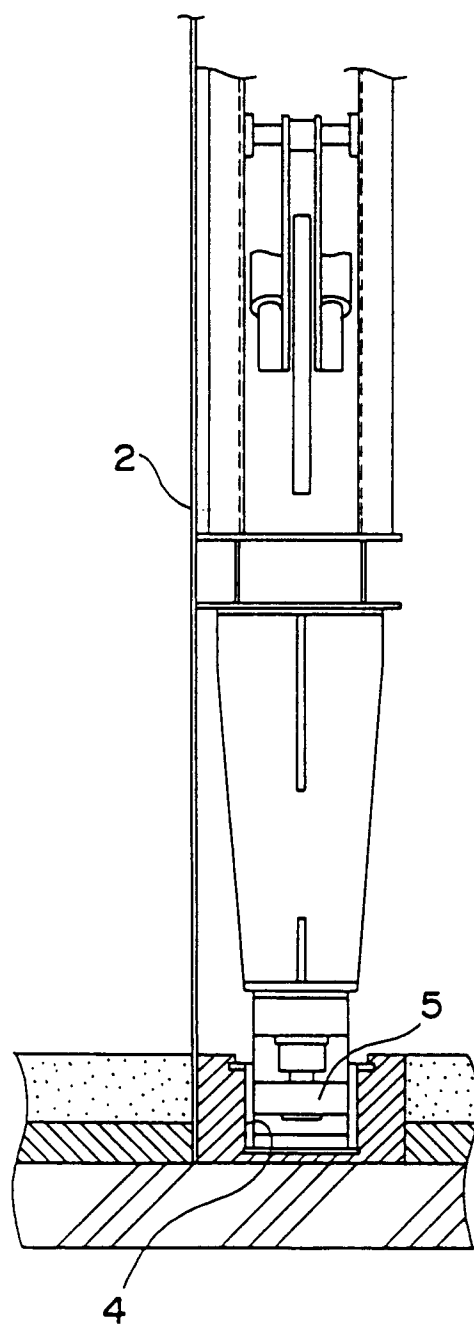


FIG. 10

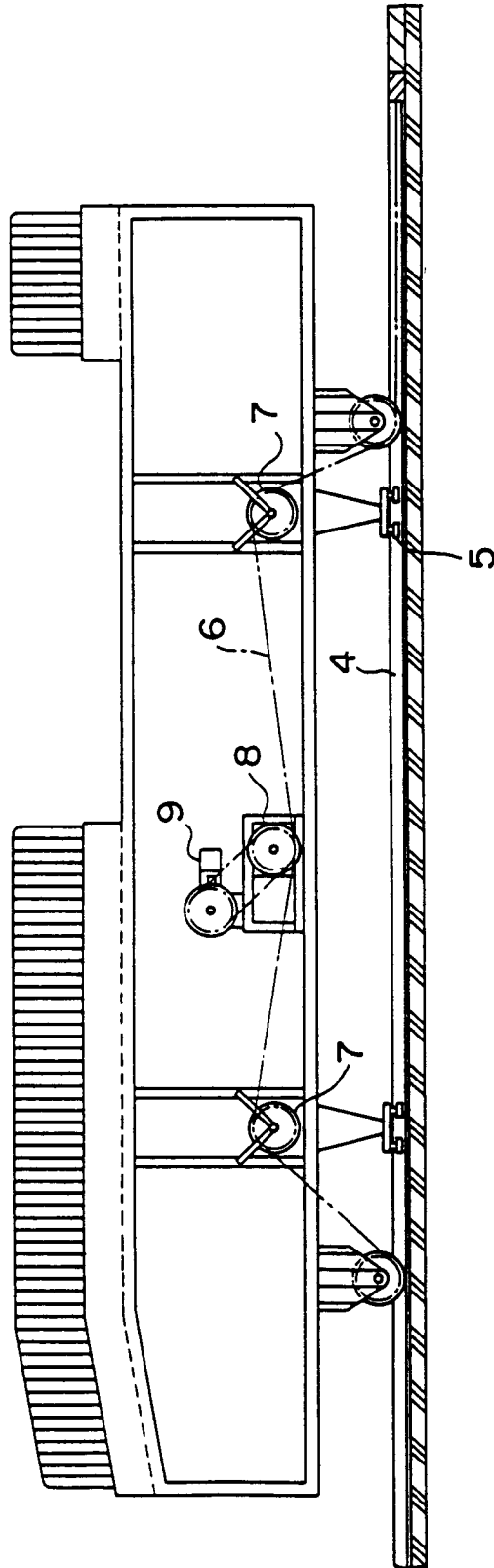




FIG. 11

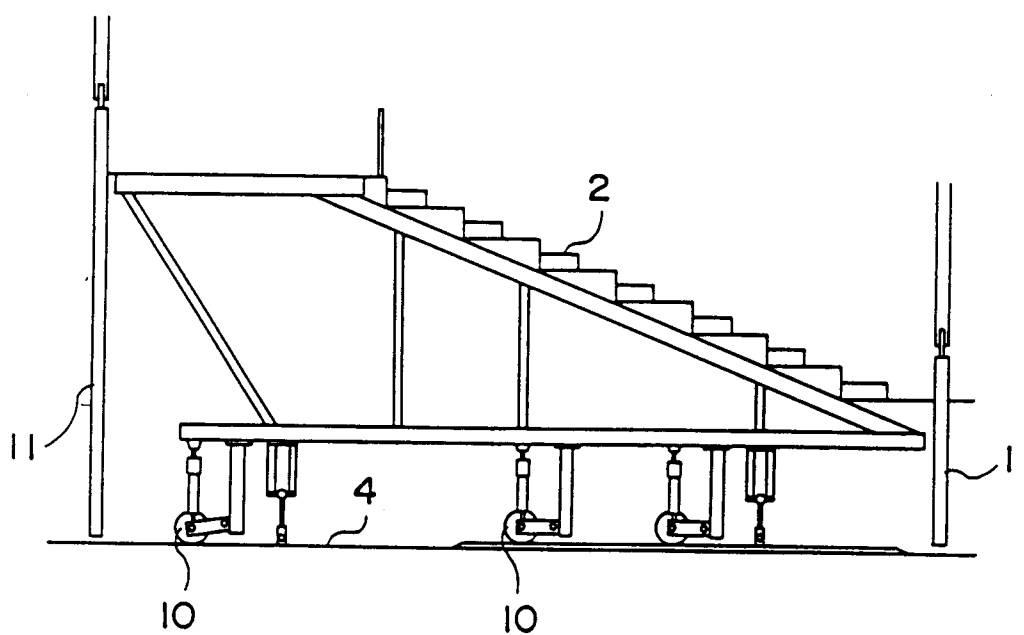


FIG. 12

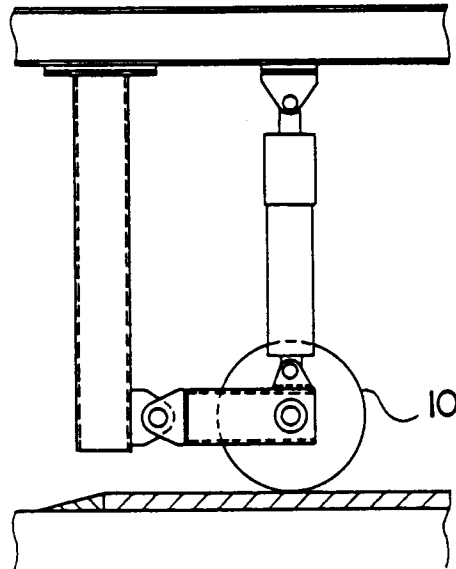


FIG. 13

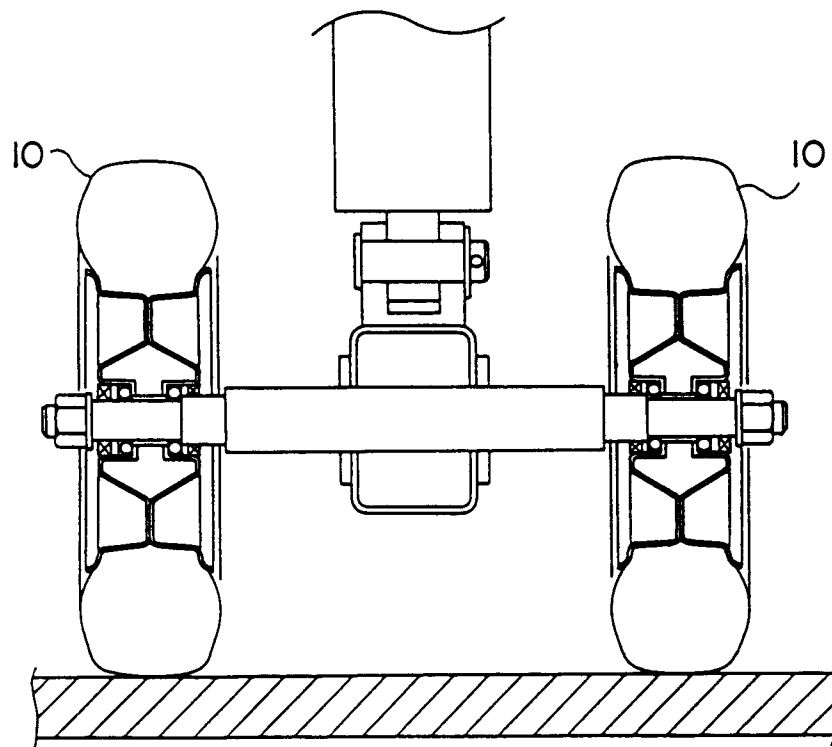


FIG. 14

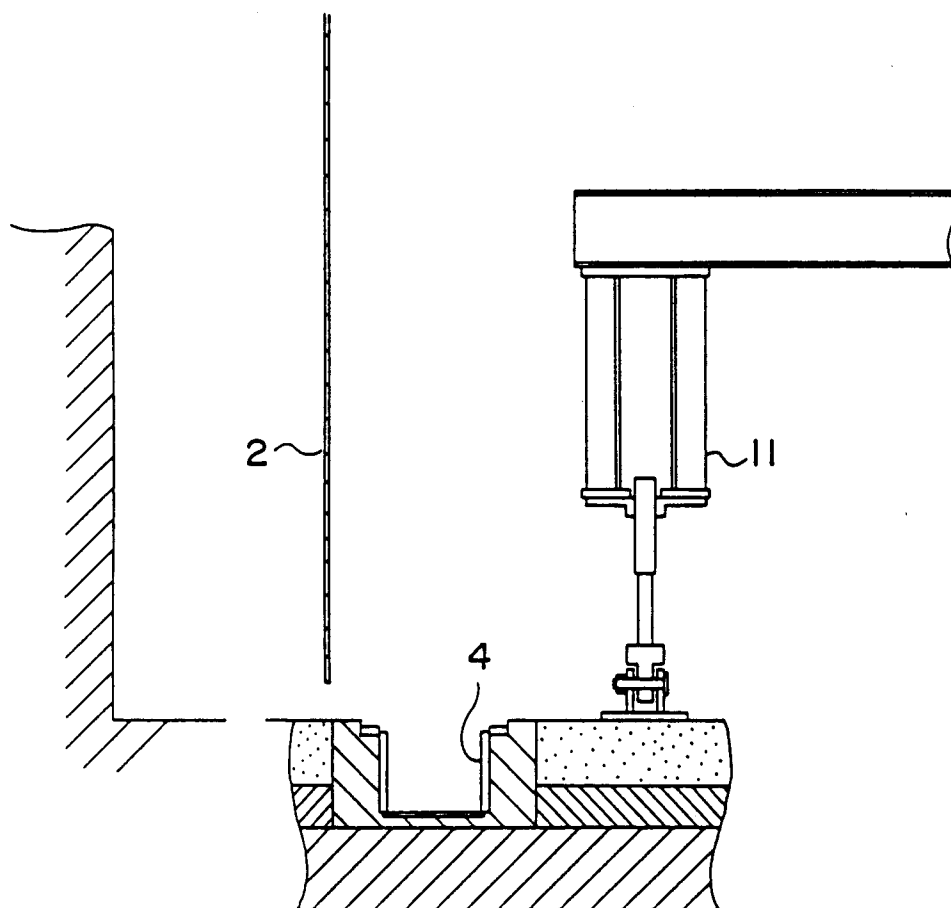


FIG. 15

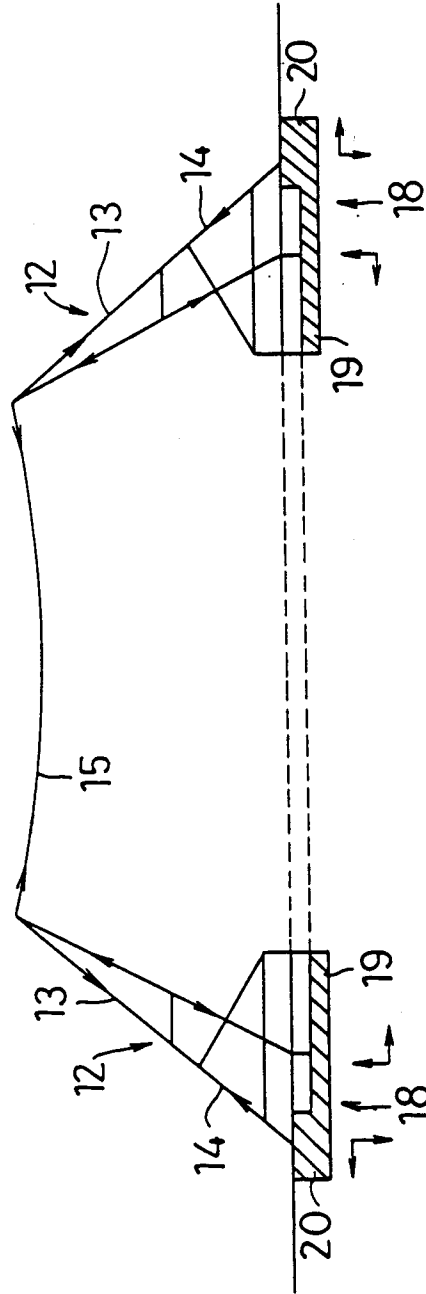


FIG. 16

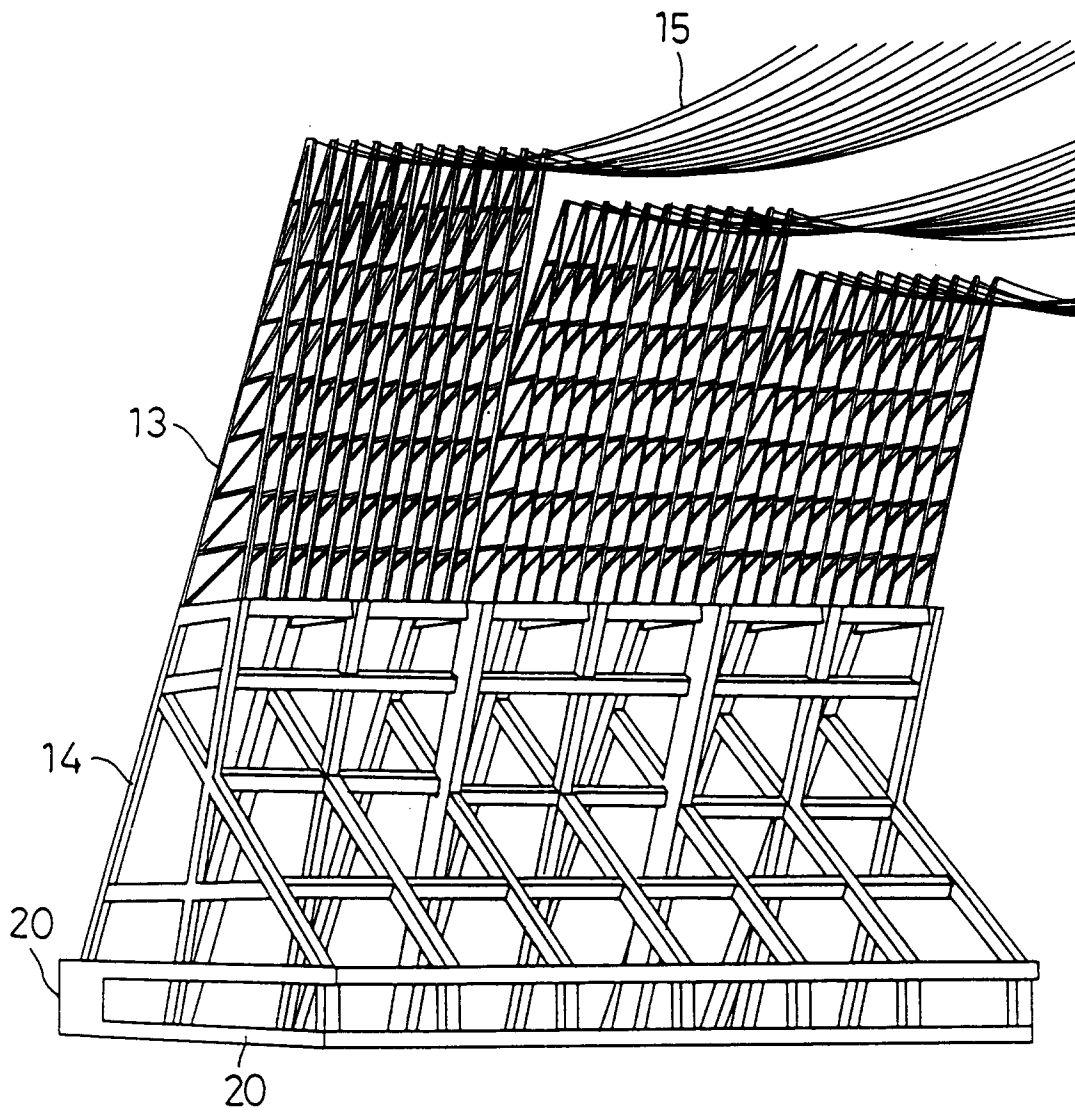


FIG. 17

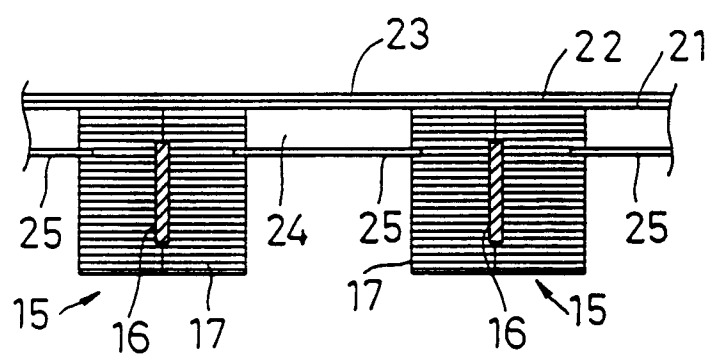


FIG. 18

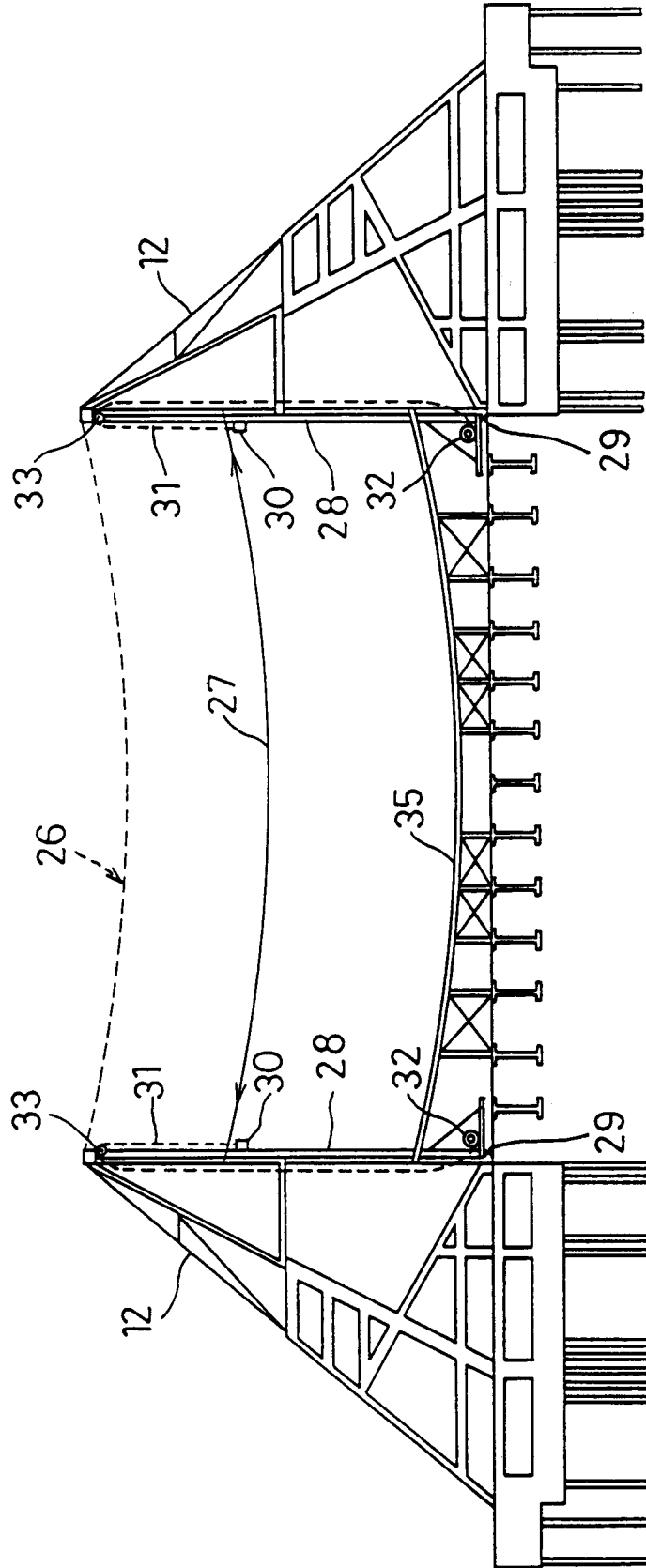


FIG. 19

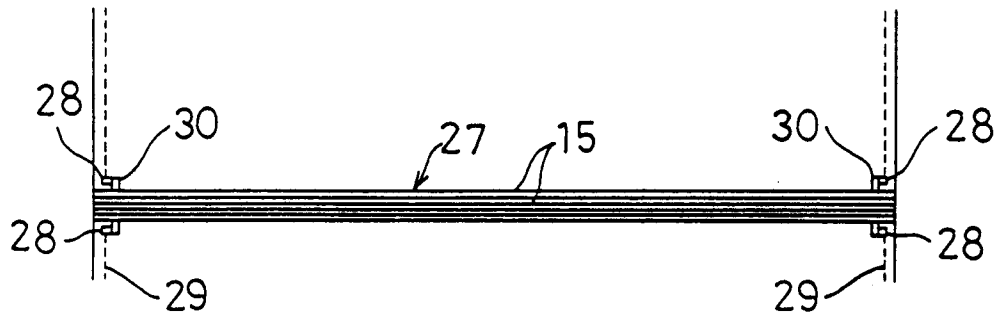


FIG. 20

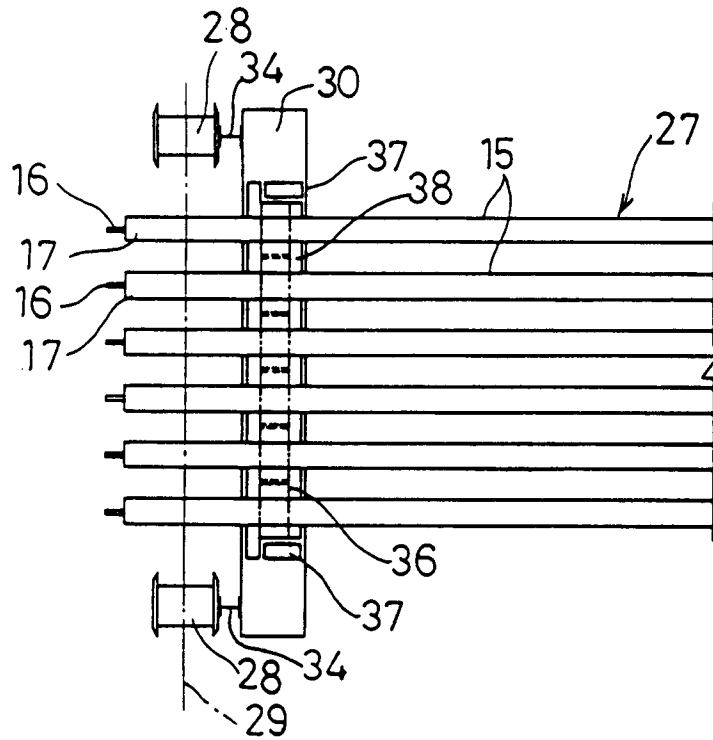


FIG. 21

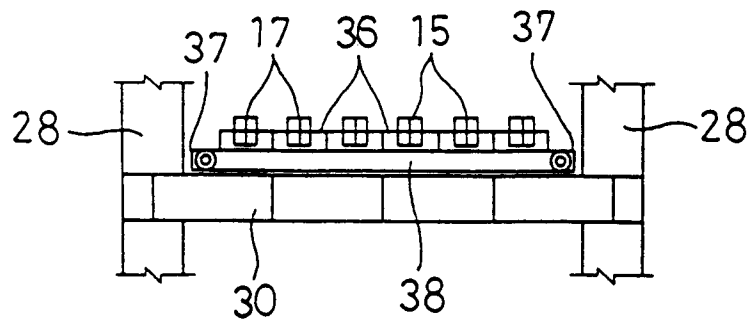




FIG. 22

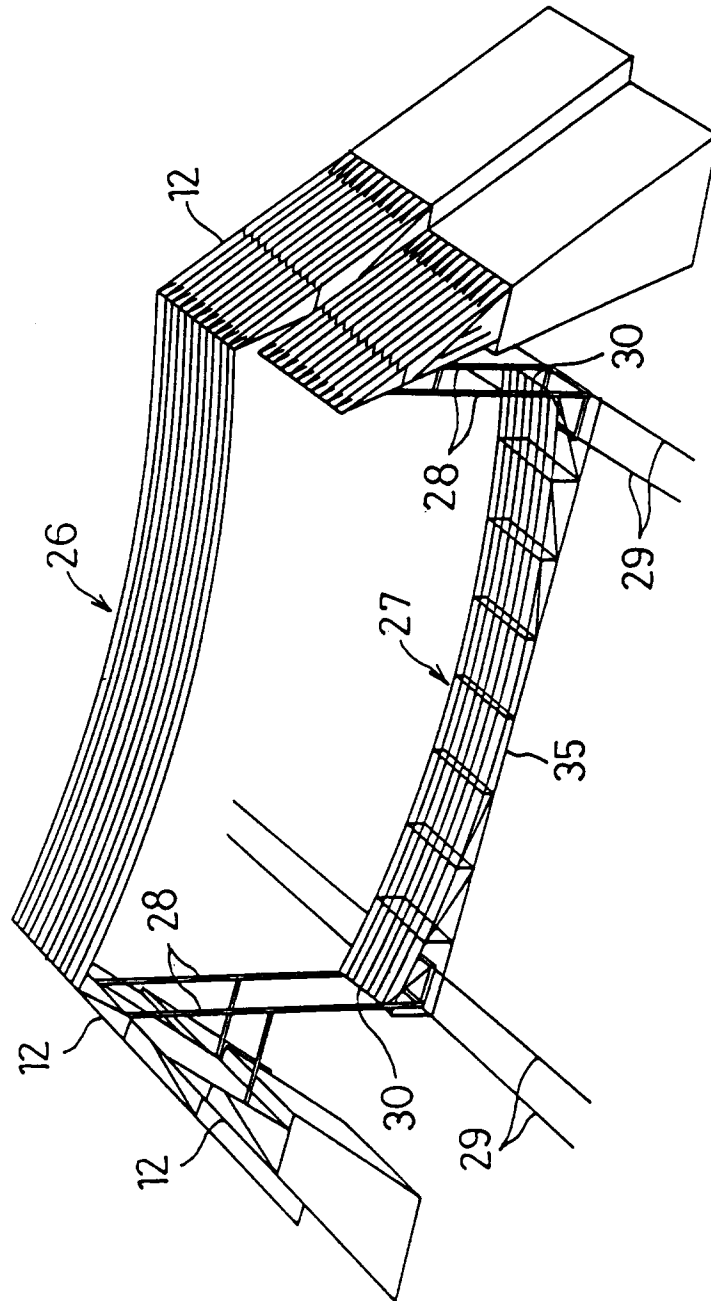


FIG. 23

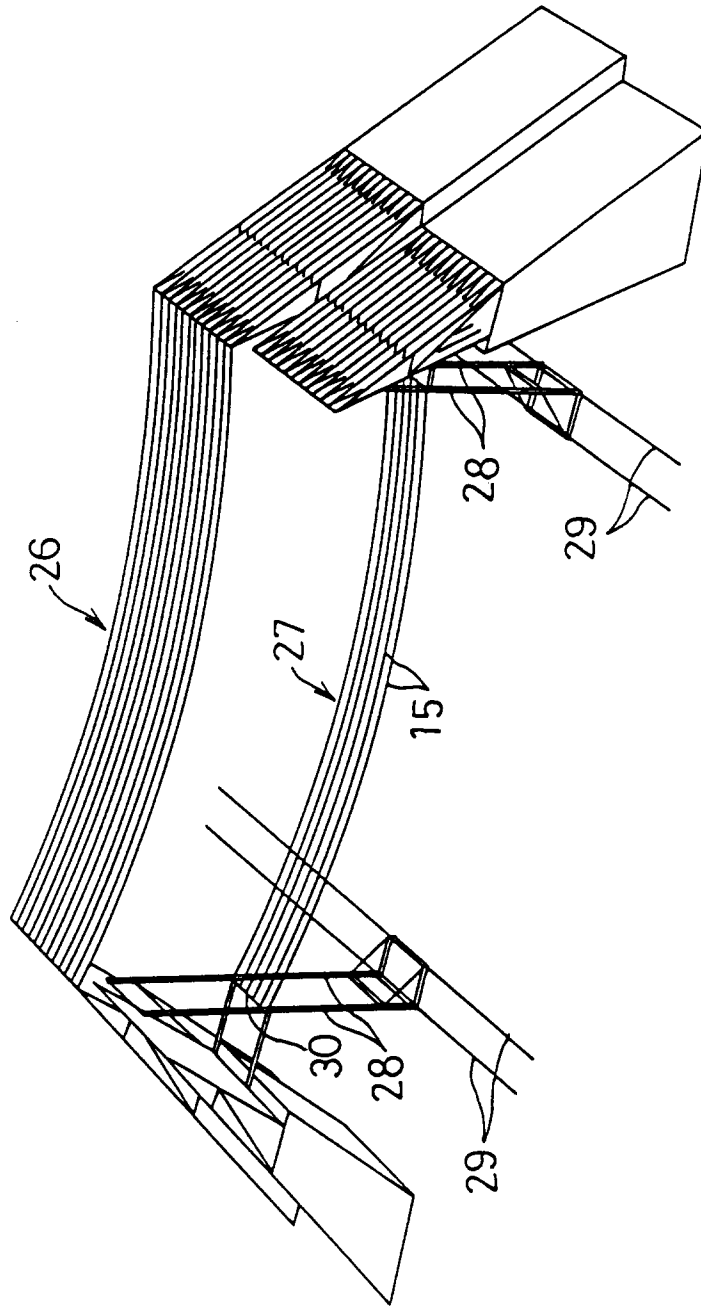
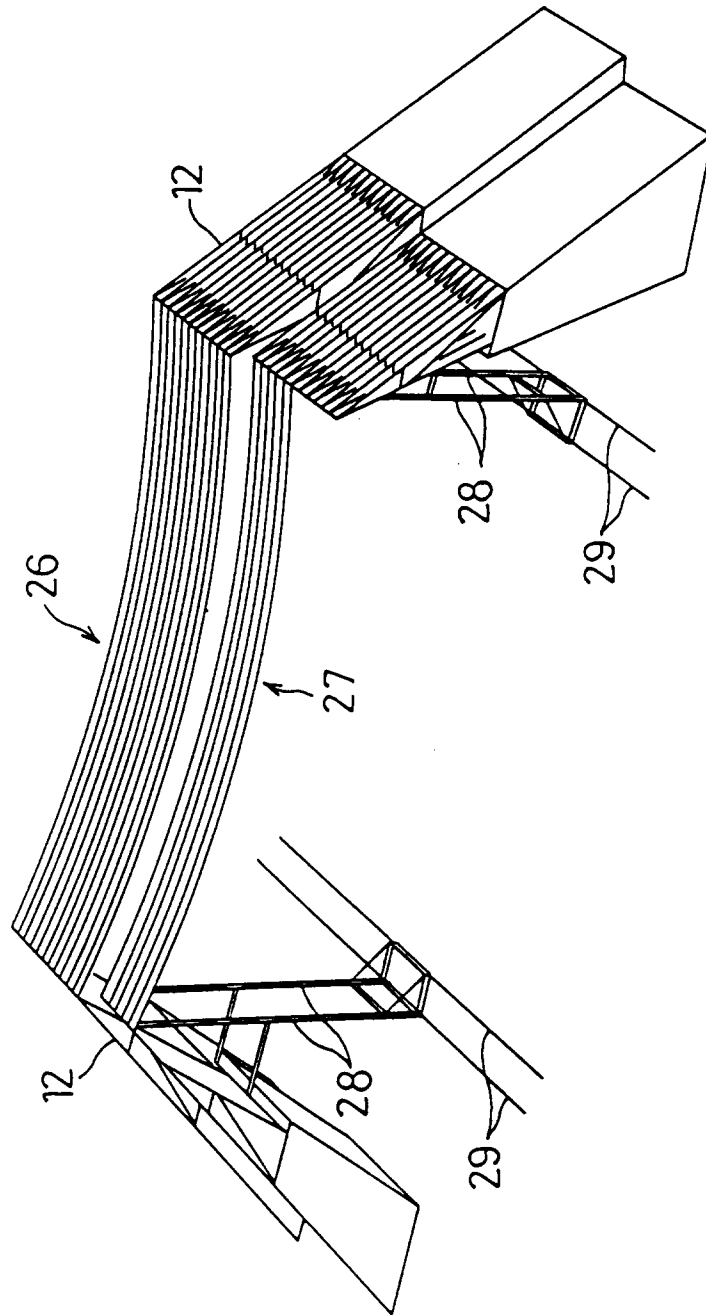


FIG. 24





European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 95 30 4964

| 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)            |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | DE-A-14 59 961 (HOCHTIEF) 30 January 1969<br>* page 5, paragraph 5 - page 6; figures *<br>---                                                                                            | 1,2                                                  | E04H3/14<br>E04B7/14                                    |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | BETONWERK + FERTIGTEIL TECHNIK,<br>vol. 58, no. 9, September 1992 WIESBADEN<br>DE,<br>pages 122-124, XP 000321664<br>W. KÜBLER 'Eislaufstadion Waldau'<br>* page 122 - page 124 *<br>--- | 1,2                                                  |                                                         |
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| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | DE-C-598 633 (W. MARTIKE) 29 June 1933<br>* the whole document *<br>---                                                                                                                  | 1                                                    |                                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | DEUTSCHE BAUZEITSCHRIFT - DBZ,<br>vol. 12, November 1964 GUTERSLOH DE,<br>pages 1817-1832,<br>O. FREI 'Zugbeanspruchte Konstruktionen'<br>* page 1829 - page 1830 *<br>---               | 1,2                                                  | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.6)<br>E04H<br>E04B |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | DE-A-43 18 710 (D. KLOSE) 8 December 1994<br>-----                                                                                                                                       |                                                      |                                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                          |                                                      |                                                         |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                          | Date of completion of the search<br>14 December 1995 | Examiner<br>Kriekoukis, S                               |
| <p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>.....<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                                          |                                                      |                                                         |

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