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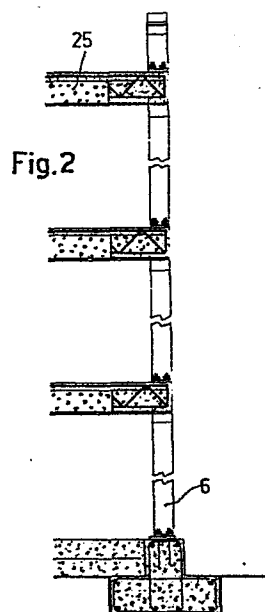
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54 **Aselsmatic building structure and method of erecting it.**

57 A modular building structure is based on a foundation comprising a framework of reinforced concrete beams crossing at right angles, the beams having all the same inverted "T" cross section and extending under all the building walls either perimetrical or interior.

Steel columns (6) are mounted at regular intervals along the foundation, which columns (6) are formed by segments of a structural shape or section iron preferably with double "T" section which have all the same length equal to the distance between two subsequent floors of the building. The building floors comprise a framework made of structural shapes connecting the columns (6) to one another and of reinforced concrete beams connected to said structural shapes. Filling blocks are inserted between the last named beams as insulating means and forms for concrete casting.



The object of this invention are an aseismatic building structure and a method of erecting it.

The sparing of labor, the erection rapidity and the strength of the building structure in particular with respect to the seismic shock being the main aims of the invention, the building structure of this invention comprises essentially prefabricated steel components which are mechanically connected to one another on the spot. Subsequent to such mechanical connection some of the steel members are buried into concrete to form reinforced concrete structures.

The sparing of labor and rapidity of erection are attained by a large use of prefabricated steel elements, by the total use of non reusable molds or forms and by eliminating any need for welding work on the spot. The capability of withstanding the earthquakes is obtained by distributing the building strength uniformly over its entire structure that is by making a structure comprising a number of moderately strong elements uniformly distributed over the whole building, including the perimetral and the interior walls and by founding the building on a monolithic frame.

The invention will be better understood from the following description and attached drawings which illustrate a preferred embodiment given by way of example. In the drawings:

Fig. 1 shows a perspective view of the foundation frame according to the invention;

Fig. 1A shows a cross section of the inverted-T foundation frame of fig. 1;

Fig. 2 shows a side view of a column of the building according to the invention and a sectioned portion of the floor and foundation connected thereto;

Fig. 3 shows a perspective view of the foot and head of a pillar section;

Fig. 4 shows an exploded view of a beam of the foundation frame and of the means for connecting the wall columns to said frame beam;

Fig. 5 shows a cross-section of a typical floor structure of the building according to the invention taken along a plane perpendicular to the floor beams;

Fig. 6 shows an elevation view of the top end section of an inner wall column and portions of the related structural shapes on which the ends of the floor beams are supported;

Fig. 6A shows a cross-section along line VI-VI of fig. 6;

Fig. 6B shows an enlarged cross-section along line VI'-VI' of fig. 6;

Fig. 7 shows a perspective view of a segment of the reinforcing structure of a floor beam along with the "L" structural shape extending from a column of a

perimetrical wall;

Fig. 8 shows a perspective view of the means for anchoring the "Pernervometal" grid to the lower rods of the floor beams according to a first embodiment thereof;

- 5 Fig. 8A shows a perspective view of a means for anchoring the "Pernervometal" grid to the lower reinforcing rods of a floor beam according to a second embodiment thereof;

Fig. 8B shows the means of fig. 8A as seen along a direction parallel to the building floor and perpendicular to the floor beam;

- 10 Fig. 8C shows the means of fig. 8A as seen in the direction of the reinforcing bar;

Fig. 9 shows a perspective view of the means for anchoring the "Pernervometal" grid to the wall columns of the building structure of the invention.

Fig. 10 shows a portion of Pernervometal grid with an enlarged detail of a smaller rib;

- 15 Fig. 10A shows another portion of the same grid of Fig. 10 with an enlarged detail of a strong rib as seen from the opposite face of the same figure;

Fig. 11 shows a detail of the terrace roof parapet of the building with the related waterproofing material layer;

- 20 Fig. 12 shows the use of twinned columns for realizing wider opening through the building walls.

With reference to the drawings (figs. 1, 1A) the foundation of the building comprises a continuous network of reinforced concrete beams intercrossing at right angles and having uniform inverted "T" cross-section, on which the building walls either perimetral or interior are supported.

- 25 The beam flange is sunk into the ground while the beam stem 2" projects therefrom.

- According to a feature of the invention a substantially square plate 3 (fig. 4) is provided at each location along the upper surface of beam 2, where a column or vertical member of the building structure is to be connected to the foundation beam.

- 30 Four vertical dowels 4 are welded to each plate 3 which have hooked lower ends and threaded upper ends for anchoring plate 3 onto the concrete beam 2. Two strips or rods 10 (fig. 4) are welded along the sides of a range of plates 3 parallel to beam 2 for keeping the plates at constant intervals from one another and coplanar with one another. The lower portions of dowels 4 are buried into the beam enough deep to bring plates 3 to abut against the beam stem 2".

The building structural columns 6 to be mounted on plates 3 have each a plate 7 welded on their lower end which is provided with four holes 8' adapted to

fit on the corresponding four dowels 4 of plate 3. Thus column 6 can be firmly anchored to beam 3 by simply tightening four nuts.

Each column length or segment is provided at its upper end, that is the end opposite to plate 8, with another plate 12 from which four stud bolts 12' project which are positioned to register with holes 8' of another column segment to be mounted, if so required, on top of it.

Plate 12 is at the level of the upper surface of a building floor.

At a distance from one another equal to the floor thickness, two horizontal plates 14,14' are welded on column 6 to function as brackets for supporting the weight of the floor structure and the load imposed thereon.

Plates 14,14' are substantially square with a side length equal to the height of the web of the double "T" structural shape of column 6. They are fitted between the flanges of column 6 and welded in advance to the web and to the adjoining portions of said flanges and project therefrom for a length. An angled plate bracket 16 may also be welded to column 6 under each 14,14' for strengthening it.

The purpose of plates 14,14' is for connecting at each side of column 6 a segment of "L" structural shape or section iron 18 with unequal legs, when column 6 pertains to a perimetrical wall and a segment of inverted "T" structural shape 21' when column 6 pertains to an interior wall. The lengths of segments 18 and 21' are one half of the distance between the centerlines of two successive columns less one half of the width of the column flanges. Thus the edge of the segment connected to a column comes to abut against the segment connected to the successive column.

The height of the vertical leg of shape 18 is the same as the stem of shape 21' and equal to the thickness of the building floor. The width of the horizontal leg of shape 18 is about one half the flange width of shape 21', but it is enough large for bearing the end portions of the floor beams which rest upon it as will be better explained hereinafter.

As shown in fig. 3, shape 18 is connected to plate 14 by means of stud bolts 20, 20' which fit into holes 20a and 20'a of shape 18 (see fig. 7). As shown in fig 6 shape 21' is connected to plate 14 by means of stud bolts 13,13'. The vertical leg of the shape segment 18 abuts against the edge on one of the flanges of column 6.

The building floor of this invention comprises an array of parallel regularly spaced beams 22 made of reinforced concrete which are perpendicular to said structural shapes, 18, 21' on which their end sections are supported. With reference to fig. 7 the reinforcement of beam 22 comprises an upper "T" bar 24 and

two lower rods 26.

The upper bar 24 is connected to the lower rod 26 by means of two zig-zagging rods 23 to form a truss 22.

Each zig-zagging rod 23 at each of its upper bendings is welded to one side of the stem of T bar 24 and at each of its lower bendings is welded to one of the lower rods 26. The lower rods 26 are connected to one another by a short rod segment 23 welded at the same locations where the zig-zagging rods are welded to the lower rods 26, with the purpose of stiffening the reinforcing structure 22.

Truss 22 at its ends is provided with a plate 28 to which the ends of upper bar 24, lower rods 26 and zig-zagging rods 23 are welded. Plate 28, when the upper end section of truss 22 rests on the horizontal leg of shape 18, engages the surface of the vertical leg of the same shape and is fastened thereto by means of studs 29, 29', or by means of a vertical small plate welded on the horizontal leg of shape 18 at a distance from the vertical leg of the same shape equal to the thickness of plate 28. When the end section of truss 22 is laid down to rest on one of the half flanges of shape 21' plate 28 engages the stem of shape 21' and is fastened thereto by means (not shown) similar to those described for shape 18.

A steel grid 39 is fastened to the underside of the array of truss 22 which will function as a boxing bottom for casting the concrete in which the truss 22 will be embedded. A grid adapted for the above purpose is obtained by cutting, pressing and expanding a steel sheet and is sold under the trademark "PERNERVOMETAL" and will be described in detail hereinafter.

The space between two successive reinforcing trusses 22 is almost totally filled with blocks 31 of a polyurethane foam or a foam of any other material. In this way a mold is formed by grid 39 and the sides of blocks 31 wherein concrete mix can be poured to reach the level of the upper edge of shape 18 or, which is the same, of the upper edge of the stem of shape 21'.

The thickness of blocks 31 being less than the height of shapes 18 and 21', a layer of concrete will be laid over the blocks for attaining the level of the upper surface of the floor.

Subsequent to the construction of the first floor, the successive floors, if any, are constructed in the same fashion as the first one by mounting a second segment of column on top of each plate 12 of each segment of column of the first floor. The building roof in the embodiment herein illustrated is a terrace roof and in this case a shorter length of column is mounted on top of the column of the last story of the building, as a stiffening member of the terrace parapet. A waterproofing material will be laid as usual over the terrace floor.

When the supporting structure of the building is assembled as above, the build-

ding walls are constructed as follows. First a vertical grid is fastened to a row of columns 6 at the side thereof corresponding to one of the two surfaces of the wall to be constructed. The portions of the wall where the building doors and windows will be located are not covered, obviously, by said grid. This will be the same kind of grid as used for making the bottom of the boxing into which the concrete mix is poured for making beams 25. Then all the lines and cables of the water, heating and electricity systems are fitted into the spaces between the building columns. The remaining voids between every two columns are then filled with panels of polyurethane foam. A second grid will then be fastened on the other side of the row of columns still leaving free the window and door spaces.

A concrete mix will then be sprayed on all the grid surface at both sides of the intended wall for building a layer thereon which will be thicker on the outside surfaces of the building than on the inside ones.

Preferably a mix of 400 Kg of portland cement and one cubic meter of sand is sprayed on said grid to obtain a layer from 2 to 4 cm thick.

When the distance between two successive columns is to be increased with respect to the standard, for providing for instance a larger aperture in a wall, then two columns are erected side by side as shown in fig. 12. The two columns of each pair are standard columns which are connected to one another at mid height thereof by a C shape crosspiece 40. Such paired columns are erected to extend from the foundation to the top of the building at a distance from one another which is 1.5 the standard distance between two successive columns whereby the distance between each of said paired columns and the next standard column will be reduced to $\frac{3}{4}$ the standard distance.

With reference to figs. 10, 10A, the "Pernervometal" grid 39 will now be described which is used according to this invention, as a bottom boxing for casting beams 25 and as a lathing for plastering the building walls. Grid 39 is obtained by cutting, pressing and expanding a steel sheet. The resulting grid 39' comprises parallel rows of romboidal meshes which are defined by thin strips 37 of metal sheet. A strong rib 33 is provided every four rows of meshes which is formed by a ripple of the metal sheet. A smaller rib 35 separates a pair of said four rows of meshes 39' from the other pair.

In an illustrative example the spacing of ribs 33 is 10 cm and one rib 35 is at mid distance between two successive ribs 33.

The dimensions of meshes 39' are such that when the concrete mortar is cast or sprayed on one side of the grid, most of the mortar is retained thereon and only a small amount of it surpasses the grid and subsequently sets on the other side thereof.

With reference to fig. 8, a means is therein illustrated for fastening grid 39 to the lower rods 26 of the reinforcing truss 22. Such means, according to a first embodiment thereof, comprises a plurality of clips 32 made of steel wire. More specifically, a steel wire comprising a straight segment 32', long about on half the distance between said two lower rods, is provided at each end of it with a hook lying in a plane perpendicular to the straight segment of the clip. One hook 32' is large enough to encircle rib 33 of grid 39 and is connected to straight segment 32' by a round bend adapted for mating the surface of rod 26 when the crest of rib 33 is contacting it. The other hook 32'' is similar to hook 32' but much smaller; it is just large enough to engage one of the lower edges of rib 33 by passing through the grid mesh nearest thereto. When grid 39 is to be fastened on the lower side of truss 22, the crests of ribs 39 are brought to engage rods 26 of the truss crosswise thereto. The larger hook 32' is inserted through a grid mesh nearest to the crossing of rib 33 and rod 26 so as to engage the bottom and sides of rib 33 and the clip portion which connects hook 32' to segment 32'' is seated on top of rod 26.

By flexing segment 32' against its elastic reaction, hook 32'' is inserted through a grid mesh and brought to engage one side edge of rib 33.

Another clip 32 is used for binding the same rib 33 as above described to the other rod 26 of the same truss 22, the straight segment 32' of the second clip being disposed in a direction opposite to the first clip.

With reference to figs. 8A, 8B, 8C, an alternative means is therein illustrated for fastening grid 39 to the lower rods 26 of truss 22. It comprises a clip 40 obtained from a steel sheet by punching and stamping. Clip 40 is in the form of a stirrup which has a center section 44 curved round for mating the cylindrical surface of rod 26. From portion 44 two arms 42 extend which terminate each with a hook 42', a space being left between said arms for receiving rib 33 therein. The clip arms are twisted through a 90 deg angle, so that hooks 42' are facing each other.

At the other end of the stirrup opposite to arms 42, a tongue 46 is provided which is folded flat over the terminal portion of said round section 44 and extends therefrom tangentially to rod 26. Tongue 45 serves as a grasping means for applying clip 40 in position. In fact, for placing clips 4 in position, the two hooks 42' are driven each through respective meshes of grid 39 the nearest possible to rib 33 and rod 26 and brought to engage the lower edges of the same rib. Then by grasping tongue 46 and pulling it against the elastic reaction of the clip and grid, the round section 44 of the clip is forced to surmount rod 26 and sit firmly thereon.

With reference to fig. 9, a means is illustrated therein for fastening grid 39 to the building columns and specifically to the flanges of the double "T" shapes of which they are formed. Such means comprises a bridgelike clamp 50 having a rectangular flat deck 52 and four strips or legs 54 perpendicular thereto extending
 5 each from a corner of deck 52 with a first segment 54' perpendicular to the clamp deck, a second shorter segment 54'' perpendicular to the first one and a third segment 54''' which forms an angle of 60 deg with the second one. The length of segment 54' is equal to the thickness of flange 6' of the column shape 6 plus the height of rib 33.

- 10 Deck 52 is provided with a window 52' for making it lighter and more easily handeable. The use of clamp 50 is as follows. Grid 39 is first laid on the surface of flange 6' of shape 6 so that the rib crests engage the same. Then clamp 50 is placed astride of rib 33 and the four ends of legs 54 are inserted each through a
 15 mesh 39' of grid 39 near to the edge of flange 6'. Clamp 50 is then forced against the elastic reaction of grid 39, towards the flange until this is surpassed by segment 54''. Leg 54 snaps then to engage the edge and underside of flange 6' whereby the grid is fastened to column 6.

EXAMPLE

The following specification of a three story building according to this invention
 20 is given by way of example.

Total height above ground	9.50 m
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a) Foundation:

Dimension of the inverted "T" beam

flange width	0.60 m
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25 flange thickness	0.20 m
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height of stem	0.20 m
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width of stem	0.20 m
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b) Walls

Column cross- section	0.05 x 0.10 m
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30 Column spacing	1.00 m
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c) Floor

"L" shape (18) cross section	0.07 x 0.10 x floor thickness
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for perimetrical walls	0.95 m long
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Cross section of the inverted T

35 shape for inner walls	0.14 x 0.20 x floor thickness
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0.95 m long

d) Reinforced concrete beam

"T" bar (24)	0.03 x 0.03 m
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	Lower rod (26) dia	0.01 m
	Average span	4.00 m
	Beam spacing	0.50 m
	Beam width	0.08 m
5	e) Wall plastering	
	Concrete mix:	
	400 Kg cement per	
	cu m of mortar.	
	Outer surface of building	
10	plastering thickness	4 cm
	Inner surface of building	
	plastering thickness	2 cm

What is claim is

1. A steel and reinforced concrete building structure characterized by comprising a foundation made of a single piece flat framework with polygonal perimeter made of beams at right angles to each other and two ranges of parallel beams intersecting each other within said perimeter, said beams being-made of reinforced concrete and having an inverted T cross-section of the same shape and size throughout the framework, said framework extending under all the building walls, a plurality of columns made of double "T" structural shape which are spaced at constant distances along the inner and outer walls of the building, which columns are made up of as many segments as the stories of the building and are connected to one another at the respective ends by bolts, the lower end of the lowest segment of each column being anchored to said foundation framework; each of said column segments being provided at its upper end with a horizontal plate for connecting it to the superincumbent column segment, by means of studs and with a bracket welded to the web of the column double T shape and to the inner sides of the flanges of the same shape at a distance from said plate equal to the thickness of the story floor for supporting two structural shapes which are affixed thereto to project from either side of the column for half the distance between two successive columns, an array of regularly spaced reinforced concrete beams with rectangular cross-section being connected to said structural shapes.
2. A building structure as per claim 1, wherein the structural shapes projecting from said columns comprise a structural L shape with unequal legs when an outer wall of the building is concerned, the vertical leg of said "L" shape having a height equal to the floor thickness and being positioned flush with the outer flange of said column and the width of the horizontal leg being equal to the web height of the double T shape of which said columns are made and being bolted at one end thereof onto said bracket, while when an inner wall of the building is concerned the structural shapes projecting from said columns comprise an inverted "T" shape with the T stem higher than the T flange, which shape is connected to said

column with its stem parallel to the column flanges and at mid way therebetween, the flange width of said "T" shape being about twice the height of the column double T shape, said flange being bolted onto a plate similar to the plate on which the "L" shapes are supported which pertain to the outer walls of the building.

3. A building structure as claimed in claim 2, wherein said horizontal reinforced concrete beams with rectangular cross-section comprise a steel truss buried in concrete, said truss comprising an upper T shape steel bar and two lower steel rods which bar and rods are disposed at the corners of a triangular prism the upper bar being connected to the lower rods by two zig-zagging rods, which are welded to said bar at each of their upper bendings and each of them to one of the lower rods at each of its lower bendings, the elements of said truss being welded at their ends to a plate which is bolted on the vertical leg of said structural L shape connected to said column and projecting therefrom, said steel truss being totally buried into concrete.
4. A building structure as claimed in claim 1, wherein the spacing of the floor beams of said array is half the distance between two successive columns
5. A building structure as claimed in claims 3,4 wherein a range of plastic foam blocks are fitted between two successive beams of said array as an insulating means and for forming the mold wherein the concrete mix is poured for burying the beam reinforced truss in it.
6. A building structure as claimed in claim 5, wherein said plastic foam is a polyurethane foam.
7. A building structure as claimed in claim 5, wherein said plastic foam is polystyrene foam.
8. A building structure as claimed in claim 3,5 wherein a steel sheet grid is affixed to the lower rods of the reinforcing truss of said beams as a means for retaining the concrete mix when this is poured between said plastic foam blocks.
9. A building structure as claimed in claim 6, wherein said steel sheet grid is a "Pernervometal" grid.
10. A building structure as claimed in claims 6 and 9, wherein said grid is fastened to the lower rods of the reinforcing truss of said beams by means of a plurality of clips each comprising a straight flexible element of steel wire long about one half the distance between said lower rods and provided at one end thereof with a hook large enough for encircling a rib of which said grid is provided and one of said rods, and at the other end with a smaller hook adapted for engaging an edge of which said rib is provided.
11. A building structure as claimed in claims 6 and 9, wherein said grid is fastened to the lower rods of the reinforcing truss of said beams by means of a plurality

of clips made of steel sheet and having the form of a stirrup with a center section curved round for mating the cylindrical surface of said rod and with two arms with hooked ends for engaging the edges of the rib of which said grid is provided, said clip being further provided with a tongue as a grasping means for applying said clip in position.

12. A building structure as claimed in claims 5 and 6, wherein the space defined by two successive ranges of plastic foam blocks and by said grid is filled with concrete and a layer of concrete is laid also on top of said blocks and of said reinforced truss the thickness of said layer being about $1/4$ the total thickness of the floor constructed thereby.
13. A building structure as claimed in claim 1, wherein a Pernervometal grid is fastened on both the surfaces of all the building walls and said grid is embedded in a concrete layer of which the thickness is greater in the case of an outer surface of the building than in the case of an inner surface of the building.
14. A building structure as claimed in claim 10, wherein said grid is fastened to the flanges of said columns by means of a plurality of bridgelike clamps comprising a rectangular flat deck enough large for being mounted astride of the column flange and four strips extending at right angles from the four corners of said deck each strip comprising a first segment whose length is equal to the thickness of said flange plus the height of a grid rib, a second segment perpendicular to the first one and directed towards the web of the column shape and a third segment which forms an angle of 60 deg. with the second one.
15. A building structure as claimed in claim 1, wherein the thickness of the concrete layer in which said grid fastened to the building column is buried is 4 cm in the case of an outer surface of the building and 2 cm in the case of an inner wall surface.
16. A building structure as claimed in claim 1, wherein at those locations of the wall building where a larger aperture is to be provided its width is one and a half times the standard distance between two of said columns and the jambs by which the aperture is defined are made each of two double T shapes identical to the shapes of the standard column which are connected to one another by a C-shape cross piece at mid height thereof.
17. A method for constructing a building as claimed in the preceding claims which comprises the following steps:
 - grading the ground where the building is to be erected and digging the foundation ditch with a depth at least equal to the thickness of the beam flange of said foundation framework;
 - fitting the reinforcing structure of said beam into said ditch;

pouring concrete mix to fill said ditch;
casting the stem of the foundation beam and embedding therein the dowels and plates for anchoring the building columns to the foundation;
erecting the wall columns of the first story;
mounting the structural shapes projecting from either side of each column;
mounting on said projecting shapes the reinforcing trusses of said floor beams;
fastening said Pernervometal grid to the bottom ribs of said trusses;
fitting the plastic foam blocks between the floor beams;
pouring concrete mix between said blocks and on top of them and of the reinforcing trusses up to the intended level of the floor surface;
building the successive stories as the first one;
applying on a first one of the surface of all the building walls the Pernervometal grid leaving free the areas of the intended apertures such as doors and windows;
fitting into the spaces between two successive columns of the building walls where said grid has been applied all the pipes, lines and cables of the water, heating and electricity systems and filling the remaining voids with plastic foam blocks;
covering with Pernervometal grid the second face of the building walls at the areas where the first face has been already covered with grid:
spraying a concrete mix on all the grid covered areas of the wall surfaces;
spraying a concrete mix on the grid surface fastened to the bottom of all the building floors.

Fig. 1

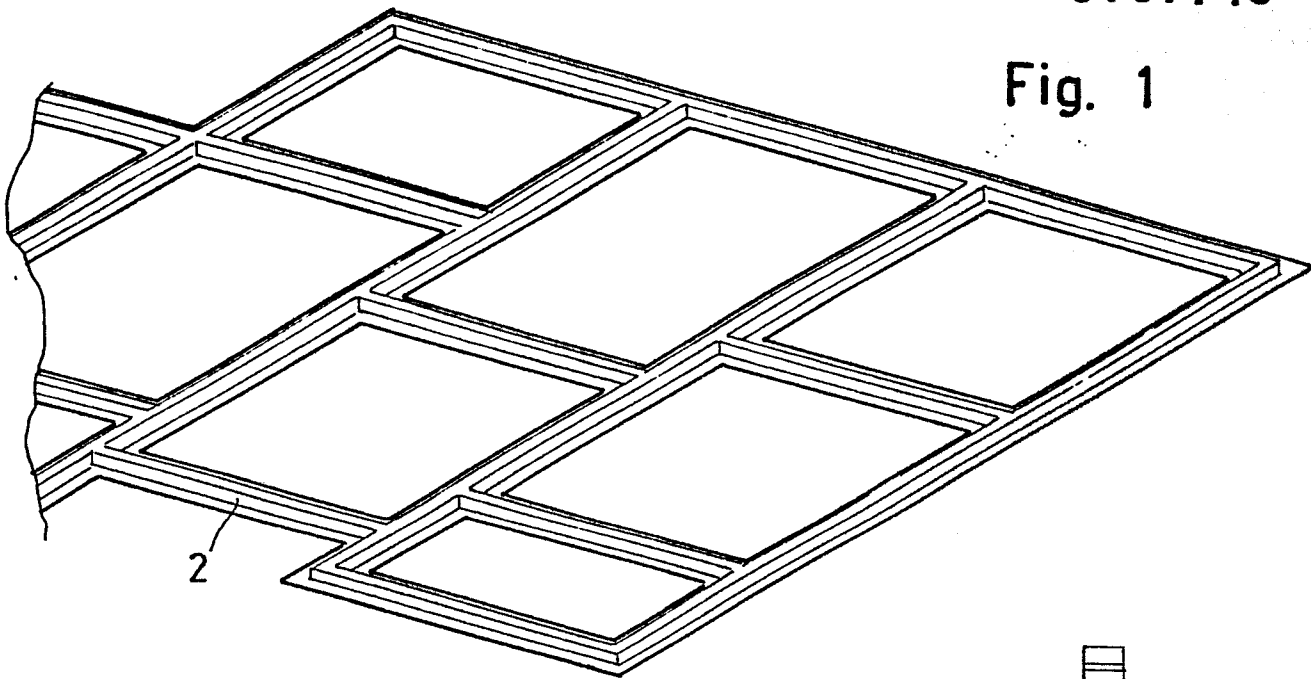


Fig. 1A

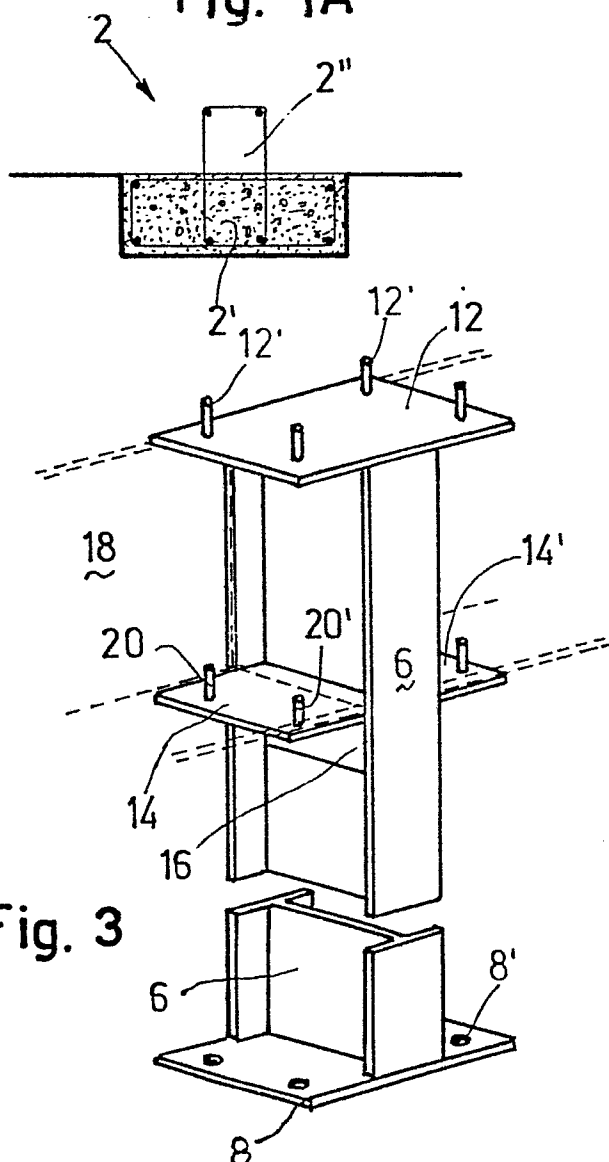
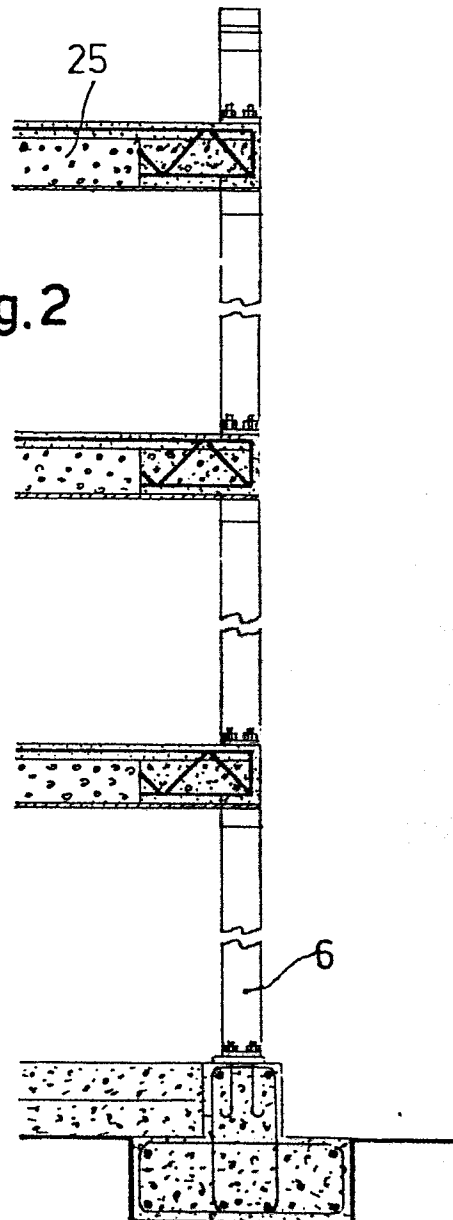


Fig. 2



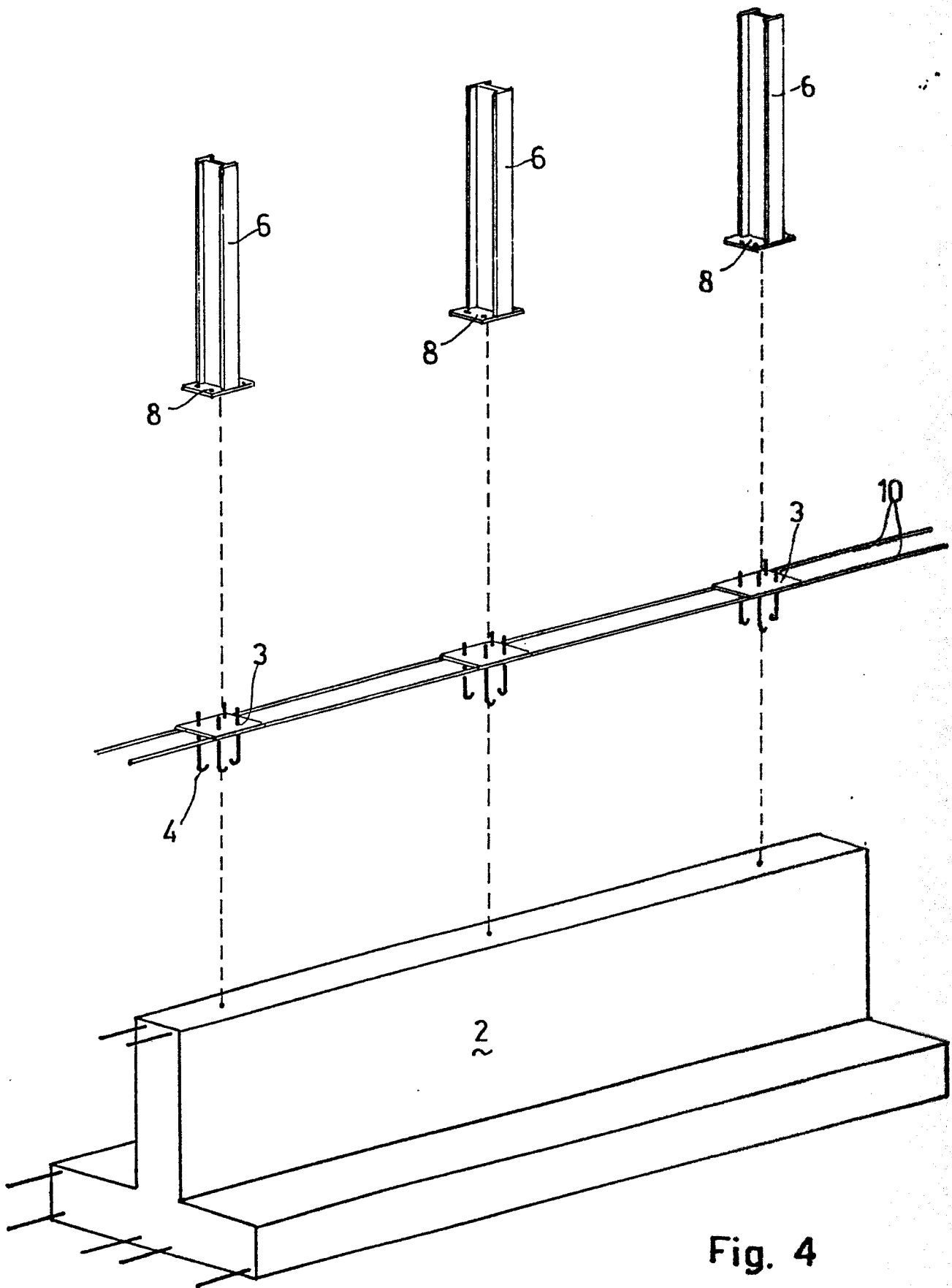
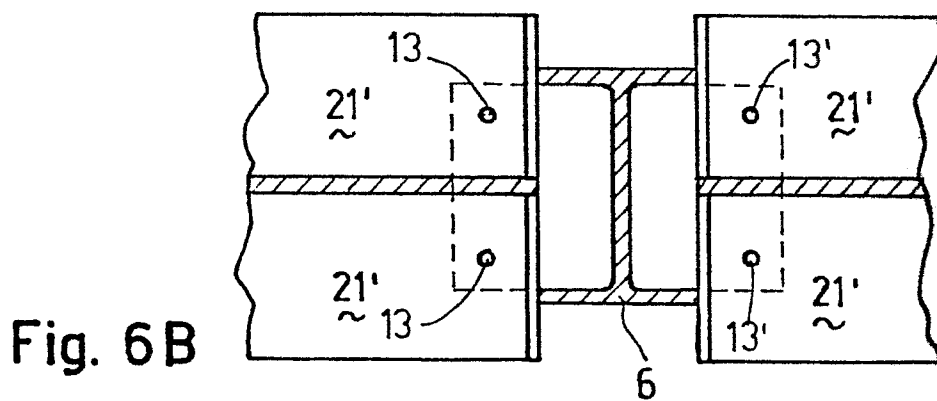
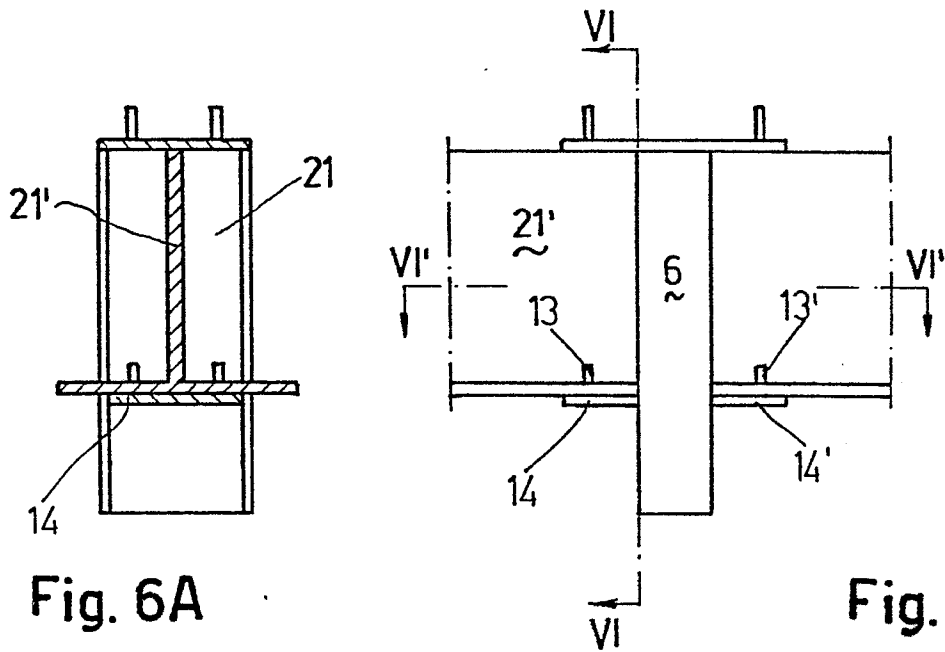
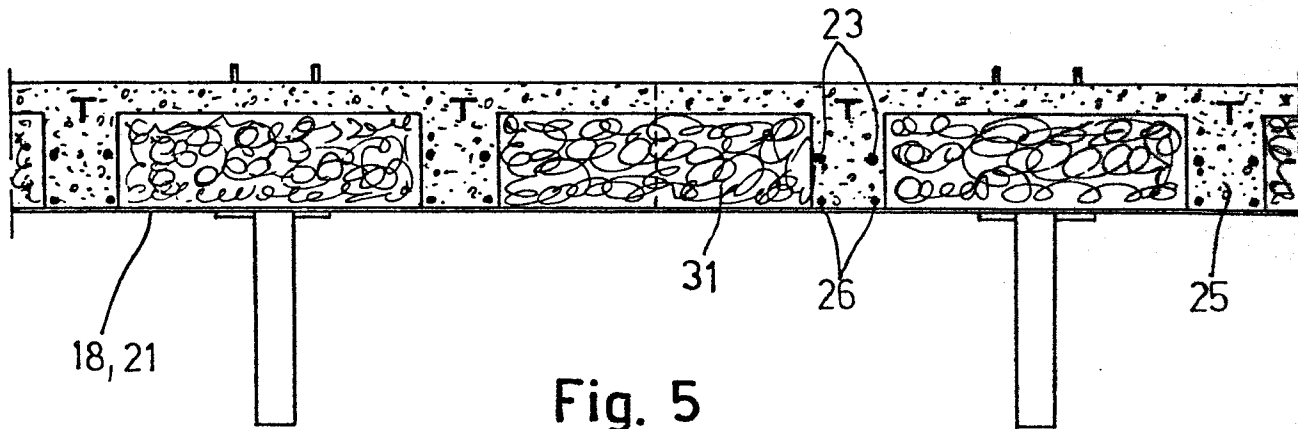


Fig. 4



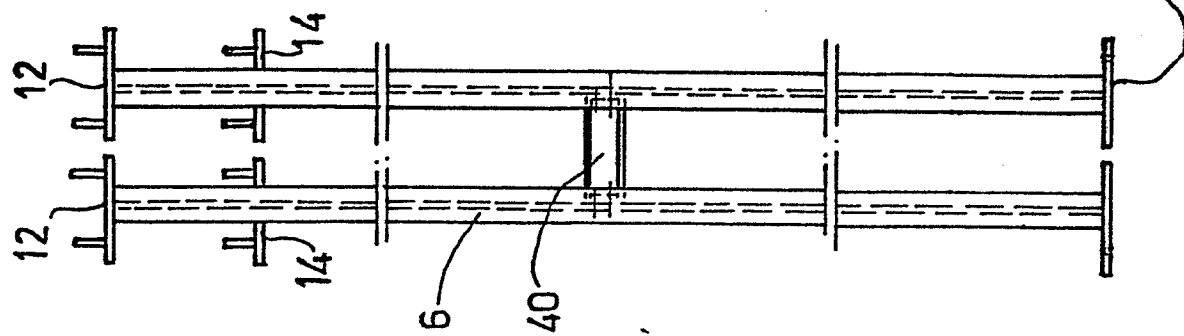


Fig. 12

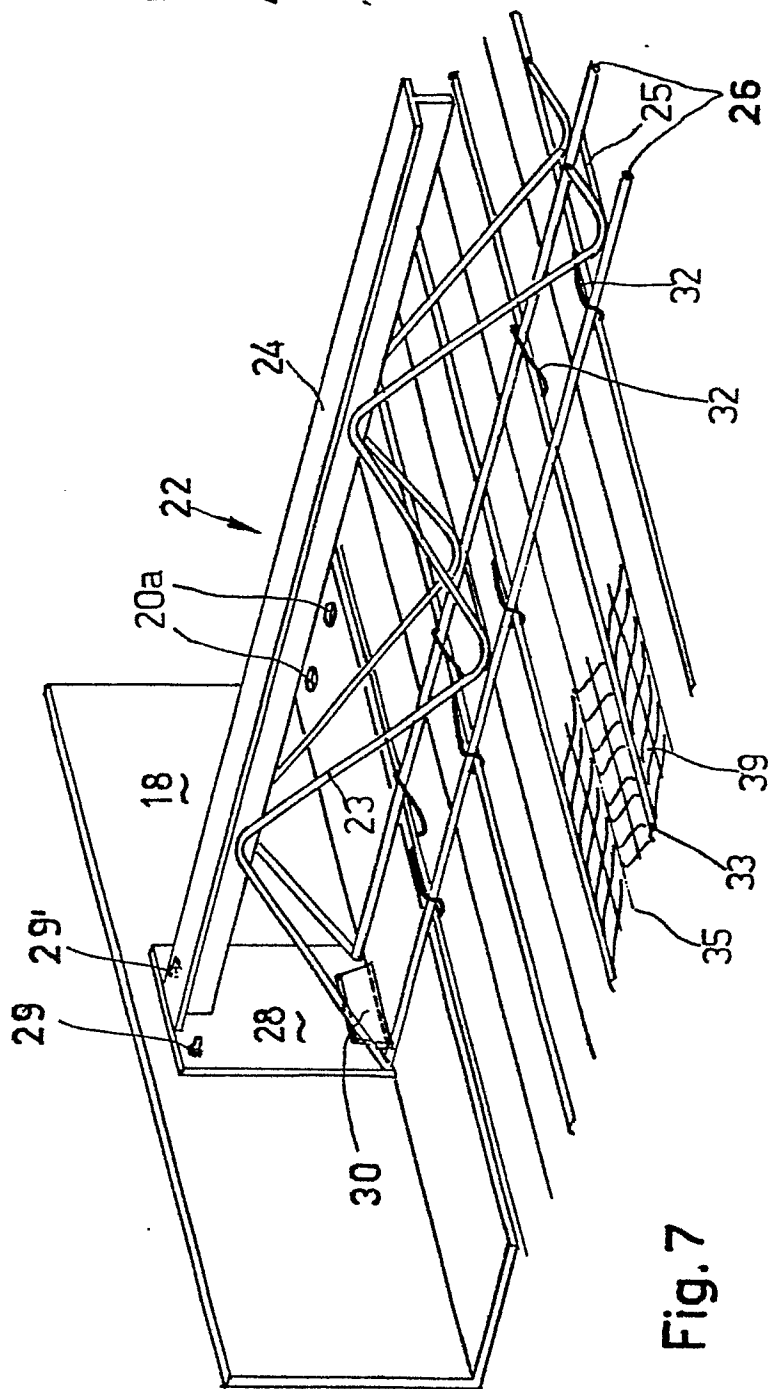


Fig. 7

Fig. 8C

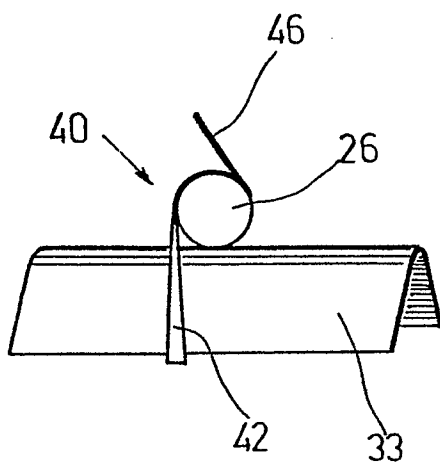


Fig. 8B

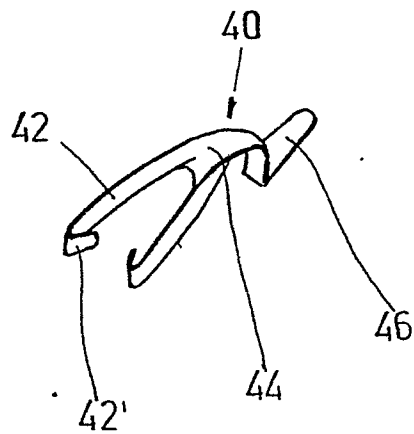
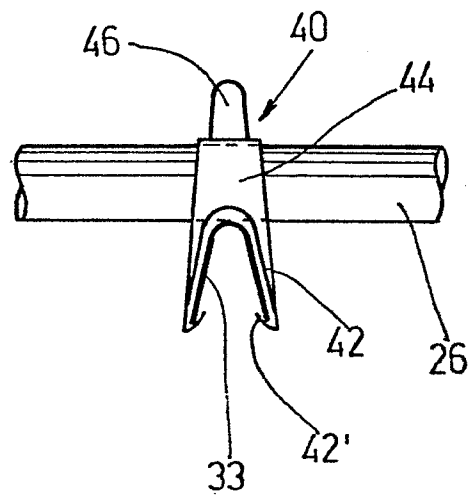


Fig. 8A

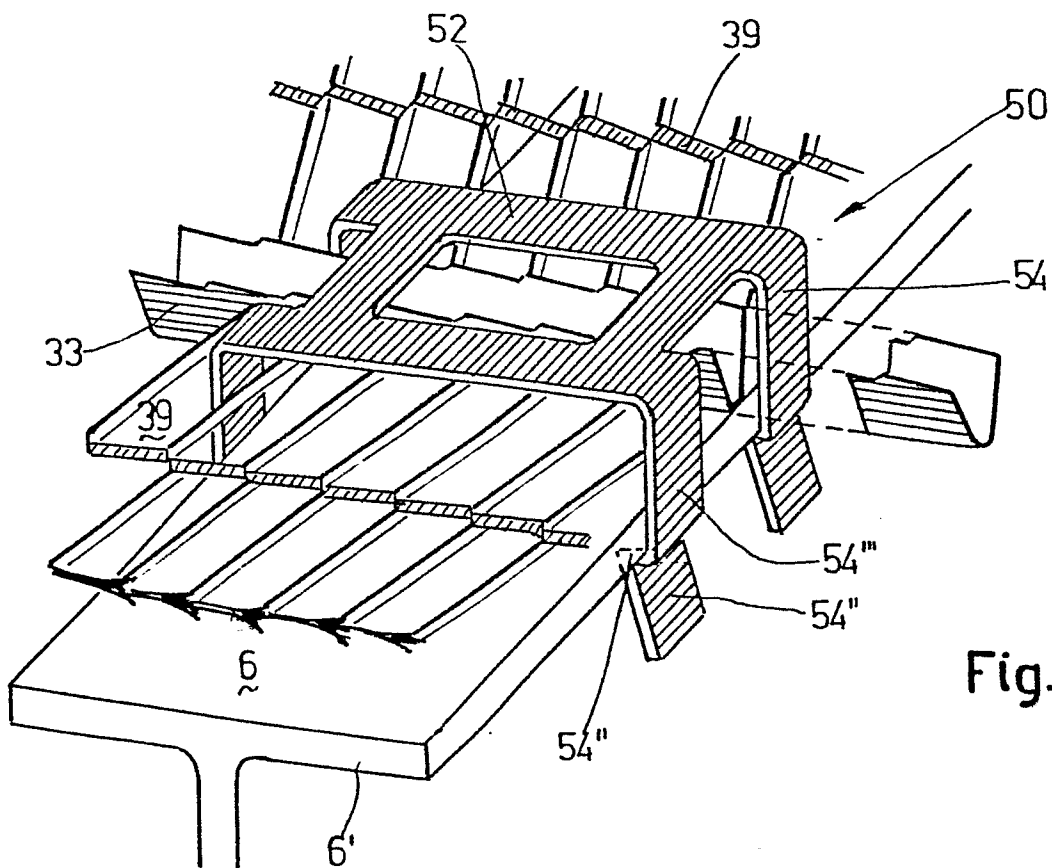
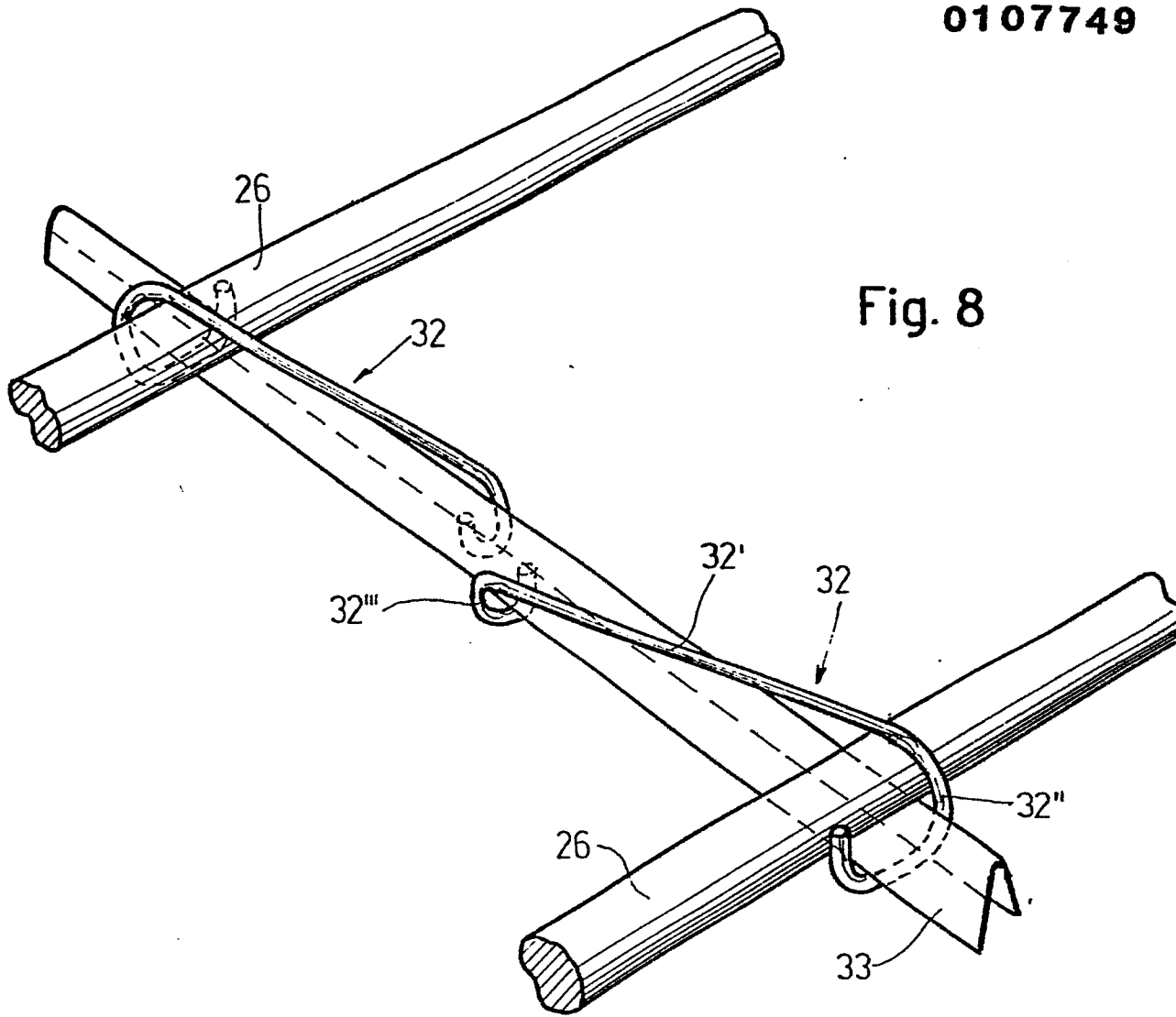


Fig. 10

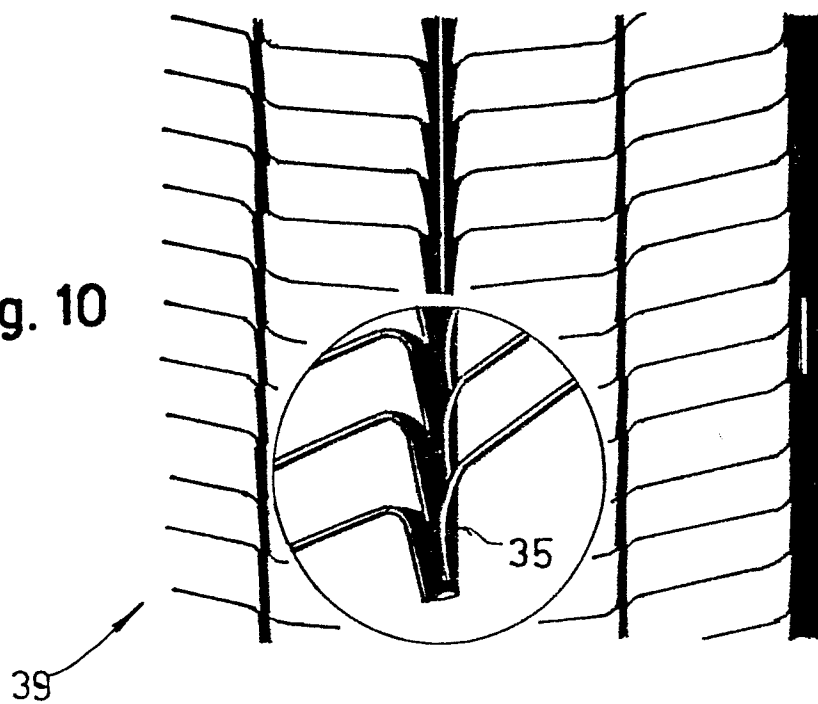


Fig. 10 A

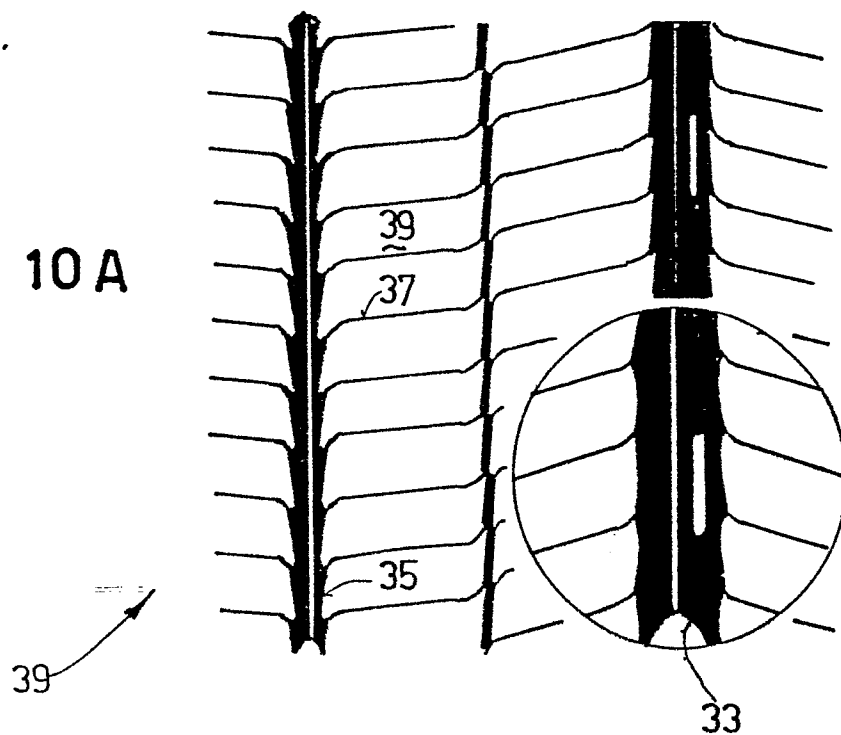
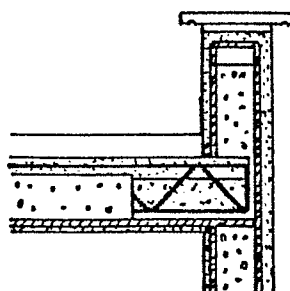


Fig. 11





European Patent
Office

EUROPEAN SEARCH REPORT

0107749

Application number

EP 82 83 0272

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. 3)
A	DE-C- 804 134 (VEREINIGTE WESTDEUTSCHE WAGGONFABRIKEN AG) * Complete document *	1, 17	E 04 H 9/02 E 04 B 1/98 E 04 B 1/24
A	DE-B-2 418 824 (G.M. BOLANZ) * Figure 4; column 1, lines 53-59; column 2, lines 3, 26-28 *	1	
A	FR-A-2 065 639 (DAVUM) * Figures 1-3 *	3	
A	DE-U-1 831 378 (RIPPENSTRECKMETALL-GMBH) * Figures 3, 7; page 8, paragraph 1 *	8	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			E 04 B 1/00 E 04 B 5/00 E 04 C 3/00 E 04 F 13/00 E 04 H 9/00
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 22-06-1983	Examiner KRABEL A.W.G.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			