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(54) IMPROVEMENTS IN OR RELATING TO CONCRETE STRUCTURES

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• **BANKS, Colin Richard, Trimulgherry Cottage**
Bedfordshire SG17 5ES (GB)

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(74) Representative: **Kidd, Piers Burgess et al**
Marks & Clerk,
57-60 Lincoln's Inn Field
London WC2A 3LS (GB)

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(73) Proprietor: **R. O'Rourke and Son Limited**
Grays, Essex RM20 4YB (GB)

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(72) Inventors:
• **2'ROURKE, Raymond Gabriel, Fiddlers Reach**
Essex RM20 4YB (GB)

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Description**Field of the invention**

[0001] This invention relates principally to a concrete structure comprising reinforced concrete columns and concrete floors, and to a method of constructing same. The invention also relates however to a metal joint for use in jointing columns together in such a structure, to a method of casting concrete columns, and to a deck unit for use in casting concrete columns.

Prior Art

[0002] The customary practice at present is for concrete columns to be individually cast in situ, which involves the erection of formwork for each column, pouring concrete into the erected formwork, waiting for the concrete to set and then dismantling the formwork, all of which is time-consuming and labour-intensive.

[0003] GB 591,431 discloses pre-cast concrete columns which are located above one another. Because reinforcing bars extend from both columns, however, both columns have to be located in situ prior to pouring a concrete floor, for example.

[0004] It is an object of the invention to dispense with the need to locate an upper column prior to casting a concrete floor in situ.

[0005] FR 1186339 relates to coupling members between concrete columns.
GB 1039126 (Laing) relates to joints between structural members.

GB 591431 (Lee) relates to reinforced concrete columns.

US 5253460 (Simenoff) relates to column assemblies.
US 4081935 (Wise) relates to a building structure utilizing precast concrete elements.

Summary of the invention

[0006] According to the invention there is provided a concrete structure as claimed in any one of claims 1 to 12, to which reference is directed.

[0007] Features and advantages of the invention will become apparent from the following description, given by way of example only, with reference to the drawings.

Brief description of the drawings

[0008]

FIGS. 1 to 4 illustrate a metal joint, comprising female and male part-joints, used in a concrete structure embodying the invention; more particularly:-

FIG. 1 is a plan view of a female part-joint;

FIG. 2 is a section on line 2-2 of FIG. 1;

FIG. 3 is a plan view of a male part-joint;

FIG. 4 is a section on line 4-4 of FIG. 3;

FIGS. 5 to 12 illustrate the concrete structure embodying the invention, including metal joints between adjacent pairs of columns; more particularly:-

FIG. 5 is a schematic side elevational view of a stage in the construction of the concrete structure embodying the invention;

FIG. 6 is a partial, side elevational, sectioned view illustrating the bottom end of a bottom column of the concrete structure, erected upon a concrete base;

FIG. 7 is a diagrammatic illustration, to a much smaller scale than any of the preceding Figs, of an initial stage in the construction of the concrete structure embodying the invention;

FIGS. 8 to 12 are views, to a still smaller scale than FIG. 7, illustrating successive stages in the construction of the concrete structure embodying the invention;

FIG. 13 is a plan view of one possible arrangement of apparatus for precasting a line of, say, four concrete columns simultaneously, already inter-connected with each other;

FIG. 13A is a scrap sectional view of an infill in FIG. 13;

FIG. 14 is a part view of a modified arrangement of the apparatus, for making columns of slightly different dimensions;

FIG. 15 is an enlargement of apart XV of the arrangement shown in FIG. 13;

FIG. 16 is a sectional view on plane XVI-XVI in FIG. 15, illustrating one of several deck units in FIGS. 13 to 15;

FIG. 17 is a sectional view on plane XVII-XVII in FIG. 16;

FIG. 18 is a sectional view on plane XVIII-XVIII in FIG. 16;

FIG. 19 is a scrap view illustrating a locking mechanism for a scissor linkage in the deck unit of FIGS. 15 to 18;

FIG. 20 illustrates an insert for casting columns of circular cross-section, in a deck unit;

FIG. 21 is a section on plane XXI-XXI in FIG. 20;

FIG. 22 is a partial view of the deck unit, equipped to cast a column of circular cross-section;

FIG. 23 shows an "A"-frame, for suspending a column, straddling a deck unit;

FIG. 24 illustrates a socket embedded in a column and secured by bent rebars, to receive a ringbolts, and

FIG. 25 is a view of FIG. 24 in the direction of arrows XXV-XXV.

Metal Joint

[0009] Referring to FIGS. 1 and 2, a first part-joint, or female part-joint, 20 comprises a female part-joint plate 21, a backing plate 22, a locating tube 23 and an end plate 24. The joint plate 21 and the backing plate 22 are welded together, both being substantially square in overall shape as shown in FIG. 1. The joint plate 21 and backing plate 22 are of steel. Joint plate 21 is relatively thick and extremely strong. It is provided with four (or more) holes 25, which are internally tapped or screw-threaded. The joint plate 21 is generally ring-shaped having a relatively wide, circular cut-out 26 with four equiangularly spaced ears, flanges or ledges 27 around the inside periphery thereof.

[0010] The backing plate 22 extends across substantially the whole of the underside of the joint plate 21, including the hole 26. At the centre of the backing plate 22 is a relatively small hole 28, of substantially the same diameter as, and co-axial with the locating tube 23, which is welded to the underside of the backing plate 22 and depends downwardly from the latter. The end plate 24, as its name suggests, is located at, and fixed to, the bottom end of the tube 23. The backing plate 22 has four (or more) holes 29, which are untapped, in alignment with the holes 25 of the joint plate 21. Finally, the female part-joint 20 comprises a stop 30, the function of which will be explained hereinafter, welded to the underside of the end of one of the ears, flanges or ledges 27 as shown in FIGS. 1 and 2.

[0011] Next, referring to FIGS. 3 and 4 a second part-joint, or male part-joint, 31 comprises a male part-joint plate 32 and a locating pin 33. The male part-joint plate 32 is substantially circular in shape, except for four equiangularly spaced, outwardly projecting, ears, flanges or ledges 34 (adapted to engage the female part-joint 20 between the backing plate 22 and the four ears, flanges or ledges 27). The male part-joint plate 32 is provided with four (or more) internally tapped, or screw-threaded holes 35 which are equiangularly spaced apart. At the centre of the male part-joint plate 32 is a relatively small hole 36.

[0012] The locating pin 33 has at its upper end a reduced diameter portion 37, which fits inside the central hole 36 of the male part-joint plate 32. The reduced diameter locating pin portion 37 is welded to the male part-joint plate 32 inside the hole 36, so that the male part-joint 31 of FIGS. 3 and 4, like the female part-joint of FIGS. 1 and 2, is effectively a unitary structure.

[0013] The male part-joint plate 32 is formed by being cut-out from the inside of the female part-joint plate 21, thereby forming the cut-out 26 with the ledges 27 in the latter and forming the ledges 34 in the former.

[0014] When, in use as described hereinafter, the female part-joint, or first part-joint, 20 is mated with the male part-joint, or second part-joint, 31 the bottom surface 38 (FIG. 4) of the male part-joint plate 32 rests directly upon the backing plate 22 (FIG. 2) of the female

part-joint 20. The backing plate 22 itself is, in use, backed and fully supported by floor concrete, as will become apparent from the following description.

[0015] Each female part-joint 20 and each male part-joint 31 is marked with a unique serial number, which has to be visible as the two part-joints 20, 31 are connected together, so as to join together two adjacent concrete columns, in the eventual concrete structure, as will be described below.

Construction of Concrete Structure

[0016] Referring now to FIG. 5, illustrated in phantom outline is the upper end 51 of a precast concrete column 50. Also shown in phantom outline (see also FIG. 6) are reinforcement bars, or "rebars", 52 and cross-links 54, interconnecting the rebars 52. The rebars 52 and the cross-links 54 are embedded in a conventional manner in the precast column 50 at the time of casting the column 50, described hereinafter. The top of the column is referenced 55. Resting upon the top of the column 55 is the underside 57 of a concrete floor 56. The top side 58 of the concrete floor 56 is also shown in phantom outline. The backing plate 22 of the female part-joint 20 is fully supported by concrete of the floor 56, and can therefore support the male part-joint plate 32 (see above).

[0017] Also shown in phantom outline is the bottom end 61 of a second precast concrete column 60. Like the first concrete column 50, the second concrete column 60 is cast with rebars 62 and cross-links 64 by way of reinforcement. The reinforcement of the concrete columns 50, 60 is conventional.

[0018] Four (or more) anchor members 66 - only two anchor members 66 being shown - are fixed to the joint plate 21 of the female part-joint 20 and anchor the female part-joint 20 to the column 50 by extending downwardly from the joint plate 21 into the concrete of column 50, being embedded therein during the casting of the column 50. More particularly the anchor members 66 are in the form of strong steel rods, the upper ends of which are screw threaded as shown and are screwed into the four (or more) tapped holes 25 at the corners of the joint plate 21. On each anchor member 66, a lock nut 68 is strongly tightened against the underside of the joint plate 21 so that the anchor member 66 cannot become loose and unscrew from the joint plate 21. As shown in FIG. 5, the anchor members 66 project above the top 55 of the column 50, so that the joint plate 21 is spaced above the top 55 of the column 50 (by the thickness of the concrete floor 56).

[0019] Similarly, four (or more) anchor members 70 (only two anchor members 70 being shown) anchor the male part-joint plate 31 to the bottom end 61 of column 60. The anchor members 70 are likewise in the form of strong steel rods, whose bottom ends are screw threaded and are screwed into the holes 35, with a respective lock nut 73 on each rod 70 tightened against the top of the male part-joint plate 31 to prevent the anchor rod

becoming loose and unscrewed. Like the lower anchor members 66, the upper anchor members 70 are embedded in the concrete of the column 60 during the casting of the column 60, so as to anchor the male part-joint 30 to the bottom 61 of column 60.

[0020] The annular bottom base 75 of the upper column 60, surrounding the male part-joint plate 31, is relieved so that, even when the male part-joint plate 31 rests inside the female part-joint plate 21, the bottom face 75 of upper column 60 is spaced above the top surface 58 of concrete floor 56 and does not rest upon the latter, all the vertical load being transmitted through the male part-joint plate 31 to the backing plate 22, backed by concrete of the floor 56. The ears, flanges or ledges 27, 34 of the female and the male part-joint plates 21, 32 respectively function to withstand strong tension forces and/or bending moments at the joint between the lower and upper columns 50, 60.

[0021] It is convenient at this point to describe the various stages in the erection of the precast columns 50, 60 and the formation of the floor 56 shown in FIG. 5, starting from the point, prior to fabrication of the concrete floor 56, where the lower precast concrete column 50 has been erected, together with its female part-joint 20, anchored as described above, and as shown in FIG. 5, to the top end 51 of column 50.

[0022] Initially, the lower anchor bars 66 are holding the female part-joint plate 21 spaced above the top 55 of column 50. Then the concrete floor 56 is cast, or laid, so that concrete of the floor 56 completely fills the space between the joint plate 21 and the top 55 of column 50. Then the concrete is allowed to set, to form the floor 56 as shown. When the concrete of the floor 56 has set, the joint plate 21 is flush with the top surface 58 of floor 56. Because the next column 60 is also precast, there is no need for so-called "starter bars" to project upwardly from the floor 56 to form the next column 60. Instead, the top of the floor 56 is flat and uninterrupted by any impedimenta, which can considerably facilitate the use of special machinery, not shown, for placing and finishing the floor slab 56, prior to positioning the next column 60 directly on top of the joint plate 21.

[0023] The existence of the female part-joint plate 21, lying flush in the top surface 58 of the floor 56, renders it very easy indeed to locate the precise required position of the next precast concrete column 60, already fitted with the male part-joint 31.

[0024] The column 60 is simply lifted by crane and positioned directly over the joint plate 20. To locate the position of column 60 laterally, the locating pin 33 of the male part-joint 31 is introduced through the hole 28 into the locating tube 23 of the female part-joint 20. Then the column 60 is lowered, with the ledges 34 being guided past the ledges 27, until the bottom 38 of the male part-joint plate 32 rests upon the backing plate 22, which is supported by the concrete of the floor 56. The column 60 is then rotated through a small angle about its vertical axis, to move the ledges 34 underneath the ledges 27,

until one ledge 34 abuts the stop 30. The close manufacturing tolerances of the male and female part-joints 20, 31 result in the lower end 61 of the upper column 60 being held tightly in position and prevent the upper column 60 from leaning over.

[0025] The above description, with reference to FIG. 5, of fabricating floor 56 and then erecting column 60, starts from the stage where the lower column 50 has already been erected.

[0026] Assuming that column 50 is the first, that is, the lowermost, column to be erected, there will now be described, with reference to FIG. 6, how the bottom end 80 of column 50 is prepared for erection, and how column 50 itself is erected on a concrete base 81.

[0027] Firstly the concrete base 81 itself is laid. Well before the concrete of the base 81 has been placed, the required position of the column 50 is determined and four vertical bolts 82 inside four respective, commercially available, tubes 83 are embedded as shown in the concrete of the base 81, with the bolt heads 84 resting at the bottoms of the tubes 83 against the undersides of four washers 85. The tubes 83 serve to keep the concrete away from intimate, pressing contact with the bolts 82, so that the bolts 82 can be laterally adjusted in position if necessary, even after the concrete of the base 81 has set, or has started to set.

[0028] At the time of precasting the column 50, its bottom end 80 has, anchored to it, a base plate 86. More particularly, base plate 86 has, welded to it, four (or more) anchor members in the form of metal bars 87, of which only two bars 87 are shown. The anchor bars 87, just like the anchor bars 66, 67 (FIG. 5) extend into and are embedded in the concrete of column 50 when the latter is cast, thereby anchoring the base plate 86 to the bottom 80 of column 50. As seen in the plane of FIG. 6, the base plate 86 is slightly wider than the column 50. The base plate 86 is substantially longer than the width of column 50, that is, as seen in the direction normal to the plane of FIG. 6, and extends beyond the column 50 on both sides. The base plate 86 is formed with holes to receive the bolts 82, the positions of the said holes corresponding to the positions of the bolts 82, which are outside of the column 50. The column 50 is hoisted by crane into position, over the bolts 82, which are guided through the holes in the base plate 86, whereupon a nut 88 is put onto each bolt 82. When the column 50 has been manoeuvred into its exact required position, the nuts 88 are tightened fully down, thereby securing the column 50 in its exact required position. Layer 89 is a layer of grouting interposed in well-known manner between the concrete base 81 and the metal base plate 86.

[0029] When this has been done, the floor 56 and the upper column 60 can be respectively laid and erected as already described with reference to FIG. 5.

[0030] FIGS. 7 to 12, in that order, illustrate diagrammatically the successive stages of constructing a structure in accordance with the invention.

[0031] More particularly, FIG. 7 illustrates the first

stage, which is the laying of the concrete floor 81 (FIG. 6) incorporating the bolts 82 in their tubes 83.

[0032] FIG. 8 illustrates the second stage, which is the erection of the first column 50 (FIGS. 5 & 6) with its female part-joint 20, the joint plate 21 being spaced above the top 55 of column 50.

[0033] FIG. 9 illustrates the third stage, which is the laying of the floor 56, so that joint plate 21 is flush with the top floor surface 58.

[0034] FIG. 10 illustrates the fourth stage, which is the erection of the second column 60. FIG. 10 illustrates the top of the second column already fitted with a female anchor 90 which is similar to the female part-joint 20 of FIGS. 1, 2 and 5 and which is anchored in exactly the same way during the precasting of column 60.

[0035] These four stages, as illustrated in FIGS. 7 to 10 respectively, have already been described above in detail, with reference to FIGS. 5 and 6.

[0036] FIG. 11 illustrates the laying of another floor 91 on top of column 60, just as floor 56 was laid on column 50, whilst FIG. 12 shows the erection of a third column 92 just like column 60. This can be repeated for as many columns and floors as required, subject to stress and strength limitations, of course. It is assumed that the structure will terminate with a floor, not shown, at the top of the structure.

[0037] Whilst the drawings - FIGS. 5 to 12, that is - show a single "column of columns" 50, 60, 92, it will be appreciated that the intention is that the invention shall be of use where a structure is to have an array of columns, distributed across the structure, at each floor level, so that each column at the bottom shall have one or more other columns directly above it, each adjacent pair of columns, one above the other, being mutually interconnected by a metal joint, through a respective concrete floor at the level where the two columns meet.

Casting of Concrete Columns

[0038] The apparatus for casting the concrete columns, and the method of casting the columns, will now be described with reference to FIGS. 13 to 25.

[0039] It is in practice difficult or impossible to guarantee the exact correct length of each column, and the exact correct centralisation and axial positioning of the female and male part-joints 20, 31 at the ends of each column. It is thus preferable to cast each and every pair of mutually adjacent columns - that is, any and every two columns that will be one directly on top of the other, at the same time, with the metal connectors already connected up as the concrete sets, then to disconnect the columns after the concrete has hardened, and later to ensure that the same two columns are connected together end-to-end in the same way - in particular, in the same relative angular, or rotational, positions relative to the column axes - in the eventual concrete structure. This is why the part-connectors 20, 31 are marked with unique serial numbers.

[0040] For example, if a given structure is to be, say, four columns high, then the columns themselves are preferably cast in lines of four; a record is made of the serial numbers of the three pairs of part-connectors between the four columns, and the relative order in which they are connected together; the columns (and/or connectors) may be marked in some way so that their relative rotational or angular positions before disconnection are known; and the four columns are temporarily stored, or racked, after being cast, in individually known positions, so that the columns can be individually retrieved later, as and when they are wanted, for eventual erection in the self-same lines of four columns each. This is best done by keeping records on computer.

[0041] Continuing the explanation by way of the example of the four column high structure, this structure may for example have, at each level, longitudinal rows of, say, six columns each and transverse rows of four columns each, so that there are twenty-four columns at each level. This means that one has to cast twenty-four lines of columns with four columns in each line. When the first level of columns is erected, at ground level, the bottom end column (such as column 50) will be taken of each line of columns. At the next level, the next column (such as column 60) will be taken of each line of columns. At the third level the third column (such as column 92) will be taken of each line of columns, and so on.

[0042] FIGS. 13 and 15 illustrate an arrangement of apparatus for casting the three columns 50, 60 and 92, and a fourth column 93, in a line, already interconnected by three connectors 20, 31, as described above and as shown. The apparatus comprises several identical deck units 100 arranged side-by-side in a line as shown, with infills 102a to 102f arranged between certain adjacent deck units 100 as shown to accommodate required variations in the lengths of the columns 50, 60, 92 and 93.

[0043] FIG. 14 illustrates a slightly different arrangement of deck units 100 and one infill 102g, for making the bottom most column 50 a different length if required.

[0044] Referring back to FIGS. 13 and 15, the apparatus comprises (FIG. 13) walers, or waling members 104, supported by the deck units 100 when casting the columns. The apparatus also (FIG. 13) comprises adjustable side shutters 106.

[0045] Longitudinally extending timber infill 110 (FIGS. 13 and 15) is used where necessary, for example, with columns 92 and 93, to make them smaller in width than the lower columns 50, 60. Steel plate "stop-ends" 111, 113, supported by struts 115 and supports 117, form the spaced-apart ends of adjacent columns: these have to accommodate the connector parts 20, 31 already connected together as shown in FIG. 15. The stop-ends 111, 113 and the parts 115, 117 have to be replaced after each casting operation. That is, a fresh set is required for each line of columns.

[0046] Back-to-back pairs of rolled-steel-channels 112 are arranged as shown in FIG. 15, to provide structural rigidity.

[0047] Referring now also to FIGS. 16 to 19, the construction and manner of operation of each of the deck units 12 will now be described in detail. In order to establish a form of relationship between FIGS. 13 to 15 on the one hand and FIGS. 16 to 19 on the other hand, FIG. 16 shows a typical column such as column 60 in phantom outline as being of circular cross-section. For casting such a column, the deck unit 12 comprises a ply-lined hinged sliding side panel 116 (see also FIG. 13) on one side of column 60 and a ply-lined hinged (but not sliding) side panel 118 on the other side of the column. Both panels 116 and 118 are shown in two alternative positions, namely, closed-in operative positions, shown in full lines, for the casting of the columns, and opened-out or striking positions, shown in broken lines, after casting has been completed. The panel 116 is hinged to an upper base 120 on hinges 122, one at each end of the panel 116 (only one hinge 122 being shown). The hinges 122 can be adjustably moved inwardly and outwardly, as illustrated by arrows 124, to accommodate columns of different widths. More particularly, the hinges 122 are each bolted to the base 120 by a bolt 121, fitted with a nut 123, which can be undone to enable the position of the associated hinge 122 to be changed, after which the bolt 121 with its nut 123 can be done up again.

[0048] The panel 116 is held closed in, during casting, by a strut 126 which is provided with an over-centre knuckle joint 128, for setting and releasing the strut 126 in well known manner. FIG. 15 shows several of the struts 126, but without the knuckle joints 128. The panel 118 is hinged on a hinge 130 to a vertical member 132, which depends downwardly from the base 120 and which is braced by a brace 133. The panel 118 is held in, for casting, by a securing bolt 134 fitted with a nut 135. A replaceable platform 139 is supported upon the upper base 120 by beams 137, so that the platform 139 is level with the bottom edges of side panels 116, 118, spaced above the base 120.

[0049] It will be appreciated that the panels 116, 118, struts 126, vertical member 132, platform 139 and beams 137 are all mounted directly or indirectly to, or on, and are supported by, the upper base 120. The base 120, together with the parts that it supports, can be selectively raised and lowered by means of a scissor linkage mechanism 136, powered by a ram, or jack, 138. The scissor linkage 136 comprises a first pair of arms 140 and a second pair of arms 142. A lower base 144 is bolted firmly to the ground as shown in FIGS. 16 and 17. The upper ends of each of the two arms 140 are each pivoted on a fixed pivot 146 to the upper base 120, which can be raised and lowered as described above. The lower ends of the two arms 140 are mounted in roller bearings 148 for sliding along the lower base 144 as indicated by arrows 150. The lower ends of the arms 142 are pivoted on fixed pivots 152 to the lower base 144, whilst the upper ends of the arms 142 are mounted in roller bearings 154 for sliding along the upper base 120 as indicated by arrows 156, in the well known manner

of a scissor linkage. Where the pair of arms 140 cross the pair of arms 142, they are all pivoted together on a cross member 158, to which the upper end of the jack 138 is connected. The lower end of the jack 138 is pivoted on a fixed pivot 160 to the lower base 144.

[0050] During casting of the column, such as column 60, the upper base 120 is held in its raised position as shown in FIGS. 16 and 17. After the column has hardened, or set, the strut 126 is released, to open out the side panel 116, and the bolt 134 is released to open out the panel 118. Then, if it is desired to lower the base 120 of a particular deck unit 112 away from the column, the jack 138 is retracted so as to lower the base 120 on the scissor linkage 136.

[0051] FIG. 16 shows an optional top yoke 162 in phantom, for deeper columns. FIG. 16 also shows in phantom an insert 164 (FIGS. 20 and 21) introduced for making columns of circular cross-section.

[0052] For reasons of safety, so that the scissor linkage 136 can not collapse and accidentally lower the platform 120 during casting of a column, the two roller bearings 148 are each fitted with a locking mechanism 166, shown in detail in FIG. 19. Each locking mechanism 166 comprises a strut 168, pivoted at 170 to the roller bearing 148. The locking mechanism 166 also comprises an adjusting bolt 170. In its lowered position, shown in full lines, the distal end of the strut 168 abuts the adjusting bolt 170, so that the scissor linkage 136 can not collapse. After casting, in order to collapse the scissor linkage 136 if this is desired, the arm 168 may be raised to the position shown in phantom in FIG. 19, to permit outward movement of the roller bearing 148.

[0053] Returning to the subject of the insert 164 (FIGS. 20 and 21) for casting columns of circular cross-section, the insert 164 is in two halves 172, 174, bolted together at 176, 178. The upper half 174 is provided with chutes 180, 182 for pouring the concrete into the insert 164. The insert 164 rests upon the platform 135.

[0054] FIG. 22 shows the insert 164 after the concrete has been poured in. The chutes 180, 182 are removed and replaced by a screed 184 for forming the required surface texture on the column. The insert 164 is laterally supported, between the side panels 116, 118, by suitably shaped infills 186.

[0055] Reference has been made above to the need to disconnect the line of columns 50, 60, 92 and 93 all from each other after casting. FIG. 23 shows one of a number of "A"-frames 190, mounted upon lockable wheels 192, and straddling a deck unit 112. A cross-beam 194 of "A"-frame 190 is fitted with a lifting mechanism 196, terminating in a hook 198, from which the column, such as column 50, can be suspended, in a manner to be described.

[0056] More particularly, at the time of casting the line of columns 50, 60, 92 and 93, as described above, each column is provided with internally screw threaded sockets 200 (see FIGS. 15 and 24). Preferably, each column is provided with two such sockets 200, one near each

end as shown in FIG. 15. Referring to FIGS. 24 and 25, each socket 200 is embedded in the column, such as column 60, so that a ringbolt 202 can be screwed into the socket 200 temporarily, to be removed later when no longer required. The ringbolt 202 is engageable by the hook 198 of "A"-frame 190 so that the latter can be used to take the weight of the column, or even to lift the column if required. As shown in FIGS. 24 and 25, three bent "rebars" (reinforcement bars) 204, 206 and 208 are embedded in the concrete as shown, and engage the screw threaded socket 200 to retain the latter securely in the column, so that the socket 200 and the ringbolt 202 will not be liable to be accidentally pulled off the column when under load. At the time of casting, all the sockets 200 are aligned along the tops of the columns, so that the positions of the sockets 200 can be used later as references in order to ensure that the columns in each line are reconnected, at the time of erecting the concrete structure, in the same angular relationship or rotational position. Initially, the only way in which the "A"-frames 190 can support the columns is by engagement of the hooks 198 in the ringbolts 202, the latter being screwed into the sockets 200. Although FIGS. 24 and 25 show the rebars 204, 206 and 208 in full lines, it will be appreciated that the rebars are actually embedded in the concrete, out of sight. Indeed, whilst rebars 204 and 206 are embedded at a relatively shallow angle, so as to be relatively near the surface 210 of the concrete column, the rebar 208 is relatively deeply embedded, so as to distribute the load through the thickness of the column when the column is lifted by the ringbolt 202.

[0057] Referring back to FIGS. 13, 14 and 15, it will have been already appreciated that each column is supported by a plurality of deck units 112. After the columns have hardened, or set, one or other (but not all simultaneously) of the deck units 112 can be lowered, that is, the upper base 120 can be lowered, after the side panels 116, 118 have been "struck", or opened out, so that straps (not shown) can be passed around the column, where the upper base 120 has been lowered, and the straps can be hung from the hooks 198 of the "A"-frames 190. By lowering one deck unit 112 at a time, so as to pass straps first round one end and then round the other end of a column, finally disconnecting the "A"-frame hooks 198 completely from the ringbolts 202, and unscrewing the ringbolts 202 from the sockets 200, so that the column is only supported by the straps from the "A"-frames 190, each column can then be rotated about its axis, supported by the straps from the "A"-frames 190, through 45°, so as to disconnect the column from the remainder of the line of columns.

[0058] Once the line of columns have all been disconnected from each other, they can be transported - by crane, fork-lift truck or whatever - to a storage site, where each column is stored until required for use. As mentioned previously, it is preferred for each column to be stored in an individually recorded location so that the right column can be quickly retrieved when wanted. If

the individual location in storage of each column is sufficiently reliably recorded, individual marked identification of each column, and/or of the part-connectors 20, 31 becomes superfluous, and vice versa. However, it might be thought prudent to identifiably mark each column, and/or the part-connectors 20, 31 in any case, in order to ensure correct connection subsequently.

[0059] In a modified method of casting the columns, instead of casting all four columns 50, 60, 92 and 93 simultaneously, they are cast in stages, for example, one or two (or even three) at a time.

[0060] If one wished to cast the columns one at a time, one would start with column 50. Then, after the concrete of column 50 has fully set, one places column 50 adjacent where column 60 is to be cast, with the female part-connector 20 of column 50 already connected to the male part-connector of column 60, and casts column 60. Then, after the concrete of column 60 has fully set, one disconnects it from column 50, removes column 50, places column 60 where column 50 was previously placed, and proceeds to cast column 92 adjacent to column 60 in the same way as column 60 was cast adjacent to column 50. Then, after the concrete of column 92 has fully set, one disconnects it from column 60, removes column 60, places column 92 where column 60 was previously placed, and proceeds to cast column 93 adjacent to column 92 in the same way as column 92 was cast adjacent to column 60.

[0061] It will be appreciated that by the time that column 92 is being cast, column 50 will have been removed and could be in the course of being erected. Similarly, by the time that column 93 is being cast, column 60 will have been removed and could be in the course of being erected. That is to say, this modified method removes the requirement to cast all of the columns of the structure before commencing erection of any of them.

[0062] One is not limited to casting only one column at a time. One could cast two or three (or more) columns at a time. The only limitation is that any column being cast is already connected, at the time of casting, to the column which will be immediately below it in the structure, so that proper vertical alignment of the columns can be ensured.

Claims

1. A concrete structure, comprising reinforced concrete columns and concrete floors (56); pairs of said columns (50,60) being arranged one directly on top of the other; each of said floors being arranged, above ground level, at the junction between the adjacent ends of each said pair of columns; wherein each said pair of columns are of precast concrete and are jointed together by means of a metal joint comprising first (20) and second (31) part-joints; said first and second part-joints being respectively anchored rigidly in or to the upper end of the lower

column (50) and the lower end of the upper column (60) of each said pair of columns, by means of anchor members of said two part-joints anchoring the two part-joints in the respective ends of the two columns by being embedded in the precast concrete thereof; wherein adjacent ends (55,75) of each said pair of columns are spaced apart and a respective one of said concrete floors (56) substantially fills the space between the adjacent ends of each said pair of columns; said first and second part-joints being jointed rigidly together, whereby the pair of columns are jointed rigidly together, and the two part-joints each comprise a respective metal plate element (21,32) extending substantially perpendicularly of a central axis of the associated column, wherein the two metal plate elements interfit or inter-engage with each other, the two part-joints being interlockable by relative rotation thereof about central axes of the two columns; **characterised in that** the metal plate element (21) of said first part-joint is spaced above the upper end of the lower column (50).

2. A structure as claimed in claim 1, wherein one metal plate element (21) is generally ring-shaped and the other metal plate (32) fits inside it.
3. A structure as claimed in claim 2, wherein the two metal plate elements (21,32) have been fabricated, prior to use, from one and the same piece of plate metal, said one metal plate element being cut out from inside the other metal plate element.
4. A structure as claimed in claim 2 or 3, wherein the ring-shaped metal plate element (21) is the metal plate element of said first part-joint (20).
5. A structure as claimed in claim 2, 3 or 4, wherein the ring-shaped metal plate element (21) is backed by a backing plate (22) which is itself backed by concrete (56) and wherein the other metal plate (31) bears against the backing plate.
6. A structure as claimed in any one of claims 2 to 5, wherein ledges, ears or flanges (27) of one metal plate element are engageable with ledges, ears or flanges (34) of the other metal plate element to withstand tension forces and/or bending moments at the joint between the two columns (51,61).
7. A structure as claimed in any preceding claim, wherein one said part-joint (31) comprises a vertical axial pin (33) which locates rotatably into a vertical axial tube (23) of the other said part-joint.
8. A structure as claimed in claim 7, wherein said first and second part-joints respectively comprise the tube and the pin, the pin (33) projecting downwardly into the tube (23).

9. A structure as claimed in any preceding claim, wherein the metal joint is load-bearing.

10. A structure as claimed in claim 9, wherein clearance is provided between the two columns, all the load being transmitted through the metal joint.

11. A structure as claimed in any preceding claim, wherein the metal joint maintains alignment of the two columns by virtue of close tolerances between mating parts of the joint.

12. A structure as claimed in any one of the preceding claims, wherein the last-mentioned metal plate element (21) is substantially flush with the upper surface of said one floor (56).

Patentansprüche

1. Betonstruktur, die Kolonnen aus Stahlbeton und Betondecken (56) aufweist, wobei unter den Paaren dieser Kolonnen (50,60) die eine direkt oberhalb der anderen angeordnet ist; wobei ein jeder dieser Böden über dem Erdgeschoss angeordnet ist, an der Verbindung zwischen den benachbarten Enden eines jeden dieser Paare von Kolonnen; Struktur in welcher ein jedes dieser Paare der Kolonnen aus Fertigbeton besteht und zusammengefügt wird mit Hilfe einer metallischen Verbindung, die eine erste (20) und eine zweite (31) Teilverbindung aufweist; wobei die erste und die zweite Teilverbindung jeweils starr verankert sind in oder gegen das obere Ende der unteren Kolonne (50) und das untere Ende der oberen Kolonne (60) eines jeden der Paare der Kolonnen, und zwar mit Hilfe von Verankerungsgliedern der besagten zwei Teilverbindungen, welche die beiden Teilverbindungen an den respektiven Enden der zwei Kolonnen dadurch verankern, dass sie in dem Fertigbeton derselben eingelagert sind; Struktur in welcher die benachbarten Enden (55,75) eines jeden dieser Paare der Kolonnen entfernt voneinander angeordnet sind und ein jeweiliger der besagten Betonböden (56) füllt im Wesentlichen den Raum zwischen den benachbarten Enden eines jeden der Paare der Kolonnen; wobei die erste und die zweite Teilverbindung starr miteinander verbunden sind, wodurch das Paar der Kolonnen starr zusammengefügt ist, und die zwei Teilverbindungen weisen eine jede ein aus einer respektiven Metallplatte bestehendes Element (21,32) auf, das sich im Wesentlichen senkrecht zu der zentralen Achse der zusammengefügten Kolonne erstreckt, in welcher die zwei aus einer Metallplatte bestehenden Elemente ein jedes mit dem anderen ineinander passt oder ineinander greift, wobei die zwei Teilverbindungen gegenseitig durch eine relative Drehung derselben um die zentrale Achse

se der zwei Kolonnen verblockt werden können; **dadurch gekennzeichnet, dass** das aus einer Metallplatte bestehende Element (21) der ersten Teilverbindung mit einem Abstand über dem oberen Ende der unteren Kolonne (50) angeordnet ist.

2. Struktur gemäß Anspruch 1, in welcher ein aus einer Metallplatte bestehendes Element (21) im Allgemeinen eine Ringform aufweist und dass die andere Metallplatte (32) in dasselbe hineinpasst.
3. Struktur gemäß Anspruch 2, in welcher die zwei aus Metallplatten bestehenden Elemente (21,32) vor ihrem Einsatz hergestellt worden sind aus ein und demselben Stück einer Metallplatte, wobei das eine aus einer Metallplatte bestehende Element aus dem Innern des anderen aus einer Metallplatte bestehenden Elementes herausgeschnitten worden ist.
4. Struktur gemäß Anspruch 2 oder 3, in welcher das ringförmige aus einer Metallplatte bestehende Element (21) das aus einer Metallplatte bestehende Element der ersten Teilverbindung (20) ist.
5. Struktur gemäß Anspruch 2, 3 oder 4, in welcher das ringförmige aus einer Metallplatte bestehende Element (21) von einer Hinterlegungsplatte (22) versteift ist, die ihrerseits von Beton (56) verstärkt ist und in welcher sich die andere Metallplatte (31) gegen die Hinterlegungsplatte stützt.
6. Struktur gemäß irgendeinem der Ansprüche 2 bis 5, in welcher Verstärkungsrippen, Schleifen oder Flanschen (27) von einem aus einer Metallplatte bestehenden Element in Eingriff gebracht werden können mit Verstärkungsrippen, Schleifen oder Flanschen (34) von dem anderen aus einer Metallplatte bestehenden Element, um Zugspannungen und/oder Biegemomenten an den Verbindungen zwischen den zwei Kolonnen (51,61) widerstehen zu können.
7. Struktur gemäß irgendeinem der vorhergehenden Ansprüche, in welcher eine der Teilverbindungen (31) einen vertikalen axialen Zapfen (33) aufweist, der drehbar in einem vertikalen axialen Rohr (23) der anderen Teilverbindung angeordnet ist.
8. Struktur gemäß Anspruch 7, in welcher die erste und die zweite der Teilverbindungen jeweils das Rohr und den Zapfen aufweisen, wobei sich der Zapfen (33) nach unten in das Rohr (23) erstreckt.
9. Struktur gemäß irgendeinem der vorhergehenden Ansprüche, in welcher die metallische Verbindung lasttragend ist.

10. Struktur gemäß Anspruch 9, in welcher ein Zwischenraum zwischen den beiden Kolonnen vorgesehen ist, wobei die gesamte Belastung durch die metallische Verbindung hindurch weitergeleitet wird.

11. Struktur gemäß irgendeinem der vorhergehenden Ansprüche, in welcher die metallische Verbindung die Ausrichtung der beiden Kolonnen aufrecht erhält auf Grund der engen Toleranzen zwischen den zusammenpassenden Teilen der Verbindung.

12. Struktur gemäß irgendeinem der vorhergehenden Ansprüche, in welcher das zuletzt erwähnte aus einer Metallplatte bestehende Element (21) im Wesentlichen bündig ist mit der oberen Oberfläche des besagten einen Bodens (56).

20 Revendications

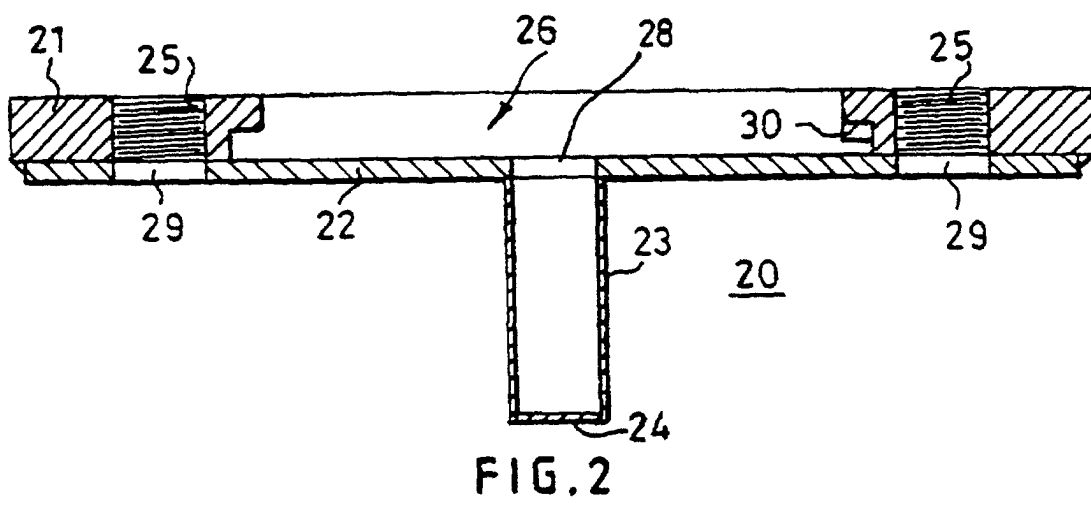
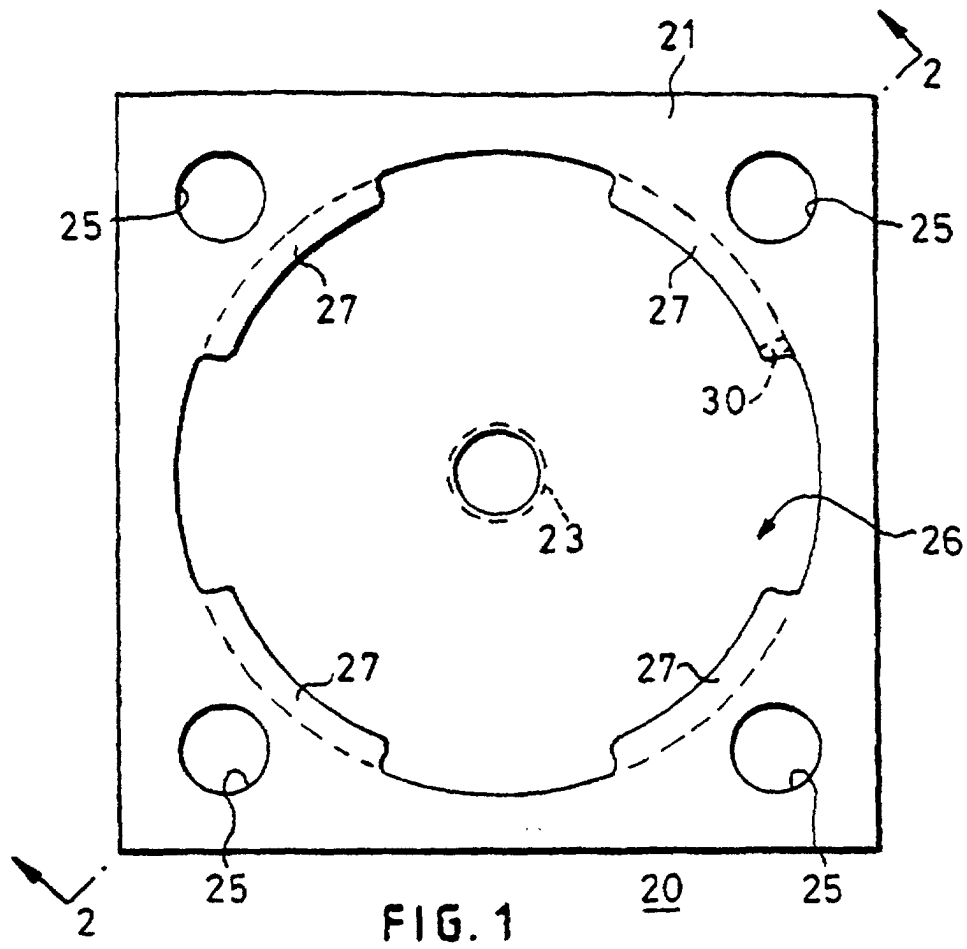
1. Structure en béton, comprenant des colonnes de béton renforcées et des planchers en béton (56); des paires desdites colonnes (50, 60) étant agencées l'une directement au-dessus de l'autre; chacun desdits planchers étant agencé, au-dessus du niveau du sol, au niveau de la jonction entre les extrémités adjacentes de chaque dite paire de colonnes; chaque dite paire de colonnes étant composée de béton préfabriqué, les paires étant reliées par l'intermédiaire d'un joint métallique comprenant des premier (20) et deuxième (31) joints partiels; lesdits premier et deuxième joints partiels étant respectivement ancrés de manière rigide dans ou sur l'extrémité supérieure de la colonne inférieure (50) et l'extrémité inférieure de la colonne supérieure (60) de chaque dite paire de colonnes, par l'intermédiaire d'éléments d'ancrage desdits deux joints partiels ancrant les deux joints partiels dans les extrémités respectives des deux colonnes par encastrement dans le béton préfabriqué correspondant; les extrémités adjacentes (55, 75) de chaque dite paire de colonnes étant espacées et un desdits planchers en béton respectifs remplissant pratiquement l'espace entre les extrémités adjacentes de chaque dite paire de colonnes; lesdits premier et deuxième joints partiels étant reliés de manière rigide, la paire de colonnes étant ainsi reliée de manière rigide; les deux joints partiels comprenant chacun un élément de plaque métallique respectif (21, 32), s'étendant de manière pratiquement perpendiculaire à un axe central de la colonne associée, les deux éléments de plaque métallique étant ajustés l'un sur l'autre ou engagés l'un dans l'autre, les deux joints partiels pouvant être soumis à un verrouillage mutuel par l'intermédiaire d'une rotation relative correspondante autour des axes centraux des deux colonnes; **caractérisée en ce que** l'élément de

plaque métallique (21) dudit premier joint partiel est espacé au-dessus de l'extrémité supérieure de la colonne inférieure (50).

2. Structure selon la revendication 1, dans laquelle un élément de plaque métallique (21) a en général une forme annulaire, l'autre élément de plaque métallique (32) étant ajusté dans celui-ci. 5
3. Structure selon la revendication 2, dans laquelle les deux éléments de plaque métallique (21, 32) ont été fabriqués, avant l'utilisation, à partir de la même pièce de métal en plaque, ledit un élément de plaque métallique étant découpé de l'intérieur de l'autre élément de plaque métallique. 10 15
4. Structure selon les revendications 2 ou 3, dans laquelle l'élément de plaque métallique de forme annulaire (21) constitue l'élément de plaque métallique dudit premier joint partiel (20). 20
5. Structure selon les revendications 2, 3 ou 4, dans laquelle l'élément de plaque métallique de forme annulaire (21) est renforcé par une plaque de renforcement (22), renforcée pour sa part par le béton (56), l'autre élément de plaque métallique (31) reposant contre la plaque de renforcement. 25
6. Structure selon l'une quelconque des revendications 2 à 5, dans laquelle des moulures, des pattes ou des brides (27) d'un élément de plaque métallique peuvent s'engager dans des moulures, des pattes ou des brides (34) de l'autre élément de plaque métallique pour résister aux forces de tension et/ou aux couples de flexion au niveau de la liaison des deux colonnes (51, 61). 30 35
7. Structure selon l'une quelconque des revendications précédentes, dans laquelle un dit joint partiel (31) comprend une goupille axiale verticale (33) agencée par rotation dans un tube axial vertical (23) de l'autre dit joint partiel. 40
8. Structure selon la revendication 7, dans laquelle lesdits premier et deuxième joints partiels comprennent respectivement le tube et la goupille, la goupille (33) débordant vers le bas dans le tube (23). 45
9. Structure selon l'une quelconque des revendications précédentes, dans laquelle le joint métallique est un élément de support de charge. 50
10. Structure selon la revendication 9, dans laquelle un dégagement est établi entre les deux colonnes, l'ensemble de la charge étant transmis à travers le joint métallique. 55
11. Structure selon l'une quelconque des revendica-

tions précédentes, dans laquelle le joint métallique maintient l'alignement des deux colonnes par l'intermédiaire de tolérances étroites entre les éléments d'accouplement du joint.

12. Structure selon l'une quelconque des revendications précédentes, dans laquelle le dernier élément de plaque métallique (21) affleure pratiquement la surface supérieure dudit un plancher (56).



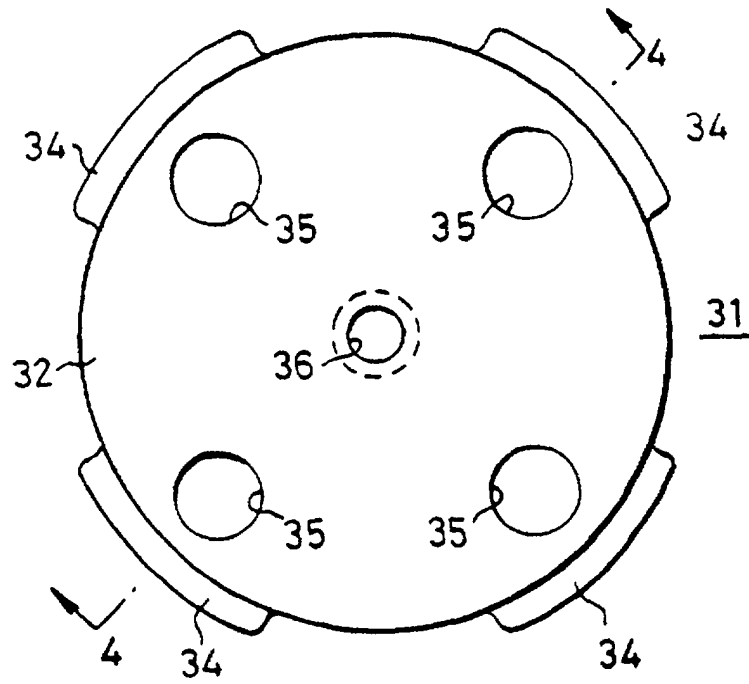


FIG. 3

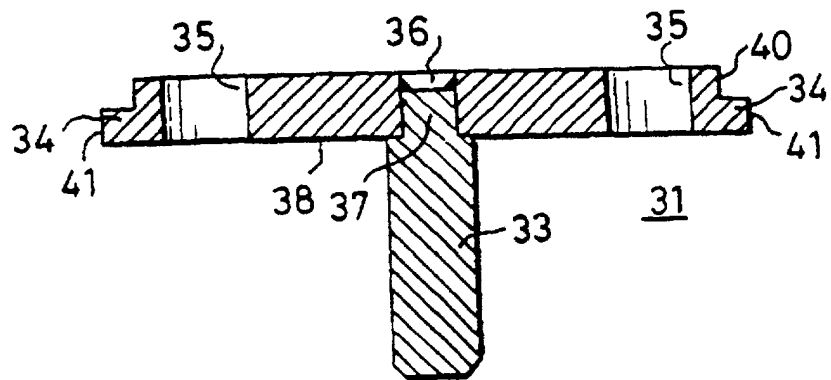


FIG. 4

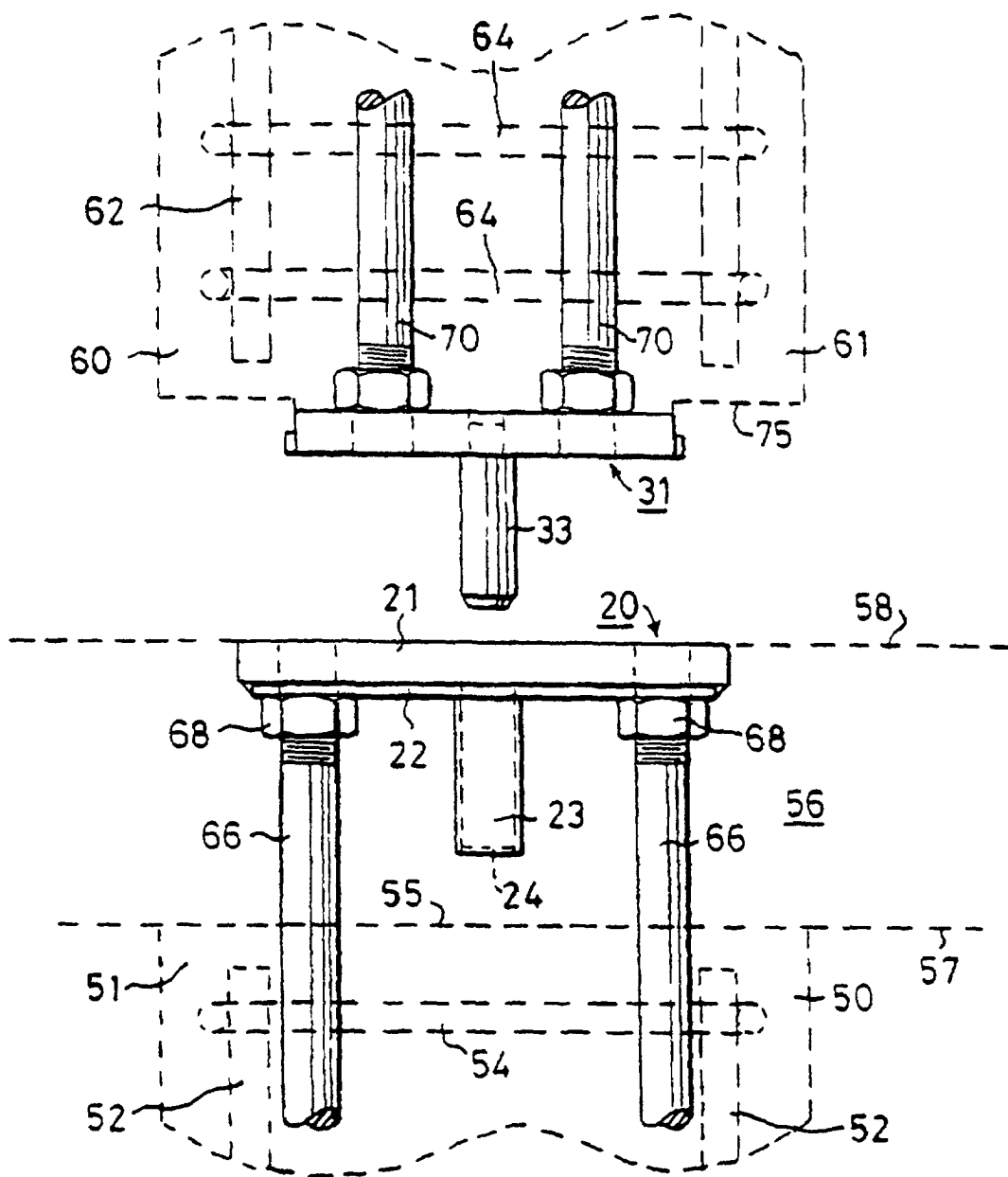


FIG.5

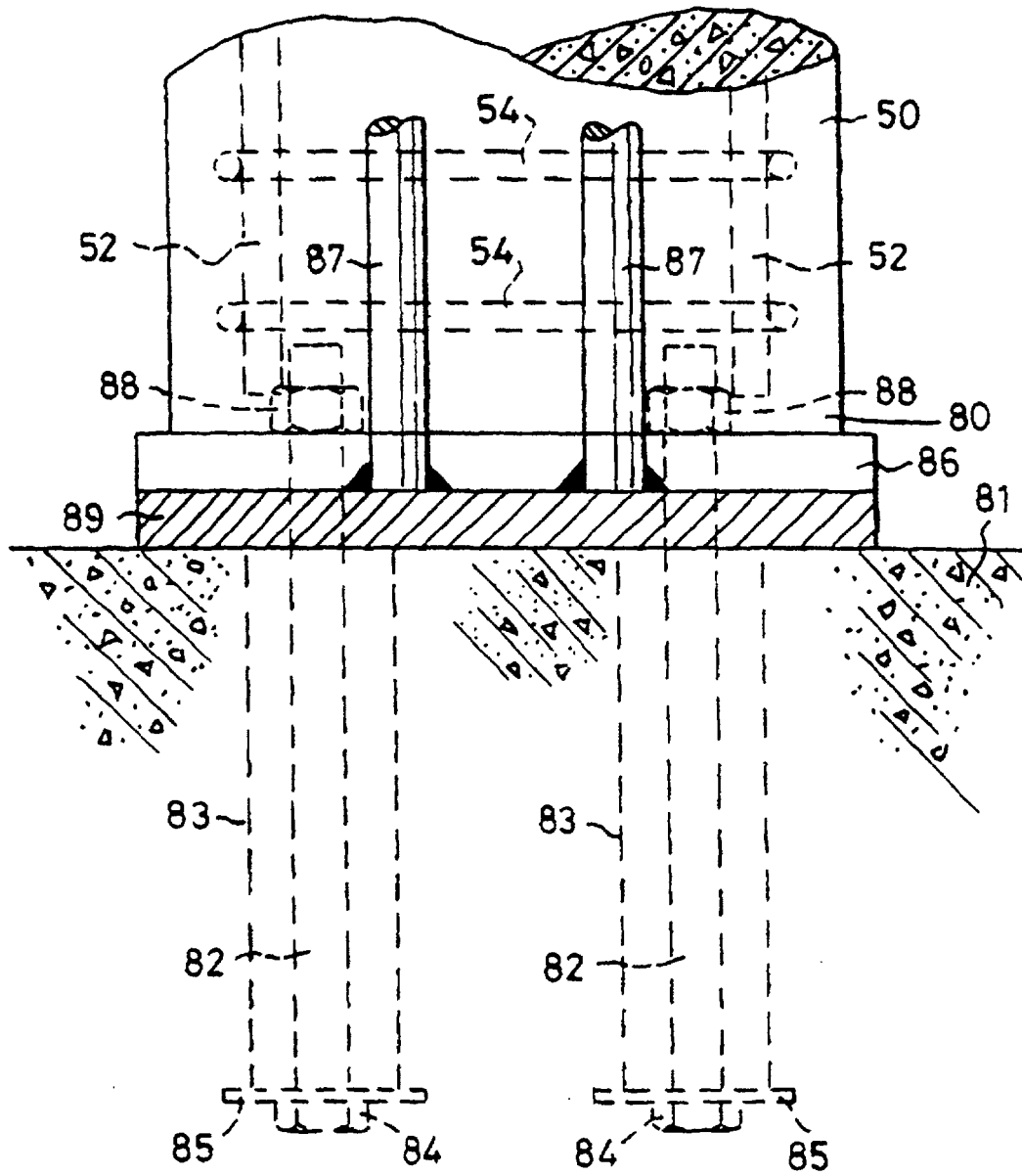


FIG. 6

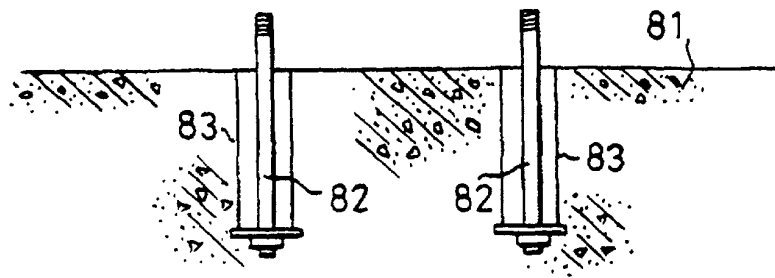


FIG. 7

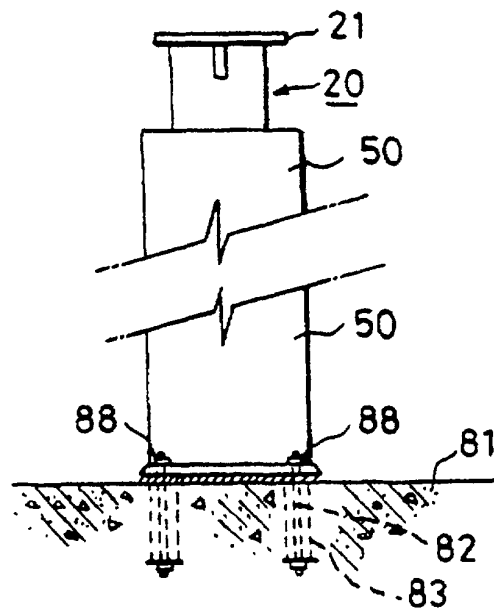


FIG. 8

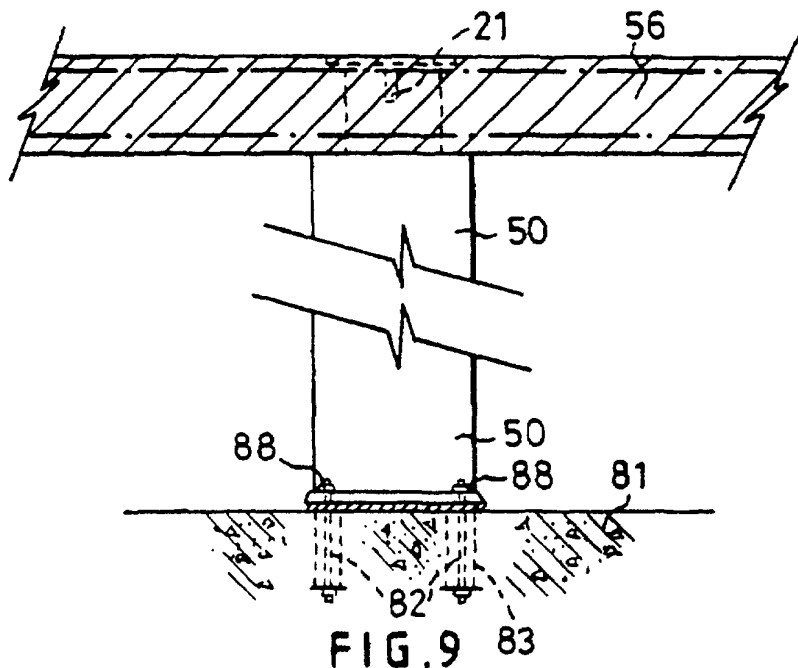


FIG. 9

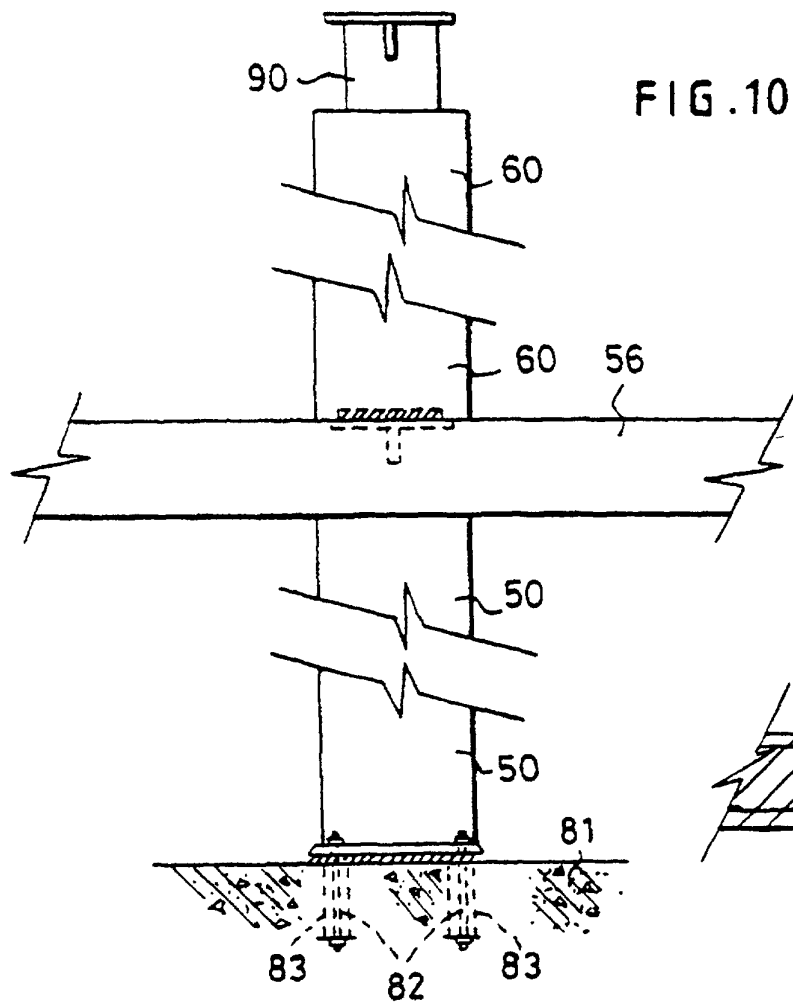
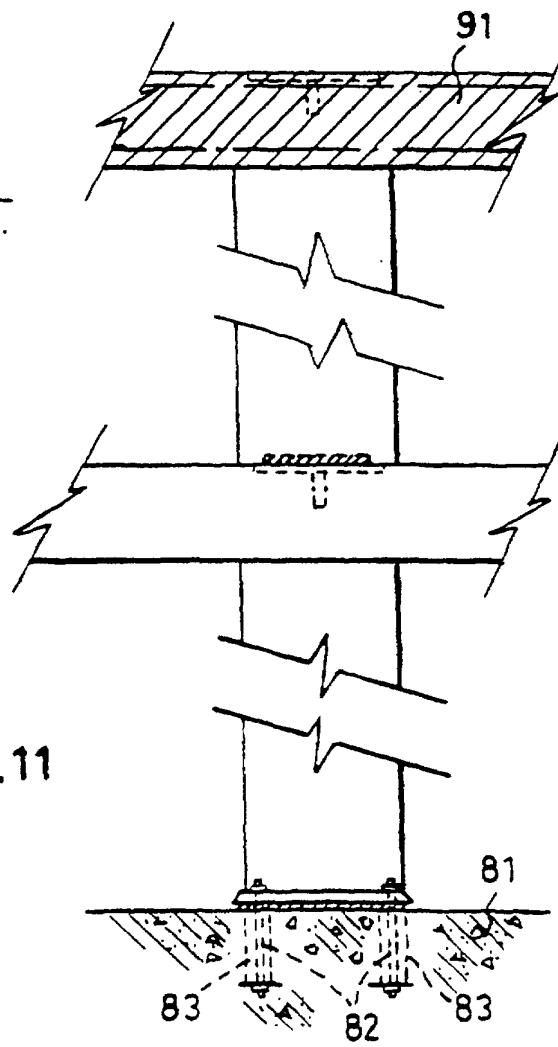


FIG. 11



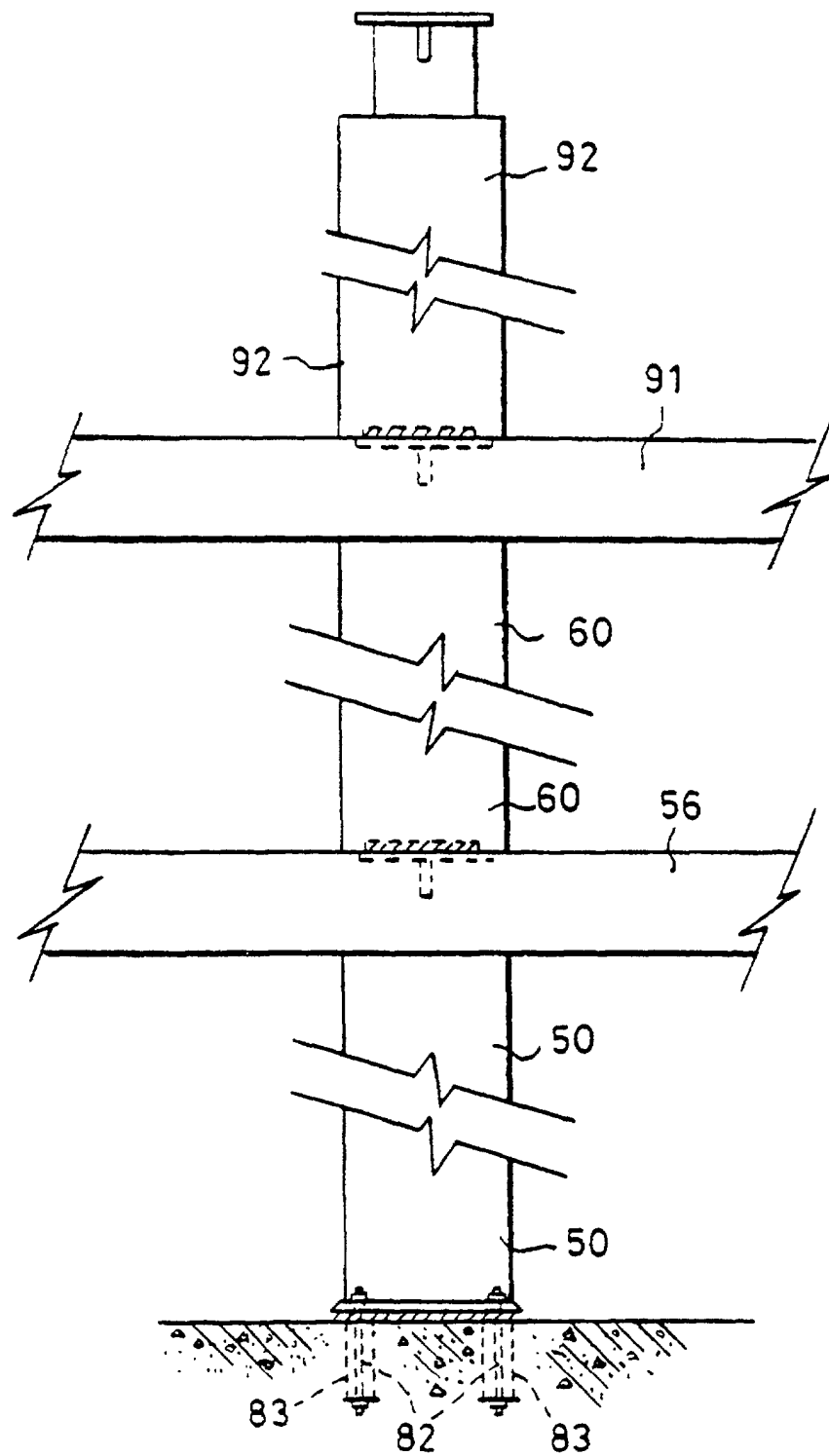


FIG. 12



FIG. 13A

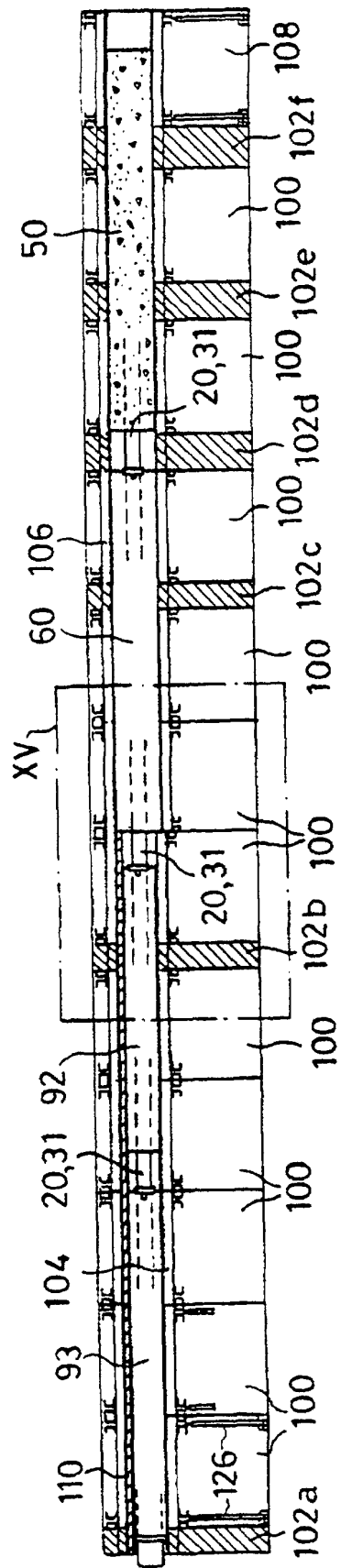


FIG. 13

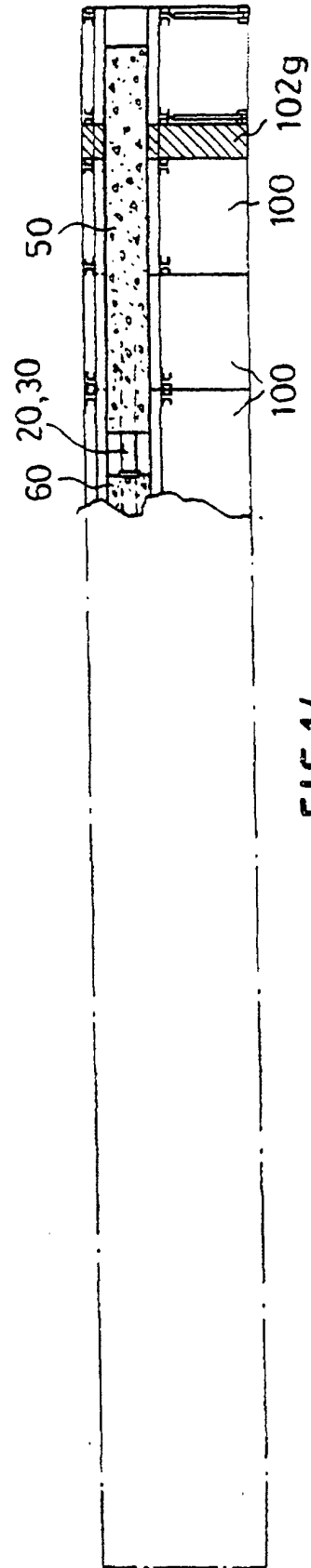


FIG. 14

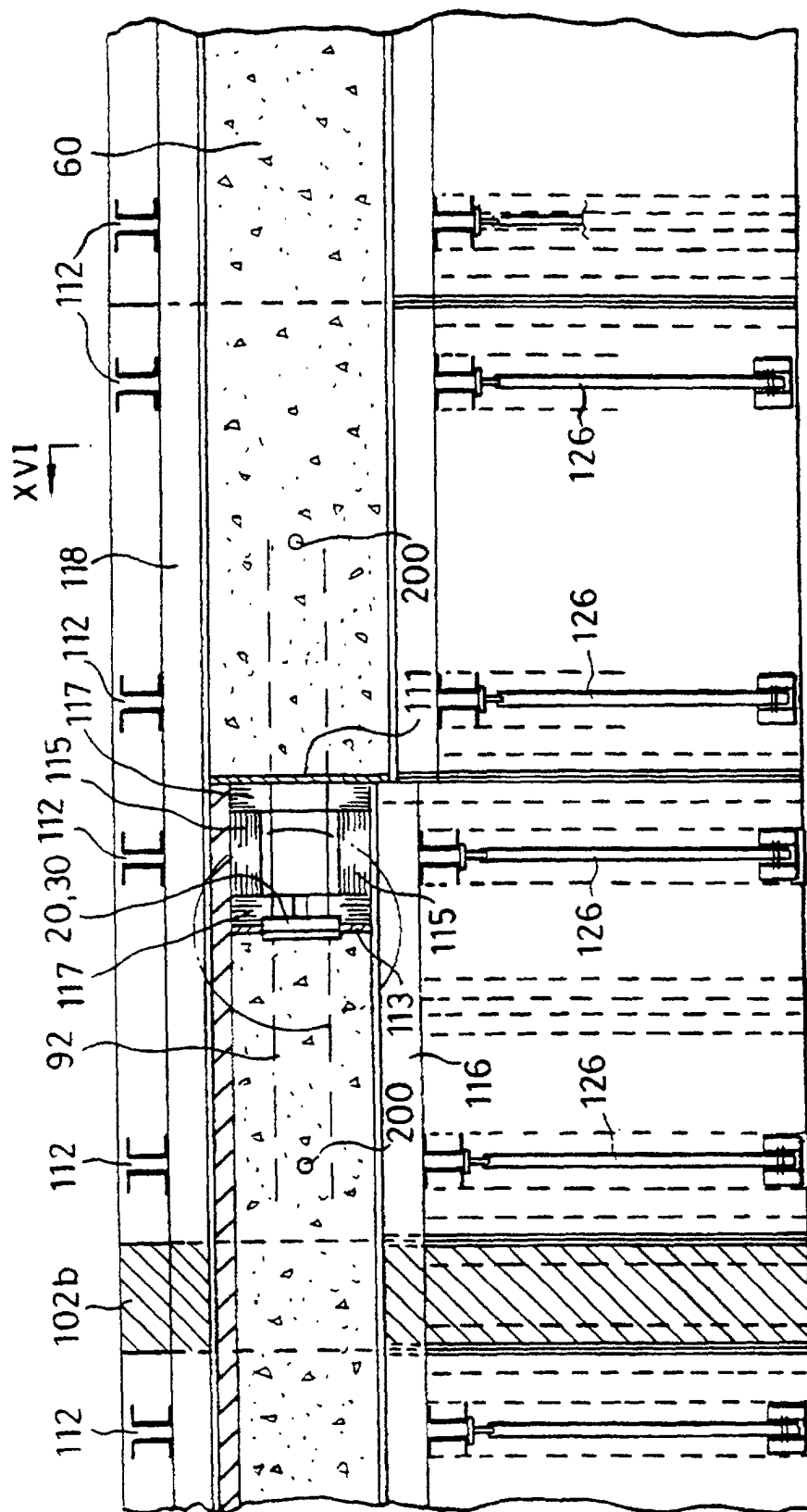
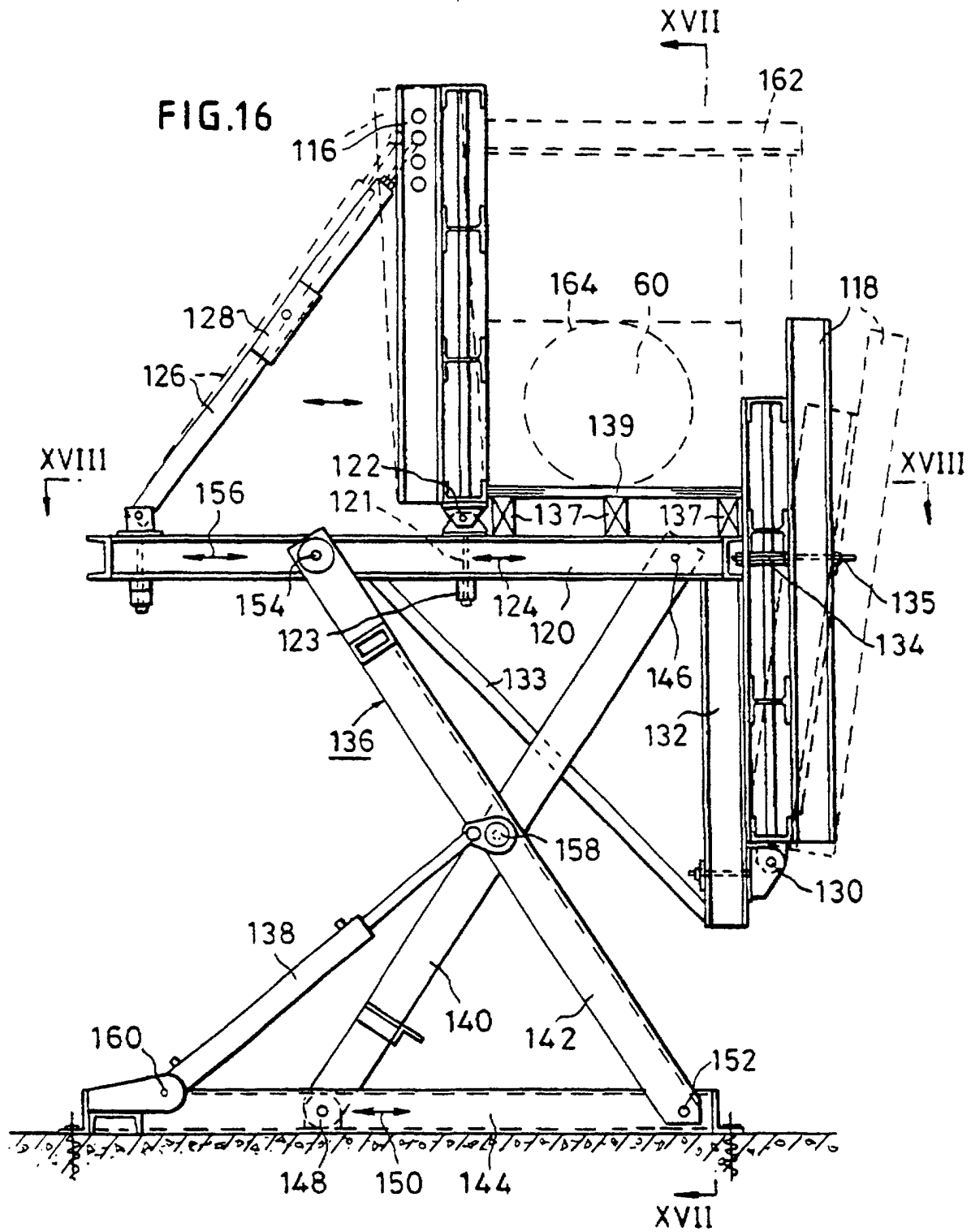
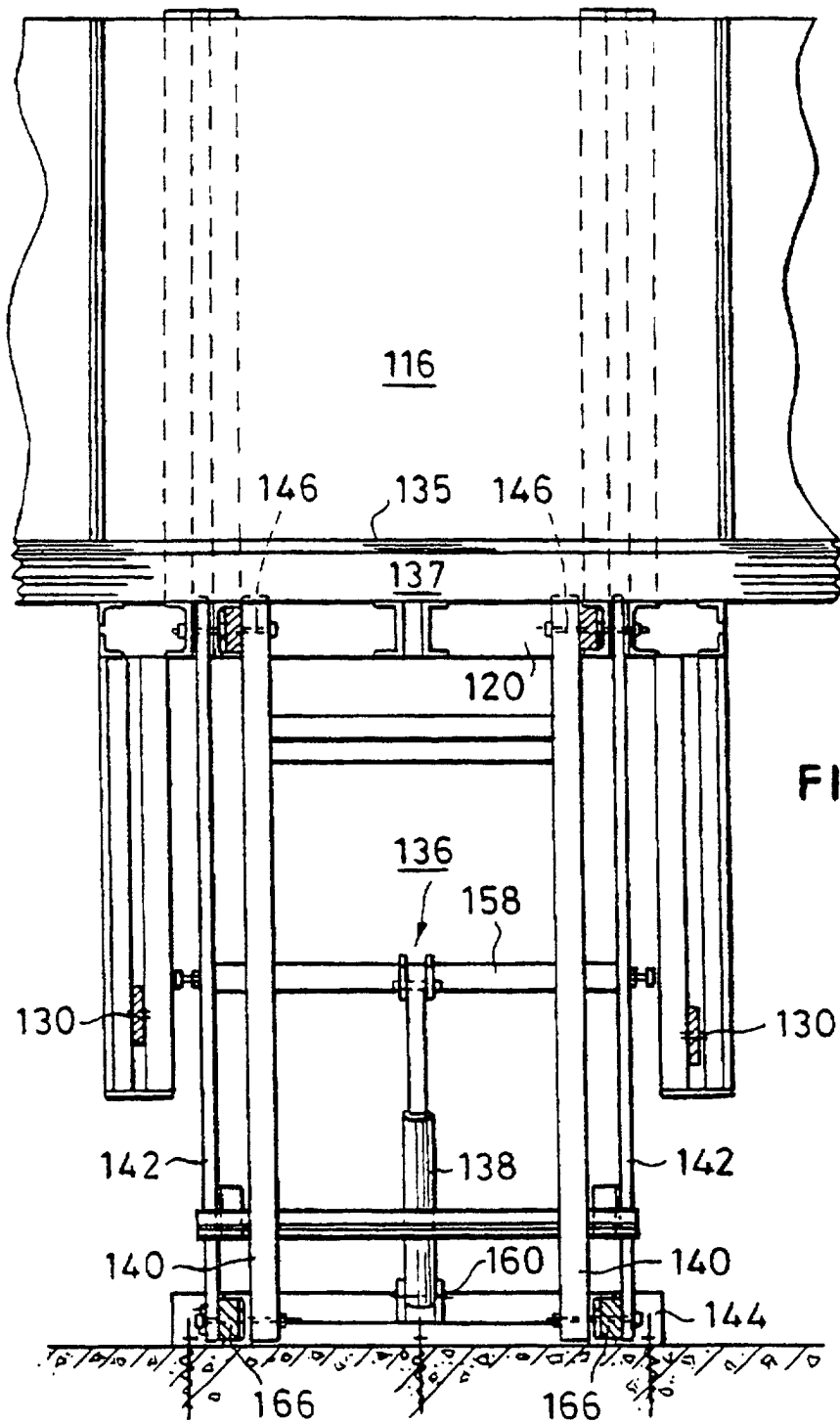


FIG.15





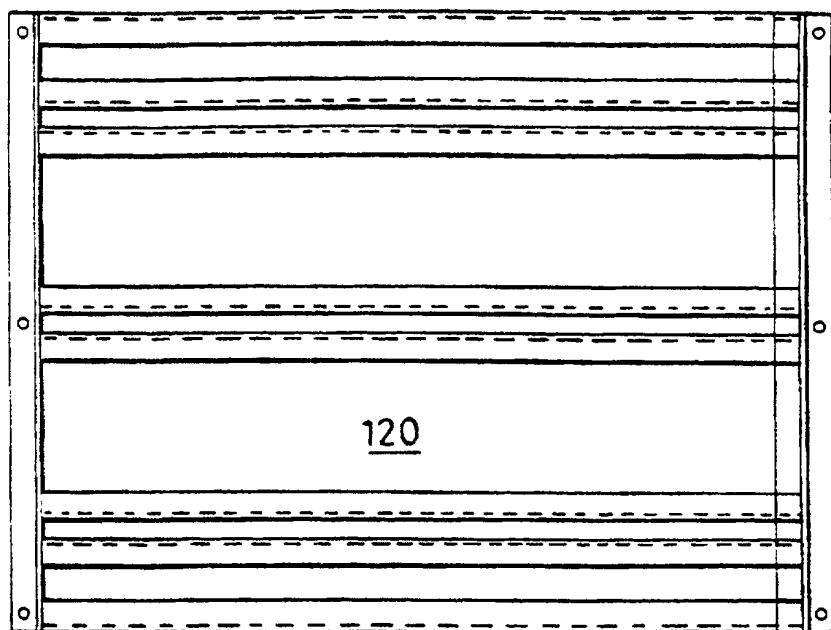


FIG. 18

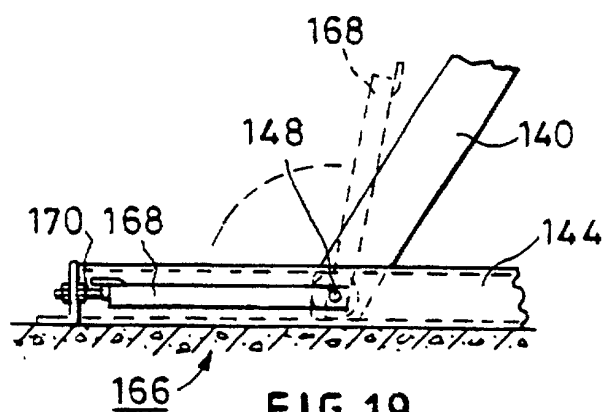


FIG. 19

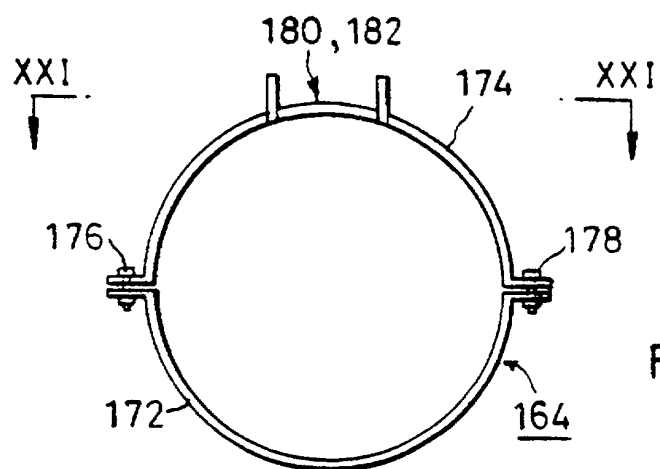


FIG. 20

