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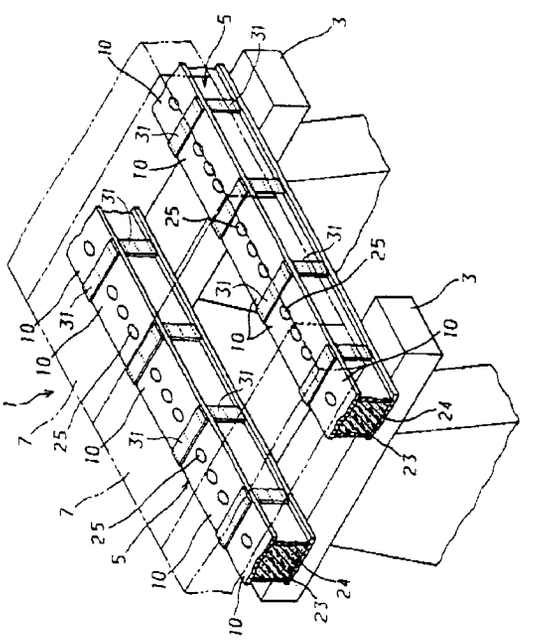
## (54) Bridge girder, bridge girder part and process for constructing bridge girder

(57) A bridge girder (5) comprising bride girder parts (10) each having a body of a top plate (11), side plates (15) and a bottom plate (13) connected with each other by a connecting means capable of assembling and disassembling them with the top plate (11) having a hole (17) therethrough. The bridge girder (5) is produced by the process comprising the step of connecting bottom plates (13) with each other, mounting on an abutment and a pier (3) or piers the plural bottom plates (13), connecting the bottom plates (13) with side plates (15) and top plates (11), respectively, to form bridge girder parts (10), connecting the bridge girder parts (10) with each other, disposing a reinforcement (22,23) in the bridge girder parts, and pouring concrete (24) into the bridge girder parts through the hole (17) provided that no concrete flows through at least one hole among them.

FIG. 1



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## Description

This invention relates to a bridge girder, a bridge girder part and a process for constructing the bridge girder.

Generally, bridges are constructed of an abutments and a pier, a bridge girder mounted thereon, and a floor slab provided further thereon with the floor slab being asphalted.

Hitherto, bridge girders have comprised plate girders, box-girders and preflection beam girders.

A plate girder comprises an upper flange and a lower flange connected therewith through a piece of web.

A box girder comprises an upper flange and a lower flange connected therewith by two pieces of webs. The upper flange, the lower flange and the webs have hollow forms.

Both of the plate girders and the box girders are made only of steel.

The preflection bean girders are constructed of a plate girder surrounded by a concrete body. The concrete has poured to surround the plate girder and solidified.

The plate girders and box girders, however, involve expensive material cost, thereby causing increased production cost because they are made only of steel.

The preflection beam girders involve extremely expensive production cost because they require the process steps of assembling a formwork for forming a concrete body and removing the formwork after solidification of concrete to form the concrete body.

Conventional bridge girders such as plate girders, box-girders and preflection beam girders are constructed on highly large scales and extremely heavy whereby the transportation and construction operation are very difficult. Especially, operation for erecting a bridge girder on an abutment or a pier involves the step of providing a temporary member for temporally supporting the bridge girder between an abutment and a pier or piers. Therefore, it requires works, thereby causing extremely high construction cost as well as extremely prolonged construction period of time.

Further, conventional bridge girders need piers to be disposed away from each other by short spans because they exhibit poor rigid properties for their sizes and weights. Consequently, they need a lot of piers and are results in increase in cost.

Furthermore, there is another problem. In plate girders and box-girders, an upper flange and a web and a lower flange and a web are connected by means of welding. Therefore, the steel may suffer from weld heat affect and deform, thereby causing adverse influences on durability of the plate girders and the box girders.

This invention is accomplished for solving the above-mentioned prior art problems.

An object of the invention is to provide a bridge girder, a bridge girder part and a process for constructing the bridge girder having the advantages that the transportation and construction operation can be easily done and the operation period of time is short, the material and construction costs are low and the resultant bridge girder exhibits high rigid properties and high durabilities.

According to the invention, there is provided a bridge girder part comprising a tubular body with a hole therethrough. Preferably, the bridge girder part is made of steel. Preferably, the body comprises a top plate, side plates and a bottom plate connected with each other and has a prismal tubular form. The top plate has the hole therethrough. Preferably, the top plate, the side plates and the bottom plate are connected by a connecting means capable of assembling and disassembling them. Preferably, there are provided a plurality of holes disposed from each other by a given distance. Preferably, the bridge girder part comprises a support member for supporting a reinforcement on the inner surface of the side plate.

According to the invention, there is further provided a bridge girder having bridge girder parts each having a tubular body to define the outer wall thereof, a connecting means for connecting the parts, a reinforcement disposed in the bridge girder part and a concrete body poured into the bridge girder part and existing therein.

Preferably, within the body, there is provided a hollow member for forming a space into which no concrete flows. Preferably, in the bridge girder part, prestress has been applied on the concrete body by providing steel for prestressed concrete in the bridge girder part and applying tension to the steel.

According to the invention, there is provided a process for constructing a bridge girder comprising the steps of mounting on abutments or an abutment and a pier bridge girder bodies each having a tubular body with a hole therethrough to define an outer wall of the bridge girder body, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the hole.

According to the invention, there is provided another process for constructing a bridge girder comprising bride girder parts each having a body of a top plate, side plashes and a bottom plate connected with each other by a connecting means capable of assembling and disassembling them with the top plate having a hole therethrough comprising the step of connecting botton plates with each other, mounting on an abutment and a pier or piers the plural bottom plates, connecting the bottom plates with side plates and top plates, respectively, to form bridge girder parts, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the hole.

According to the invention, there is provided a further process for constructing a bridge girder comprising the steps of mounting on an abutment and a pier or piers bridge girder parts each having a tubular body with holes therethrough to define an outer wall thereof, connecting

the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the holes provided that through at least one hole among them, no concrete is poured.

According to the invention, there is provided a still further process far constructing a bridge girder comprising bride girder parts each having a body of a top plate, side plates and a bottom plate connected with each other by a connecting means capable of assembling and disassembling them with the top plate having a hole therethrough comprising the step of connecting bottom plates with each other, mounting on an abutment and a pier or piers the plural botton plates, connecting the bottom plates with side plates and top plates, respectively, to form bridge girder parts, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the hole provided that no concrete flows through at least one hole among then.

Preferably, the processes further comprise the step of disposing on a given position in the bridge girder parts a hollow member for forming a space into which no concrete flows. Preferably, the processes further comprise the step of applying prestress to the concrete body in the bridge girder parts by providing a steel body for prestressed concrete in the bridge girder part and applying tension to the steel body.

The invention has succeed in reducing material cost because the bridge girder is made only of steel and concrete, which is different from conventional plate girders and box-girders. Further, the invention requires no steps of assembling a formwork for forming concrete and removing the formwork, which is different from preflection beam girder. Consequently, the invention has succeeded in reducing construction cost in comparison with conventional bridge girders.

The process of the invention employs the steps of mounting the bridge girder parts which will form the outer wall of a bridge girder one by one or several pieces at a time on an abutment and a pier or piers and thereafter connecting them, or otherwise the steps of connecting the bottom plates (which will define a bridge girder part together with other members), and thereafter assembling bridge girder parts together with side plates and top plates. Therefore, the process enables employment of small-sized and light members. That is to say, the transportation and construction operation of bride girder can be done easily. This results in the period of construction to be shortened.

Because the bridge girder parts, the reinforcement and the concrete body are consolidated to form a composite structure, the resultant bridge girder has high rigid properties. Therefore, the piers can be disposed away from each other by a long span. This results in reduction of the number of the piers and decrease in cost in comparison with conventional bridge girders.

Connecting the top plate, the bottom plate and the side plates by other connecting means than welding inhibits deformation of the steel due to weld heat and causes no adverse influence on durability of the bridge girder.

If prestress has been applied to the concrete body in the bridge girder body by disposing a steel for prestressed concrete in the bridge girder part and applying tension to the steel, load resistance strength is enhanced without any substantial increase in weight.

By way of exanple and to make the description more clear, reference is made to the accompanying drawings in which:

Fig. 1 is a perspective illustration of a principal portion of a bridge comprising a bridge girder of a first embodinent according to the invention,

Fig. 2 is a perspective illustration of a bridge girder part of the embodiment in which the the part has reinforcements disposed therein,

Fig. 3 is an enlarged, cross-sectional view taken along line A-A of Fig. 2,

Fig. 4 is a partially cutaway and principal perspective illustration of two pieces of the Fig. 3 bridge girder parts connected with each other,

Fig. 5 is a diagrammatical view illustrating a first stage of a process for constructing a bridge girder according to the invention,

Fig. 6 is a diagrannatical view illustrating a final stage of the process for constructing a bridge girder according to the invention,

Fig. 7 is a diagrammatical view illustrating a step of pouring concrete according to the process for constructing a bridge girder falling within the scope of the invention.

Fig. 8 is a diagrammatical view illustrating another process for constructing a bridge girder according to the invention,

Fig. 9 is a diagrammatical view illustrating a final bridge girder constructed in accordance with the Fig. 8 process,

Fig. 10 is a cross-sectional view of a bridge girder of a second embodiment according to the invention,

Fig. 11 is a cross-sectional view of a modification of the Fig. 10 bridge girder,

Fig. 12 is a principal, virtual cross-sectional view of a bridge girder of a third embodiment according to the invention, and

Fig. 13 is an enlarged cross-sectional view taken along line B-B of Fig. 12.

Hereunder, there is described embodiments of a bridge girder, a bridge girder part and a process for manufacturing the bridge girder falling within the scope of the invention, with reference to the attached drawings.

Figures 1 to 9 show a bridge girder 5 of a first embodiment.

Referring to Fig. 1, there is shown a bridge 1 comprising a bridge girder 5.

Numerical symbol 3 denotes a pier. On the piers 3, there is provided the bridge girder 5, which is supported at the opposite ends thereof by abutments 2.

On two pieces of the piers 5, there are provided a plurality of floor slabs 7 asphalted thereon. Further, there are provided handrails and the like.

The outer wall of the bridge girder 5 is defined by the plural bridge girder parts 10.

Referring to Figs. 2 and 3, there are shown the construct of the bridge girder part 10.

Numerical symbol 9 denotes an prismal tubular body. The body comprises an upper flange 11 as the top plate, a lower flange 13 as the bottom plate and two pieces of webs 15 as the side plates. The upper flange 11, the lower flange 13 and the webs are all made of steel.

The upper flange 11 has a bolt through hole 28. The lower flange 13 has e bolt through hole 30.

Both of the webs 15 are folded perpendicularly at an upper end 14 and a lower end 16. The upper end 14 and the lower end 16 have bolt through holes 26 therethrough.

The upper end 14 of the web 15 is contacted with the upper flange 11 and a bolt 21 extends through the bolt through holes 26 and 28. The bolt 21 clamps together with a nut 20 to connect the upper flange 11 and the web 15.

The upper end 16 of the web 15 is contacted with the lower flange 13 and a bolt 21 extends through the bolt through holes 26 and 30. The bolt 21 is used together with a nut 20 to connect the lower flange 13 and the web 15.

The bolt 21, the nut 20 and the bolt through holes 26, 28 and 30 form a connecting means for connecting the upper flange 11, the webs 15 and the lower flange 13. The connecting neans is capable of assembling and disassembling the upper flange 11, the webs 15 and the lower flange 13.

The upper flange 11 has three oval holes 17 therethrough. The holes 17 are positioned away fron each other by a constant distance.

On the inner surface of the web 15, there are provided plural stud dowels 19 as support members for supporting reinforcements. The plural stud dowels 19 protrude so that they opposite each other.

The bridge girder part 10 has the opposite ends with plural bolt through holes 12.

As described hereunder, the bridge girder 5 comprises plural bridge girder parts 10 connected therewith within which reinforcements 22 and 23 are disposed and a concrete body 24 is filled and exists therein.

Hereunder, there is described a process for constructing a bridge girder 5.

Hereunder, there is explained a step of connecting the bridge girder parts 10 with each other.

As shown in Fig. 4, there are provided a plurality of the bodies 9 of the plural bridge girder parts 10. An end surface of one body 9 is contacted with that of another body. A splice plate 31 is placed over the contacting portion of the two end surfaces, as shown in Fig. 4. The splice plate 31 has bolt through holes 32 therethrough. The splice plate 31 is disposed both on the inner side and the outer side of the body 9. The bolt 33 extends through the bolt through hole 32 of the splice plate 31 and the bolt through hole 12 of the body and clamps then together with the nut 35 to connect the bodies 9 of the bridge girder parts 10.

The bolt through hole 12 existing at the opposite ends of the body 9, the splice plate 31, the bolt 33 and the nut 35 form a connecting means for connecting the bridge girder parts 10.

Hereunder, there is described steps of mounting the bridge girder part groups 10 on the abutment 2 and the pier 3 or the piers 3 and connecting them with each other.

As set forth above, three pieces of the bridge girder parts 10 are connected with each other to form a group. As shown in Figs. 5 and 6, the plural bridge girder part groups 10 connected are lifted by means of a crane 41 and placed on the abutment 2 or the pier 3. This lifting operation can be done relatively easily because the bridge girder part 10 is an prismal tube and light.

The bridge girder part groups 10 (which have been placed on the abutment 2 or the pier 3) are connected with each other in a similar way to that shown in Fig. 4.

Hereunder, there is described a step of disposing a reinforcement 22 and a reinforcement 23 in the bridge girder part 10.

The opposite ends of the reinforcements 22 are mounted and disposed on the stud dowel 19.

Next, 2 plurality of the reinforcements 23 are mounted and disposed on the reinforcements 22 so that they extend in the longitudinal direction of the bridge girder part 10. The reinforcements 22 and the reinforcements 23 are combined by binding them at the crossing portions with a wire or the like.

The reinforcements 23 may be disposed from each other by a constant distance or otherwise by different distances.

Hereunder, there is described a step of pouring a concrete 24 with reference to Fig. 7.

The concrete 24 is poured into the bridge girder parts 10 through one hole 17 which is positioned on one end of the parts 10. The bridge girder parts 10 are mounted on the abutment 2 and the pier 3. If the space under the hole 17 is filled with the concrete 24, the hole is closed by a cover 25. Further, the concrete 24 is poured into the bridge girder parts 10 through the neighboring hole 17. The pouring of the concrete 24 is done successively in this manner and the whole inner space of the bridge girder parts 10 is filled with the concrete 24.

When the concrete 24 is poured successively, the air in the bridge girder parts passes outwardly through the holes through which the concrete 24 is not poured during the pouring operation. Therefore, the concrete 24 is supplied smoothly into the bridge girder parts 10.

If the concrete 24 is solidified to form a concrete

body 24, the bridge girder parts 10 and the reinforcements 22 and 23 are consolidated to form a composite structure. The structure has high rigid properties. Furthermore, the structure has a smaller size and a lighter weight than conventional bridge girders. Therefore, the resultant bridge has the piers 3 disposed away from each other by a longer span than bridges comprising conventional bridge girders and has succeeded in reducing the number of the piers 3.

The webs 15 and the concrete body 24 are strongly consolidated because the stud dowels 19 are embeded in the concrete body 24.

Assembling and removing a framework for concrete is not required because the body 9 of the bridge girder part 10 defines the outer wall of the bridge girder 5.

The bridge girder 5 can be constructed without the need of provision of a temporary member.

Referring to Figs. 8 and 9, there is shown another process for mounting the bridge girder part 10 on the abutment 2 and the pier 3.

The lower flanges 13 are connected with each other by the spice plate 31, the bolts 31 and the nuts 35, as described above. The lower flanges 13 connected are mounted on the abutment 2 and the pier 3, Thereafter, the lower flanges 13 are connected with the webs 15 and the upper flanges 11, respectively, together with the bolts 21 and the nuts 20 to form the bridge girder part group 10.

The process is capable of easily lifting the members of the bridge girder parts 10 one by one by means of the crane 41. Therefore, the process may be done using cranes with relatively small lifting capacities.

Fig. 10 is a cross-sectional view of a bridge girder 51 according to a second embodiment of the invention.

In the same figure, numerical symbol 53 denotes a cyrindrical pipe as the hollow member. This cyrindrical pipe 53 comprises a so-called spiral pipe and the like.

The cyrindrical pipe 53 is supported by legs 55 and disposed on the substantially central Fosition of the bridge girder part 10.

In a bridge girder 51, no concrete 24 has flown into the cyrindrical pipe 53. That is to say, the inner space defined by the cyrindrical pipe 53 is free of the concrete body 24. Therefore, the bridge girder 51 has a light weight body. The vicinity of the upper flange 11 and the lower flange 13 of the bridge girder 51 has been filled with the concrete 24. Therefore, large stress exists in the vicinity of the upper flange 11 and the lower flange 13 because the bridge girder 51 expericnces load from the floor slab 7 and the like. Consequently, even if the cyrindrical pipe 53 forms a space free of the concrete body 24, no adverse influence is exerted on the bridge girder 51 in terms of strength.

Fig. 11 shows a modification bridge girder 61of the Fig. 10 bridge girder. This bridge girder 61 has an prisnal pipe 63 disposed on the substantially central position of the bridge girder part 10. The bridge girder 61 may also be constructed in light weight form in the similar manner employed in the bridge girder 51.

Figs. 12 and 13 shows a bridge girder 71 of a third embodiment according to the invention. In the bridge girder 71, a steel for prestressed concrete is disposed therein and tension is applied to the concrete 24 by applying tension to the steel for prestressed concrete.

In the figures, numerical symbol 73 denotes steels for prestressed concrete such as a steel bar for prestressed concrete, a steel strand for prestressed concrete, a wire for prestressed concrete and a hard wire for prcstressed concrete. The steels for prestressed concrete 73 extend in a longitudinal direction of the bridge girder 71 and passes through the concrete 24. The steels for prestressed concrete disposed 73 are disposed in five lines in and three columns. Tensicn has been pre-applied to he steel for prestressed concrete 73 to impart to the steel 73 high compress force. The tension may be applied by post-tensioning system or pre-tensioning system. The post-tentioning system applies tension upon solidification of the concrete. The pretensioning system applies tension before solidification of the concrete. The process shown in the figure employs a pre-tensioning system.

Restoring force of the steel 73 for prestressed concrcte 73 provides compressive force to the concrete 24. The compressive force offsets tensile stress induced fron dead load and live load being applied on the bridge girder 71.

Having described our invention as related to the embodiments shown in the acconpanying drawings, the scope of the invention should not be limited by the embodiments and various changes and modifications may be made in the invention without departing from the spirit and scope.

Although the body 9 of the bridge girder part 10 comprises the upper flange 11, the lower flange 13 the webs 15 connected with each other through the bolt 21 and the nut 20, the upper flange 11, the invention should not be limited to this connecting means. For example, the lower flange 13 and the webs 15 may be connected by welding.

Further, the concrete 24 may be poured simultaneously through a plurality of the holes 17 provided that the air within the body 17 can be vented.

The body 9 should, not limited to have prismal tube forms but also, include other forms such as cylindrical forms.

The hole 17 should, not limited to have oval forms but also, include circular or angular forms.

## Claims

1. A bridge girder part comprising a tubular body with a hole therethrough.

2. The bridge girder part according to claim 1, in which the bridge girder part is made of steel.

3. The bridge girder part according to claim 2, in which the body comprises a top plate, side plates and a bottom plate connected with each other to form a prismal tube, the top plate having a hole therethrough.

4. The bridge girder part according to claim 3, in which the top plate, the side plates and the botton plate are connected by a connecting means capable of assembling and disassembling them.

5. The bridge girder part according to claim 4, in which a plurality of holes is formed through the bridge girder part and is disposed from each other by a given distance.

6. The bridge girder part according to clain 5, further comprising a support member for supporting a reinforcement on the inner surface of the side plate.

7. A bridge girder comprising bridge girder parts each having a tubular body to define the outer wall thereof, a connecting means for connecting the parts, a reinforcement disposed in the bridge girder part and a concrete body poured into the bridge girder part and existing therein.

8. A bridge girder according to claim 7, further comprising in the body a hollow member for forming a space into which no concrete flows.

9. A bridge girder according to claim 7 or 8, in which prestress has been applied on the concrete body by providing steel for prestressed concrete in the bridge girder part and applying tension to the steel.

10. A process for constructing a bridge girder comprising the steps of mounting on abutments or an abutment and a pier bridge girder bodies each having a tubular body with a hole therethrough to define an outer wall of the bridge girder body, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the hole.

11. A process for constructing a bridge girder comprising bride girder parts each having a body of a top plate, side plates and a bottom plate connected with each other by a connecting means capable of assembling and disassembling them with the top plate having a hole therethrough comprising the step of connecting bottom plates with each other, mounting on an abutment and a pier or piers the plural bottom plates, connecting the botton plates with side plates and top plates, respectively, to form bridge girder parts, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the hole.

12. A process for constructing a bridge girder comprising the steps of mounting on an abutment and a pier or piers bridge girder parts each having a tubular body with holes therethrough to define an outer wall thereof, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the holes provided that through at least one hole among then, no concrete is poured.

13. A process for constructing a bridge girder comprising bride girder parts each having a body of a top plate, side plates and a bottom plate connected with each other by a connecting neans capable of assembling and disassembling them with the top plate having a hole therethrough comprising the step of connecting bottom plates with each other, mounting on an abutment and a pier or piers the plural botton plates, connecting the bottom plates with side plates and top plates, respectively, to form bridge girder parts, connecting the bridge girder parts with each other, disposing a reinforcement in the bridge girder parts, and pouring concrete into the bridge girder parts through the hole provided that no concrete flows through at least one hole among them.

14. The process for constructing a bridge girder according to any one of clams 10 to 13, further comprising the step of disposing on a given position in the bridge girder parts a hollow member for forming a space into which no concrete flows.

15. The process for constructing a bridge girder according to any one of claims 10 to 14, further comprising the step of applying prestress to the concrete body in the bridge girder parts by providing a steel body for prestressed concrete in the bridge girder part end applying tension to the steel body.

FIG. 1

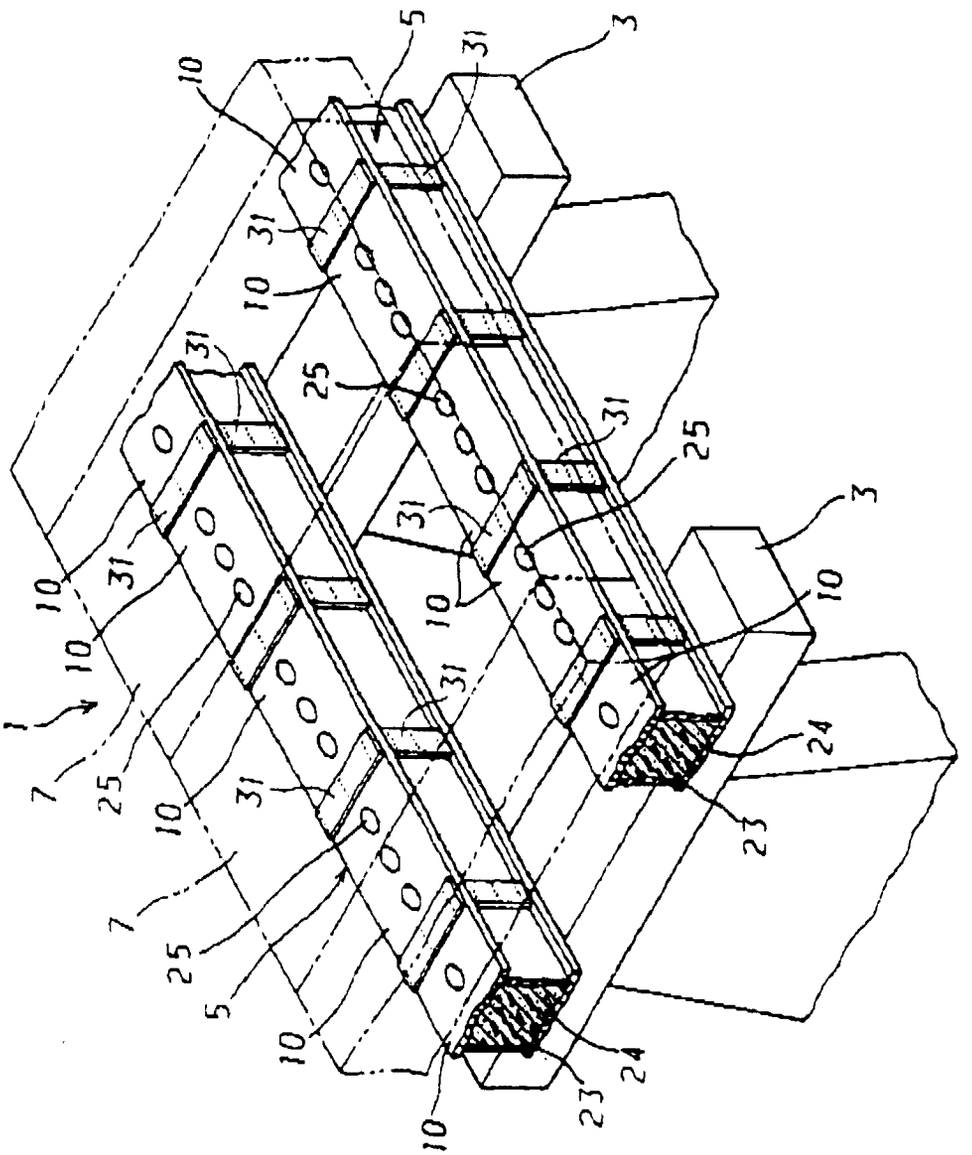

FIG. 2

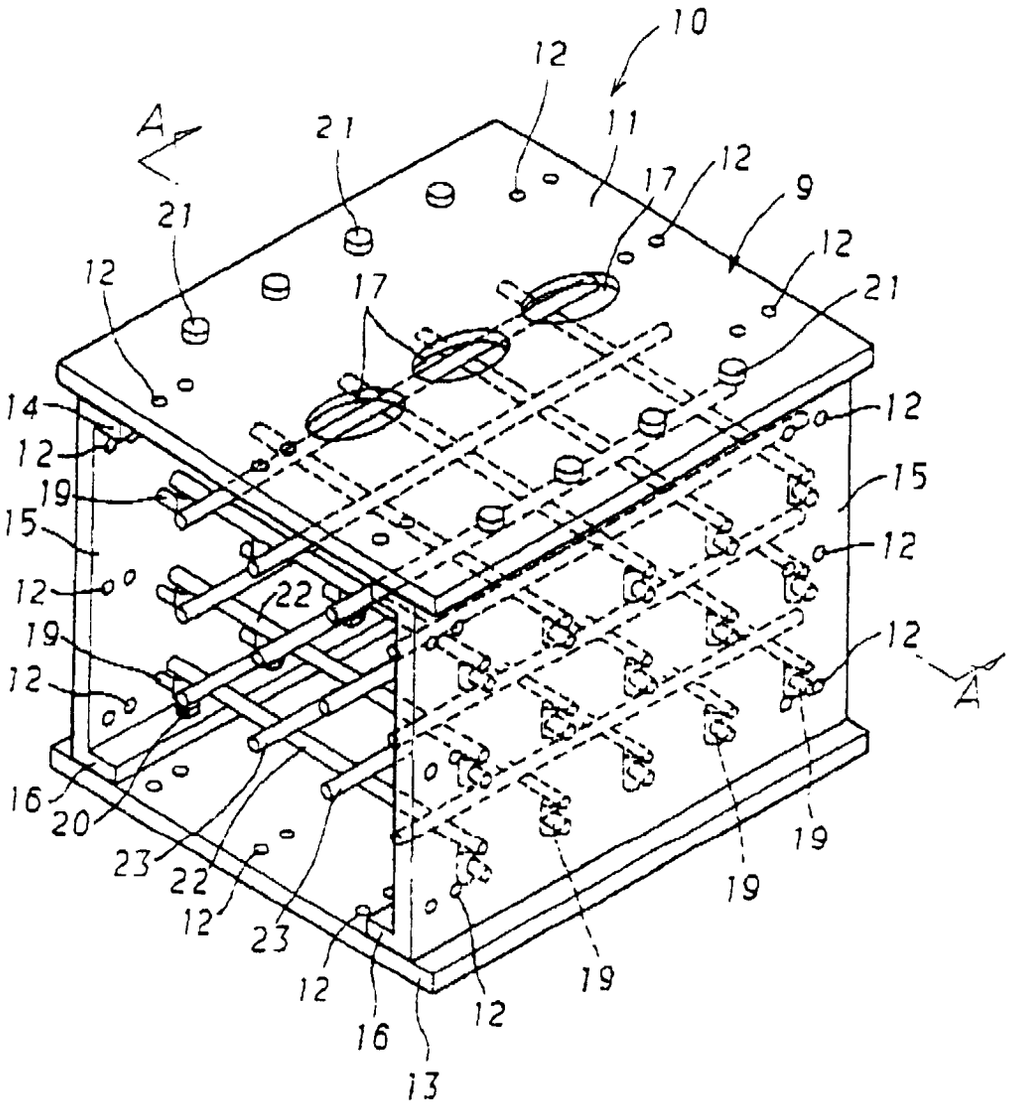
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FIG. 3

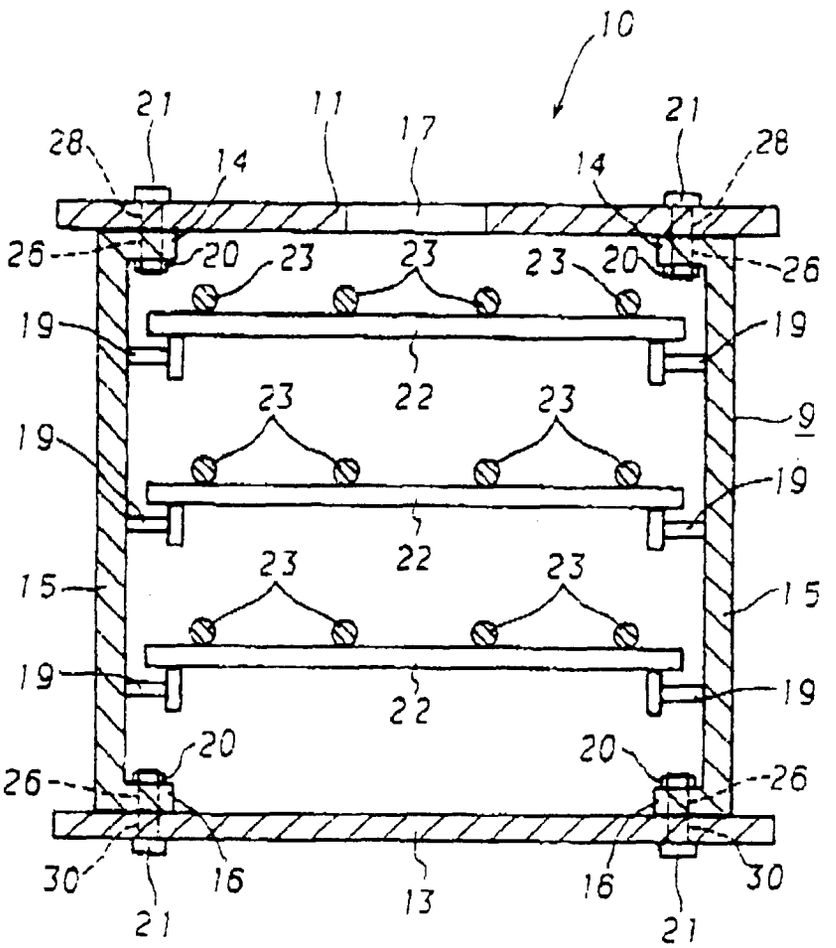
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FIG. 4

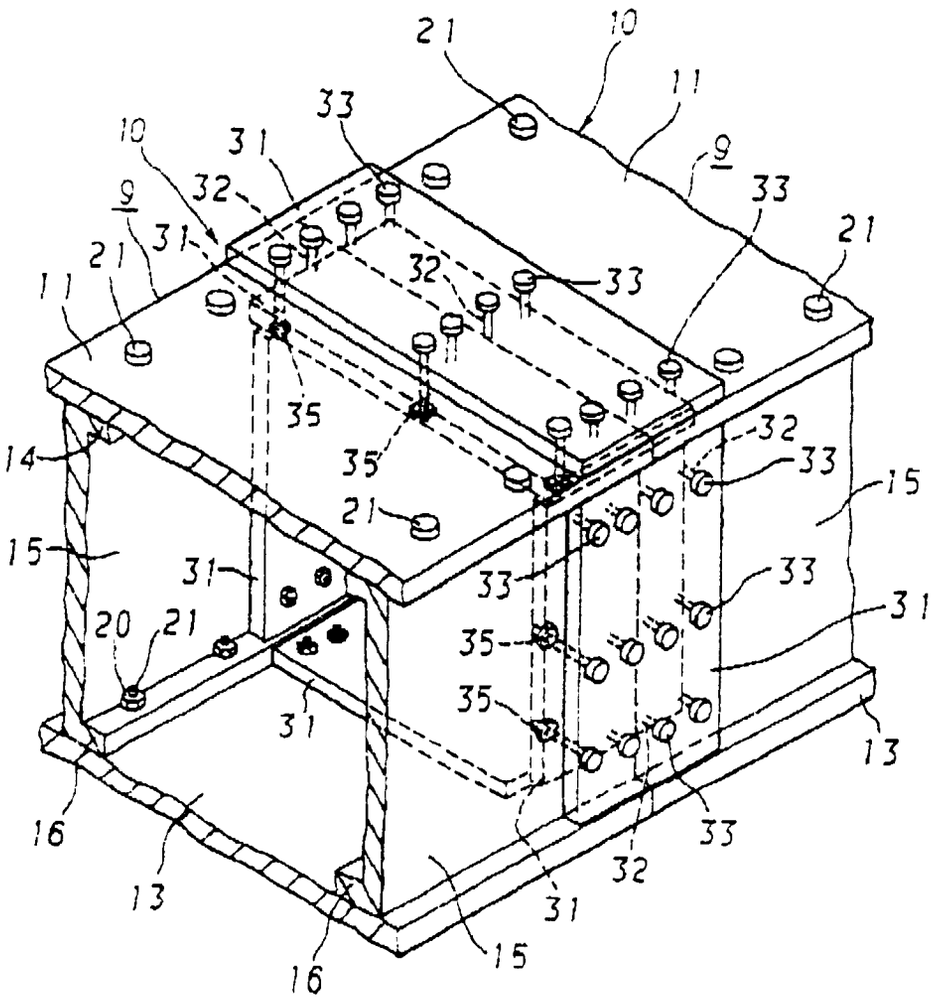
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FIG. 5

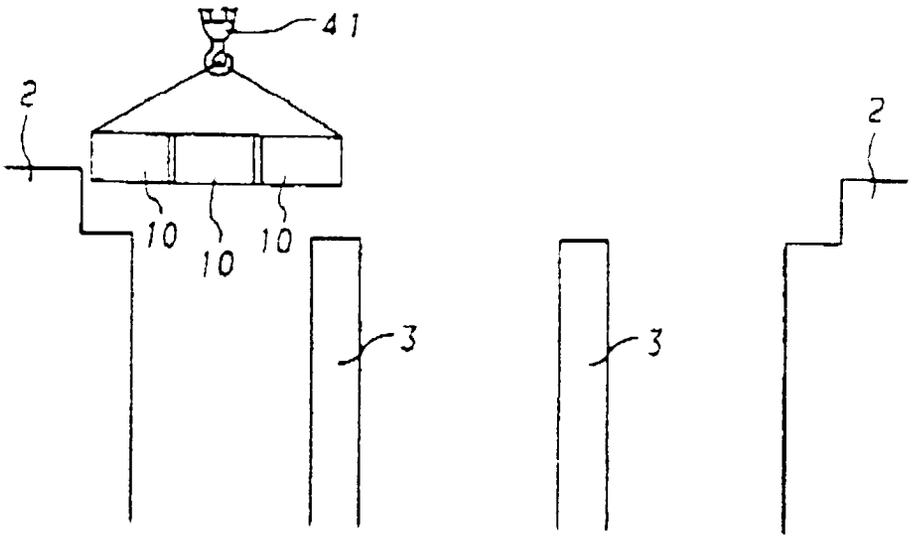


FIG. 6

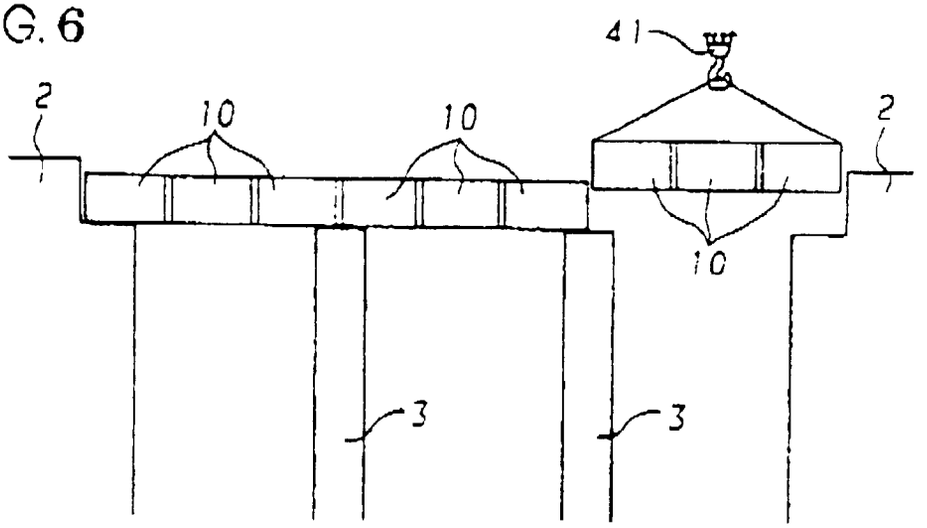

FIG. 7

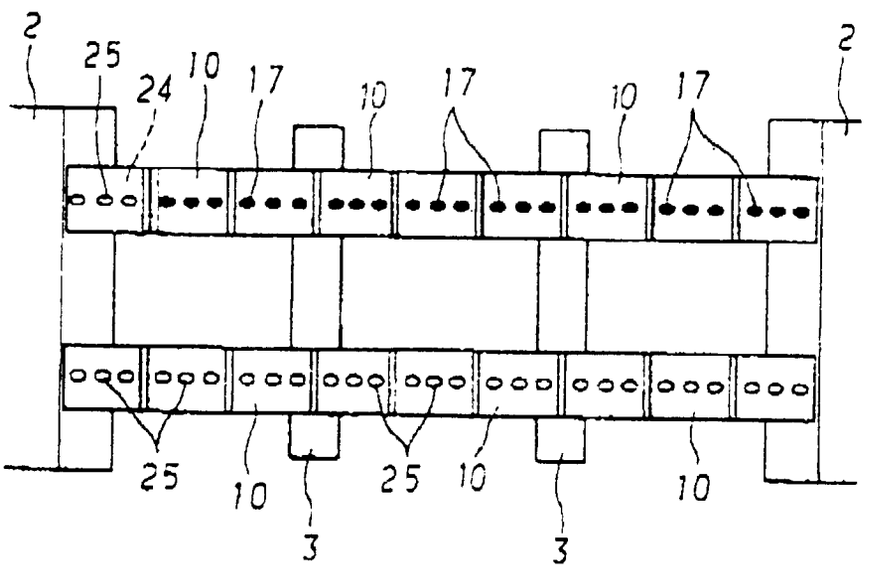

FIG. 8

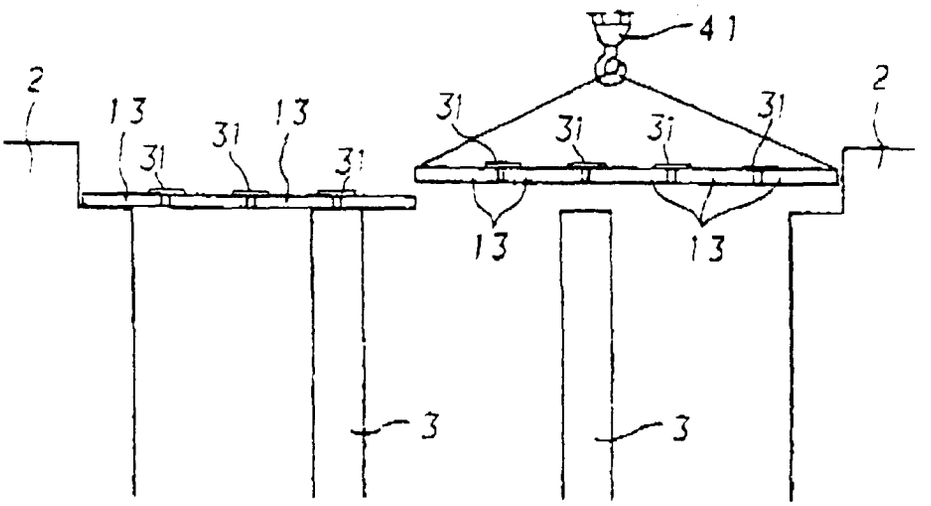


FIG. 9

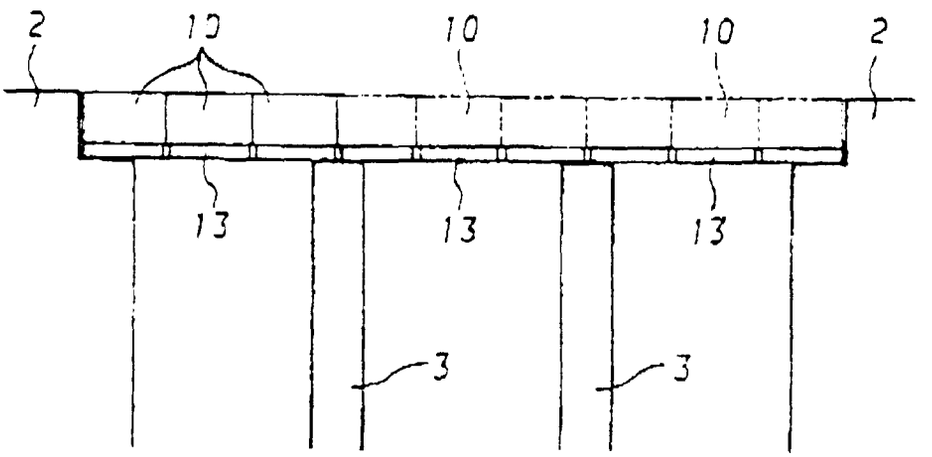

FIG. 10

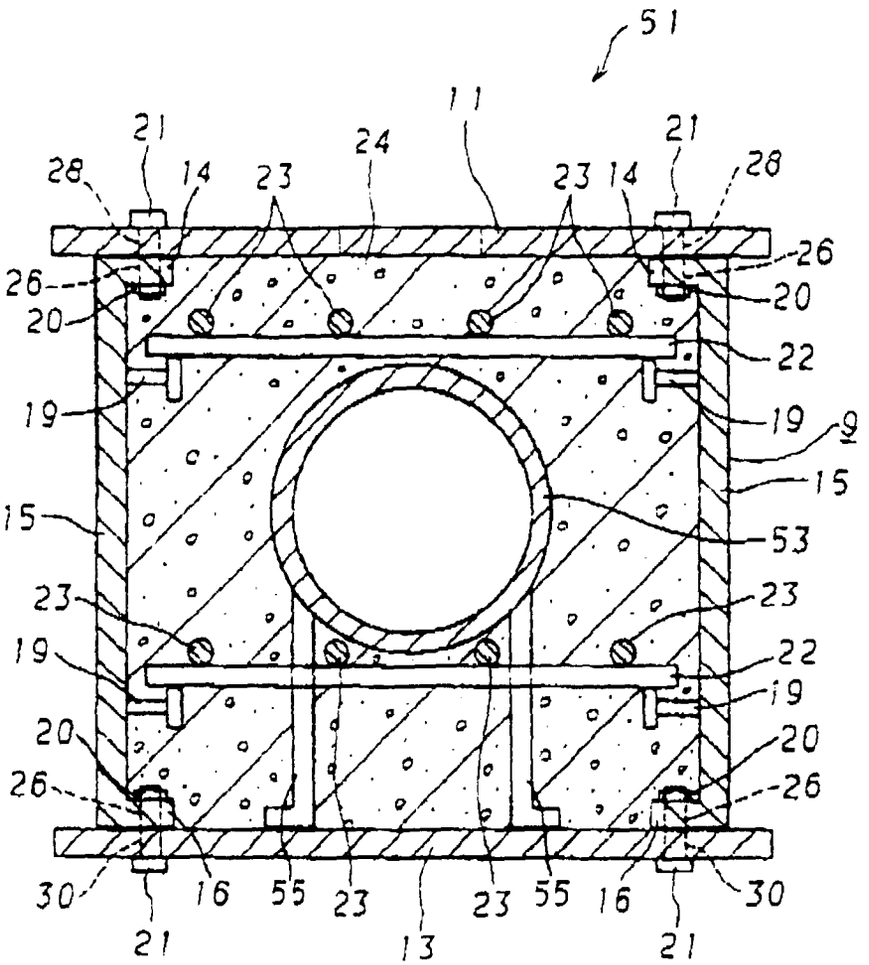
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FIG. 11

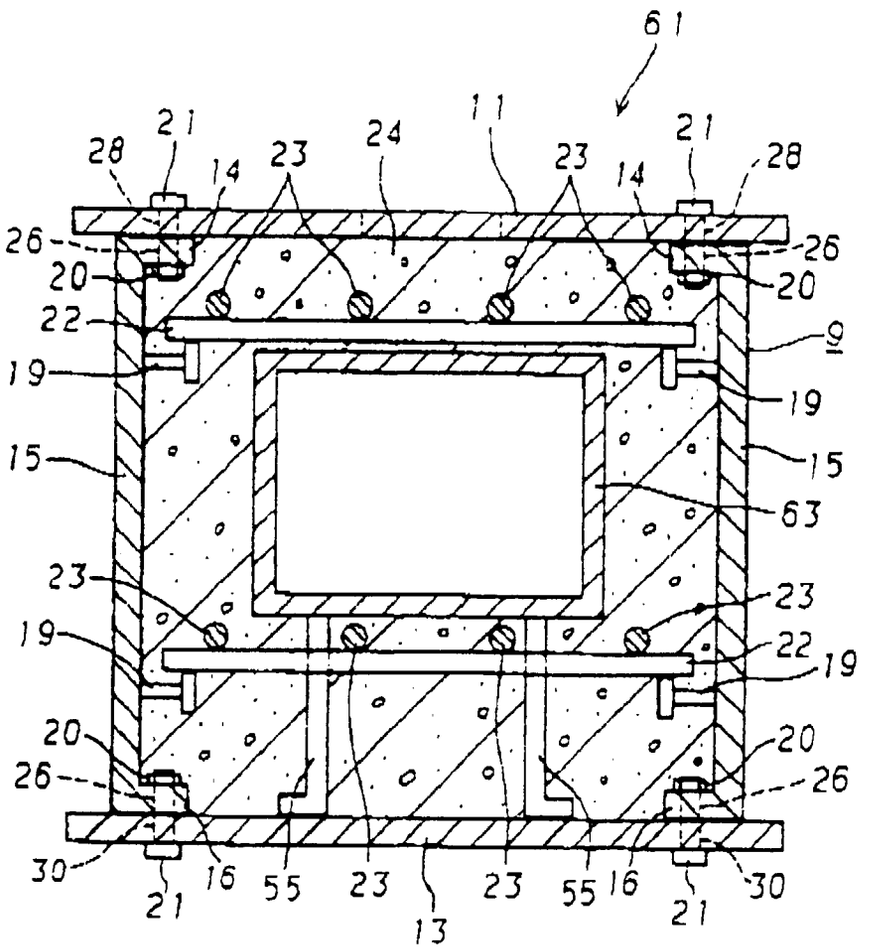
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FIG. 12

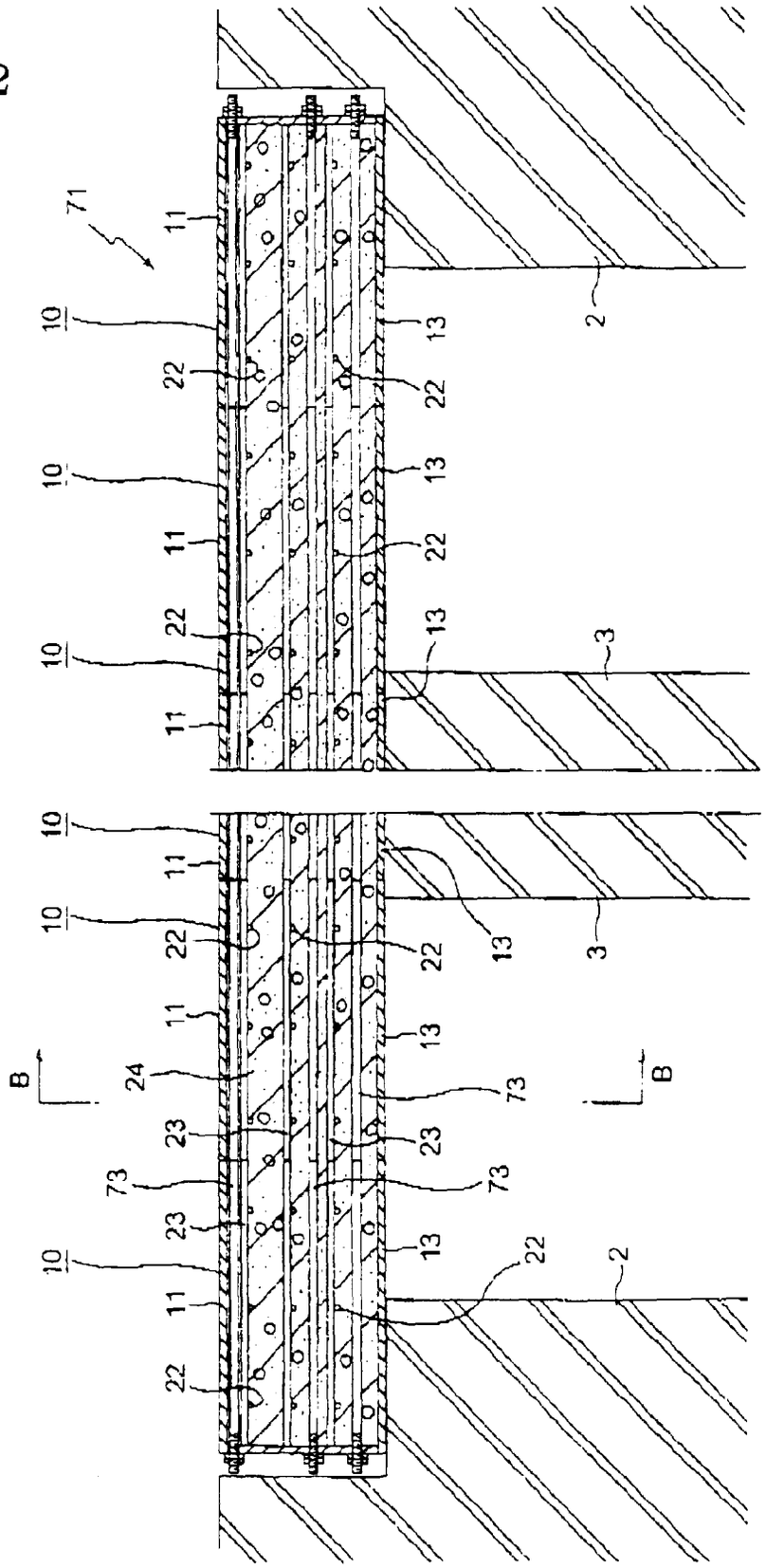
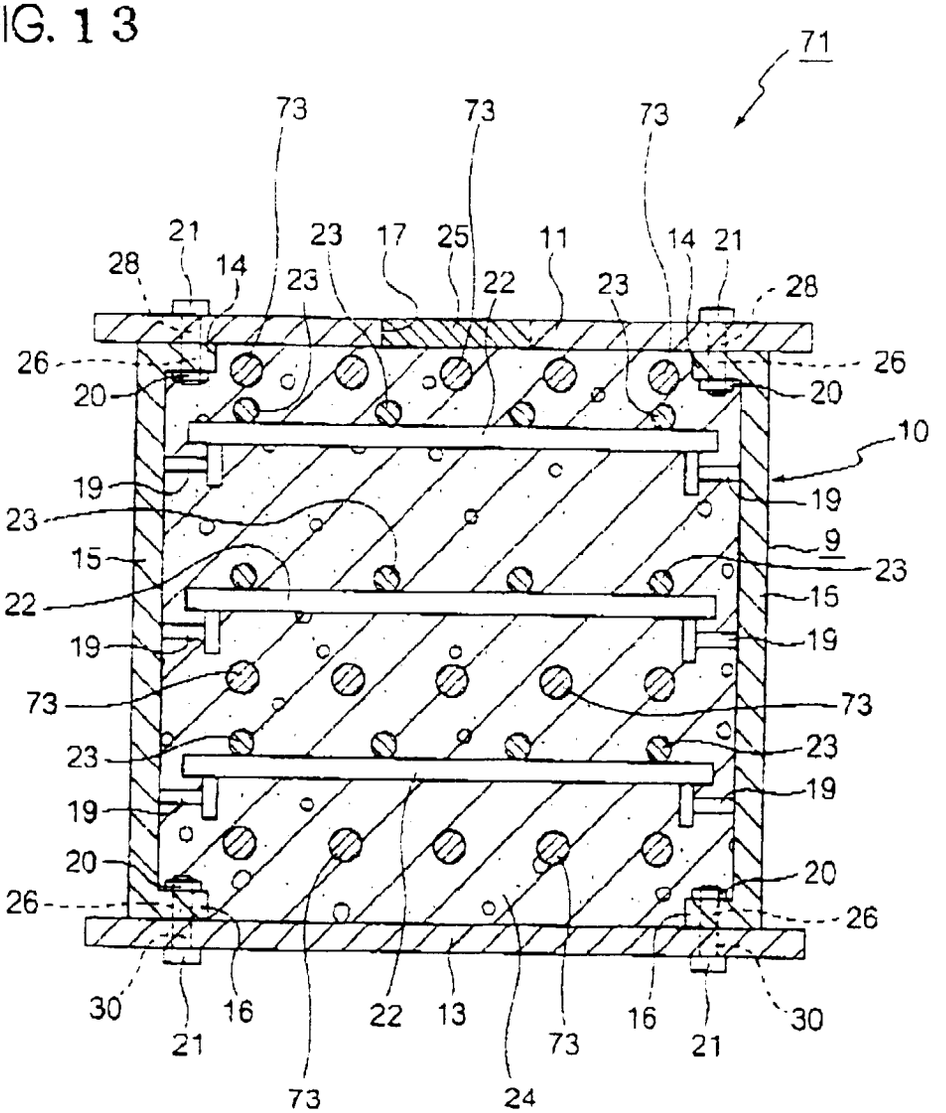


FIG. 13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European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 97 30 8931

## 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) |
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TECHNICAL FIELDS SEARCHED (Int.Cl.6)

E01D
E04C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 5 February 1998 | Dijkstra, G |

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