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(54) **TOWER, IN PARTICULAR FOR SUPPORTING TELECOMMUNICATION APPLIANCES**

TURM, INSBESONDERE ZUM STÜTZEN VON TELEKOMMUNIKATIONSGERÄTEN

TOUR, DESTINÉE NOTAMMENT AU SUPPORT D'APPAREILS DE TÉLÉCOMMUNICATION

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Description

[0001] The present invention relates to a tower, in particular for supporting telecommunication appliances, for example antennas.

[0002] The towers for supporting telecommunication appliances are substantially divided into two categories, according to height: trestles, suitable for reaching high heights, for example more than ten metres, and the simpler towers of tubular shape for smaller height. The latter serve for example for supporting the antennas of shelters for telecommunication appliances.

[0003] Precisely, towers consist of tubular elements of cylindrical or polygonal shape with a few metres length. Despite their large thickness, more tubular elements must be piled up on top of each to other to obtain sufficient heights. To do so, each tubular element is provided with connecting flanges at the ends thereof that must necessarily be made separately and then welded to the tubular body.

[0004] Moreover, each tubular element of the tower has a considerable weight, which requires the use of a crane for handling thereof. Since these towers are mainly intended for movable installations, the problem of the handiness and transportability thereof is much felt.

[0005] A tower comprising all of the features of the preamble of claim 1 is known from document AT-8-380511.

[0006] The object of the present invention is to propose a tower of the second type which should allow obviating the disadvantages mentioned above with reference to the towers used so far.

[0007] In particular, the object of the present invention is to propose a tower which should allow reaching much higher heights and which should be at the same time much lighter, much easier to made and assemble and much handier and more convenient to carry and store.

[0008] Such objects are achieved with a tower according to claim 1.

[0009] The details and the advantages of the tower according to the present invention will appear clearly from the following description of preferred embodiments, made by way of an indicative non-limiting example with reference to the annexed drawings, wherein:

Figure 1 shows a comprehensive view of a tower according to the invention in a first embodiment thereof;
Figure 2 shows an enlarged view of two superimposed sections of the tower;
Figure 3 shows a cross section of the tower along a section;
Figure 4 shows a cross section of the tower at the level of the connection between two sections;
Figures 5 and 5a show an elevation view and a development of a bar of the tower;
Figures 6 and 6a show an elevation view and a development of a bar of the tower in an embodiment variation thereof;
Figure 7 shows a plan view of a bar and two connecting plates associated thereto;
Figures 8 and 8a show an elevation view and a development of a lower bar of the tower;
Figure 9 shows a perspective enlarged view of the tower base;
Figure 10 schematically shows the anchoring of the base flange of the tower to a concrete foundation;
Figures 11a-11d show as many views of a detail of the tower base;
Figure 12 shows an element of the base flange;
Figure 13 shows a plan view of the tower base;
Figures 14, 14a and 14b show a front view, a cross section and a development of a connecting plate between two superimposed bars;
Figure 15 shows a perspective view of a tower in an embodiment variation thereof;
Figure 16 shows an elevation view of the tower of figure 15;
Figure 17 shows a plan view of the tower;
Figures 18, 18a and 18b show a perspective, elevation and end view of a bar of the tower of figures 15-18;
Figure 19 shows a perspective view of the tower in the embodiment variation, with a ladder and ground props; and
Figure 20 shows a top plan view of the tower of figure 19.

[0010] In accordance with a general embodiment, tower 1; 100 according to the present invention comprises a plurality of bars 10; 110 next to one another along the respective sides so as to make a hollow structure of tubular shape and with polygonal section.

[0011] Each bar comprises a bar body 11; 111 defining at least one side or face of said structure of tubular shape and longitudinal coupling appendices 12; 112 inclined relative to said bar body so that adjacent appendices of two sided bars are facing and fixed to each other.

[0012] In other words, tower 1; 100 comprises of a plurality of bars or panels of oblong shape that extend along a direction substantially parallel to the longitudinal axis of the tower and that are connected to one another along the respective sides.

[0013] Said sides of the bars or panels are defined by the coupling appendices 12; 112. These are shaped as tongues or ribs that preferably extend along all the side of bar 10; 110 and that have a smaller cross extension compared to the cross extension of the bar body.

[0014] According to a preferred embodiment, bars 10; 110 are equal to each other so as to make an equilateral polygon section structure.

[0015] Preferably, the coupling appendices 12; 112 are inclined outwards of the parallelepiped structure, and in particular they extend beyond the perimeter formed by the bar sides.

[0016] In other words, the coupling appendices 12; 112 extend from the vertices of the polygon formed by the

bar bodies, in radial direction relative to the centre of said polygon.

[0017] According a particularly advantageous embodiment, bars 10; 110 are obtained from sheared and bent sheets.

[0018] According to an embodiment, the coupling appendices 12; 112 carry a plurality of threaded holes 13; 113 distributed along the longitudinal extension thereof so as to be fixed to each other by bolts 14; 114.

[0019] According to an embodiment illustrated in figures 1-14, the tower comprises two sections or modules 1', 1" superimposed in height to one another, each section consisting of a single order of bars 10 fixed to one another along the sides. Superimposed sections are connected to one another by connecting plates 16 that connect the adjacent ends of at least two coupling appendices of two superimposed bars to each other. For example each bar, and thus a section, has a height of about three metres.

[0020] Preferably, the connecting plates 16 are bolted to the coupling appendices 12.

[0021] Advantageously, the connecting plates 16 are also bolted to the bar bodies 11 of two superimposed bars. In the practice, each connecting plate 16 has an L shape with angle equal to that formed by the coupling appendices 12 relative to the bar body 11, so as to overlap both to a portion of the body and to the appendix, without protruding therefrom. Each bar body 11 therefore has, at the top and bottom ends thereof, and in the proximity of the coupling appendices 12, a plurality of holes 11', for example three holes, with which as many holes 16' obtained in the corresponding portion of the connecting plate 16 are aligned. Also the coupling appendices 12 are crossed at the ends thereof by a plurality of holes 12', for example three holes, with which as many holes 16" obtained in the corresponding portion of plate 16 are aligned. Advantageously, the two orders of holes in the bar body and in the coupling appendices are staggered in height so as to not generate weakening of the tower structure.

[0022] According to an embodiment that comprises multiple superimposed sections, for example up to exceeding 20-30 metres height, the tower comprises a lower portion 2, for example comprising three or four sections 1', 1", ..., of truncated-pyramid shape in order to improve the stability of the structure.

[0023] Advantageously, such shape is obtained with the use of bars 10' of trapezoidal shape, that is, that narrow upwards (figures 6, 6a, 8, 8a).

[0024] Moreover, the bars of the higher sections have a smaller thickness than the bars of the lower sections, so as to impart greater lightness to the structure as the tower height increases.

[0025] In accordance with an embodiment illustrated in figures 1-14, each section of the tower comprises eight bars 10, 10' side by side to make an octagonal structure. Thus, each bar comprises a flat bar body 11 that defines, in cross section, the side or face of an octagon.

[0026] In one embodiment illustrated in figures 15-20, each section of the tower comprises three bars 100 side by side and fixed to each other. Each bar 100 comprises, besides the coupling appendices 112, a bar body 111 bent as a V with internal angle of 120°, so that the three bars side by side make a hexagonal structure. In other words, each bar body 111 has a median bending line that defines a pair of adjacent sides or faces of the hexagonal structure.

[0027] Such embodiment is particularly suitable for constructing a tower 100 in a single section, for example with height equal to about 10 metres.

[0028] In one embodiment particularly suitable for large height towers, bars 10 of the bottom section rest on a base flange 18 anchored to a foundation 17, for example of concrete. Preferably, the bottom ends of bars 10 are fixed to flange 18 by square plates 19 bolted both to the bar bodies 11 and to flange 18.

[0029] Figures 8, 8a show the bottom bars 10' of the tower at the base whereof there is obtained a plurality of holes 11" to which as many holes 19' obtained in the square plates 19 are obtained.

[0030] According to one embodiment, flange 18 consists of four circular crown sectors 18' side by side. Each square plate 19 exhibits at least one pair of threaded holes 20 so that adjacent sectors 18' of flange 18 are connected to each other by a square plate 19 that overlaps to the contiguous ends of said sectors.

[0031] The base flange 18 is in turn anchored to the foundation by log bolts 22. Advantageously, log bolts 22 emerge from the foundation so that the locking nuts 22' of log bolts 22 secure not only flange 18 but also the square plates 19 to the flange itself.

[0032] According to one embodiment particularly suitable for smaller size towers, for example the hexagonal tower described above, tower 100 is supported by inclined props 120 resting on the ground. In particular, the top ends 120' of the props are fixed, for example by bolts, to the coupling appendices 112 of adjacent bars. The bottom ends 120" resting on the ground may also be fixed to the tower base by respective horizontal crosspieces 121.

[0033] In this embodiment, therefore, the tower does not need the construction of a ground anchoring foundation but it is simply resting on the ground and supported by props 120 and crosspieces 121.

[0034] According to one embodiment, a rack 30 for cable support and guide is fixed to at least two coupling appendices side by side 12; 112 of adjacent bars. In particular, rack 30 comprises a plurality of brackets 31 that extend overhanging by the full tower height and that may be fixed to the appendices 12; 112 by bolts.

[0035] At least one rod 40 for supporting an antenna or other telecommunication appliance is anchored, for example by bolted brackets, in the proximity of the top of tower 1; 100.

[0036] Moreover, a rung ladder 50 is fixed to at least two coupling appendices side by side 12; 112 of adjacent

bars.

[0037] According to one embodiment particularly suitable for large height and thus large section towers 1, ladder 50 comprises a plurality of anchoring plates 51 that extend overhanging from coupling appendices 12, to which plates 51 are advantageously fixed by bolts. Each plate 51 is crossed by at least one threaded hole wherein at last one rung 52 of ladder 50 screws. Thus, the rung ladder 50 is assembled straight on the tower itself, which acts as bearing element thereof.

[0038] In one embodiment particularly suitable for smaller size towers 100, on the other hand, ladder 150 is a traditional resting ladder, at least one vertical upright of which it can be advantageously anchored, for example by special brackets 151, to the coupling appendices 112.

[0039] Advantageously, moreover, each bar 10; 110 has at least a vertical row of lightening windows 60; 160 obtained in the bar body 11; 111.

[0040] Preferably, the rows of window of two adjacent bars are staggered in height so that at the window of a bar, the other bar has a completely solid portion, that is, without window.

[0041] In all the embodiments described, the tower is completely without welds, so the galvanisation of the metal making up all the tower elements is free from discontinuity. The structure therefore has no weakening zones or flaws.

[0042] The modular structure essentially consisting of shaped bars allows an installation of the tower without the use of special means like cranes or large motor vehicles. In particular, thanks to the lightness of the bars, the tower can be manually mounted even by few operators using simple pulleys for bringing the bars to the desired height.

[0043] Thanks to the possibility of piling all the elements making up the tower, storage and transport thereof are facilitated and allowed even in very narrow spaces.

[0044] It should be noted that the tower proposed allows reaching heights comparable to those of trestles, while having a much simpler structure, consisting of a considerably smaller number of parts and much easier to carry and store.

[0045] Finally, it should be noted that the tower according to the invention is not only suitable to be used in the field of telecommunications but it may be used also as support for wind appliances or in the building field.

Claims

1. Tower (1; 100), in particular for supporting telecommunication appliances, comprising a plurality of bars (10; 110) next to one another along the respective sides so as to make a hollow structure of tubular shape with polygonal section, each bar comprising a bar body (11; 111) defining at least one side of said structure, wherein said sides of the bars comprise longitudinal appendices (12; 112) for coupling to adjacent bars, said coupling appendices extending from and in inclined direction relative to said bar body so that adjacent appendices of two sided bars are facing and fixed to each other, the tower comprising at least two sections superimposed in height to each other, **characterised in that** said sections are connected to one another by L-shaped plates (16) forming an angle equal to that formed by the coupling appendices relative to the bar body, so that to overlap and to be bolted both to a portion of the body and to the appendix without protruding therefrom.

2. Tower according to claim 1, wherein said bars (10; 110) are equal to each other so as to make an equilateral polygon section structure.

3. Tower according to claim 2, wherein said coupling appendices (12; 112) are inclined outwards of the parallelepiped structure and extend beyond the perimeter formed by the bar sides.

4. Tower according to claim 3, wherein said coupling appendices (12; 112) extend from the vertices of the polygon formed by the bar bodies (11; 111), in radial direction relative to the centre of said polygon.

5. Tower according to any one of the previous claims, wherein said coupling appendices (12; 112) are bolted to each other.

6. Tower according to any one of the previous claims, wherein said coupling appendices (12; 112) extend by the entire bar length.

7. Tower according to any one of the previous claims, wherein each bar (10; 110) is obtained from a sheared and bent sheet at least at the level of the coupling appendices (12; 112).

8. Tower according to any one of the previous claims, wherein the bars (10; 110) of at least one bottom section of the tower have a trapezoidal shape so that said section exhibits a truncated-pyramid shape.

9. Tower according to any one of the previous claims, comprising eight bars (10; 110) side by side making up an octagonal structure.

10. Tower according to any of claims 1-8, comprising three bars (10; 110) side by side, each bar comprising a bar body bent as a V with angle of 120°, so that the three bars side by side make a hexagonal structure.

11. Tower according to any one of the previous claims, wherein the bars (10; 110) of the bottom section rest on a base flange (18) whereto they are fixed by square plates (19) bolted both to the bar bodies and

to the flange, said base flange being anchored to a foundation by a plurality of log bolts (22).

12. Tower according to any one of the previous claims, wherein the bars (10; 110) of a bottom section are supported by props (120) resting on the ground, the top ends of the props being fixed to the coupling appendices (12; 112) of adjacent bars.

13. Tower according to any one of the previous claims, wherein an antenna support rod (40) is anchored to at least two coupling appendices (12; 112) side by side of adjacent bars.

14. Tower according to any one of the previous claims, wherein a rung ladder (50) is fixed to at least two coupling appendices (12; 112) side by side of adjacent bars (10; 110), said rung ladder comprising a plurality of anchoring plates (51) that extend overhanging from side by side appendices of adjacent bars, the ladder rungs (52) being screwed to said anchoring plates.

15. Tower according to any one of the previous claims, wherein each bar (10; 110) has at least one vertical row of lightening windows (60) obtained in the bar body, the rows of window of two adjacent bars being staggered in height so that at the window of a bar, the other bar exhibits a completely solid portion, that is, without window.

Patentansprüche

1. Turm (1; 100), insbesondere zum Stützen bzw. Tragen von Telekommunikationsgeräten, umfassend eine Mehrzahl von Stangen (10; 110) nebeneinander entlang der jeweiligen Seiten, um eine hohle Struktur von rohrförmiger Form mit polygonalem Querschnitt zu ergeben, wobei jede Stange einen Stangenkörper (11; 111) umfasst, der zumindest eine Seite der Struktur definiert, wobei die Seiten der Stangen longitudinale Fortsätze bzw. Längsfortsätze (12; 112) zum Koppeln an angrenzende bzw. benachbarte Stangen umfassen, wobei sich die Kopplungsfortsätze von dem Stangenkörper erstrecken und in geneigter Richtung relativ zu diesem sind, so dass angrenzende bzw. benachbarte Fortsätze von zwei seitigen Stangen einander zugewandt sind und aneinander fixiert bzw. befestigt sind, wobei der Turm zumindest zwei Sektionen umfasst, die einander in der Höhe überlagert sind, **dadurch gekennzeichnet, dass** die Sektionen miteinander durch L-förmige Platten (16) verbunden sind, die einen Winkel ähnlich demjenigen bilden, der durch die Kopplungsfortsätze relativ zu dem Stangenkörper gebildet ist, um zu überlappen und sowohl an einen Abschnitt des Körpers als auch an den Fortsatz geschraubt zu sein, ohne von diesem vorzustehen.

2. Turm nach Anspruch 1, wobei die Stangen (10; 110) zueinander gleich sind, um eine gleichseitige Polygonquerschnittsstruktur zu ergeben.

3. Turm nach Anspruch 2, wobei die Kopplungsfortsätze (12; 112) auswärts der Parallelepipedstruktur geneigt sind und sich über den Perimeter hinaus erstrecken, der durch die Stangenseiten gebildet ist.

4. Turm nach Anspruch 3, wobei sich die Kopplungsfortsätze (12; 112) von den Eck- bzw. Scheitelpunkten des Polygons erstrecken, das durch die Stangenkörper (11; 111) gebildet ist, und zwar in radialer Richtung relativ zu der Mitte des Polygons.

5. Turm nach einem der vorhergehenden Ansprüche, wobei die Kopplungsfortsätze (12; 112) aneinander geschraubt sind.

6. Turm nach einem der vorhergehenden Ansprüche, wobei sich die Kopplungsfortsätze (12; 112) durch die bzw. die gesamte Stangenlänge erstrecken.

7. Turm nach einem der vorhergehenden Ansprüche, wobei jede Stange (10; 110) aus einem gescherten und gebogenen Blech zumindest auf der Ebene der Kopplungsfortsätze (12; 112) erhalten wird.

8. Turm nach einem der vorhergehenden Ansprüche, wobei die Stangen (10; 110) von zumindest einer Bodensektion des Turms eine Trapezform aufweisen, so dass die Sektion eine Pyramidenstumpfform aufweist.

9. Turm nach einem der vorhergehenden Ansprüche, umfassend acht Stangen (10; 110) Seiten an Seite, die eine oktogonale Struktur ergeben.

10. Turm nach einem der Ansprüche 1-8, umfassend drei Stangen (10; 110) Seite an Seite, wobei jede Stange einen Stangenkörper umfasst, der als ein V mit einem Winkel von 120° gebogen ist, so dass die drei Stangen Seite an Seite eine hexagonale Struktur ergeben.

11. Turm nach einem der vorhergehenden Ansprüche, wobei die Stangen (10; 110) der Bodensektion an einem Basisflansch (18) ruhen bzw. liegen, an dem sie durch quadratische Platten (19) fixiert bzw. befestigt sind, die sowohl an die Stangenkörper als auch an den Flansch geschraubt sind, wobei der Basisflansch an einem Fundament durch eine Mehrzahl von Verriegelungsbolzen bzw. -schrauben (22) verankert ist.

12. Turm nach einem der vorhergehenden Ansprüche,

wobei die Stangen (10; 110) einer Bodensektion durch Stützen (120) gestützt bzw. getragen werden, die auf dem Boden ruhen bzw. liegen, wobei die oberen Enden der Stützen an den Kopplungsfortsätzen (12; 112) von angrenzenden bzw. benachbarten Stangen fixiert bzw. befestigt sind.

13. Turm nach einem der vorhergehenden Ansprüche, wobei ein Antennenstütz- bzw. -trägerstab (40) an zumindest zwei Kopplungsfortsätzen (12; 112) Seite an Seite von angrenzenden Stangen verankert ist.

14. Turm nach einem der vorhergehenden Ansprüche, wobei eine Sprossenleiter (50) an zumindest zwei Kopplungsfortsätzen (12; 112) Seite an Seite von angrenzenden Stangen (10; 110) fixiert bzw. befestigt ist, wobei die Sprossenleiter eine Mehrzahl von Verankerungsplatten (51) umfasst, die sich von Seite-an-Seite-Fortsätzen angrenzender Stangen überhängend erstrecken, wobei die Leitersprossen (52) an die Verankerungsplatten geschraubt sind.

15. Turm nach einem der vorhergehenden Ansprüche, wobei jede Stange (10; 110) zumindest eine vertikale Reihe von Beleuchtungsfenstern (60) aufweist, die in dem Stangenkörper erhalten bzw. enthalten sind, wobei die Reihen von Fenstern zweier angrenzender Stangen in der Höhe abgestuft sind, so dass an dem Fenster einer Stange die andere Stange einen vollständig festen bzw. durchgehenden Abschnitt aufweist, das heißt ohne Fenster.

Revendications

1. Tour (1 ; 100), en particulier pour supporter des appareils de télécommunication, comprenant une pluralité de barres (10 ; 110) l'une à côté de l'autre le long des côtés respectifs de manière à réaliser une structure creuse de forme tubulaire avec section polygonale, chaque barre comprenant un corps de barre (11 ; 111) définissant au moins un côté de ladite structure, dans laquelle lesdits côtés des barres comprennent des appendices longitudinaux (12 ; 112) pour l'accouplement avec des barres adjacentes, lesdits appendices d'accouplement s'étendant à partir dudit corps de barre et en direction inclinée par rapport à celui-ci de manière que des appendices adjacents de deux barres côte à côte soient en face l'un de l'autre et fixés ensemble, la tour comprenant au moins deux sections superposées en hauteur l'une par rapport à l'autre, **caractérisée en ce que** lesdites sections sont connectées l'une à l'autre par des plaques en forme de L (16) formant un angle égal à celui formé par les appendices d'accouplement par rapport au corps de barre, de manière à recouvrir et à être boulonnées à la fois à une partie du corps et à l'appendice sans faire saillie de ceux-ci.

2. Tour selon la revendication 1, dans laquelle lesdites barres (10 ; 110) sont identiques entre elles de manière à réaliser une structure de section en polygone équilatéral.

3. Tour selon la revendication 2, dans laquelle lesdits appendices d'accouplement (12 ; 112) sont inclinés vers l'extérieur de la structure parallélépipédique et s'étendent au-delà du périmètre formé par les côtés de barre.

4. Tour selon la revendication 3, dans laquelle lesdits appendices d'accouplement (12 ; 112) s'étendent à partir des sommets du polygone formé par les corps de barre (11 ; 111), en direction radiale par rapport au centre dudit polygone.

5. Tour selon l'une quelconque des revendications précédentes, dans laquelle lesdits appendices d'accouplement (12 ; 112) sont boulonnés l'un à l'autre.

6. Tour selon l'une quelconque des revendications précédentes, dans laquelle lesdits appendices d'accouplement (12 ; 112) s'étendent sur toute la longueur de la barre.

7. Tour selon l'une quelconque des revendications précédentes, dans laquelle chaque barre (10 ; 110) est obtenue à partir d'une tôle cisaillée et pliée au moins au niveau des appendices d'accouplement (12 ; 112).

8. Tour selon l'une quelconque des revendications précédentes, dans laquelle les barres (10 ; 110) d'au moins une section inférieure de la tour ont une forme trapézoïdale de manière que ladite section présente une forme de pyramide tronquée.

9. Tour selon l'une quelconque des revendications précédentes, comprenant huit barres (10 ; 110) côte à côte réalisant une structure octogonale.

10. Tour selon l'une quelconque des revendications 1 à 8, comprenant trois barres (10 ; 110) côte à côte, chaque barre comprenant un corps de barre plié en V avec un angle de 120°, de manière que les trois barres côte à côte réalisent une structure hexagonale.

11. Tour selon l'une quelconque des revendications précédentes, dans laquelle les barres (10 ; 110) de la section inférieure reposent sur une bride de base (18) à laquelle elles sont fixées par des plaques carrées (19) boulonnées à la fois aux corps de barre et à la bride, ladite bride de base étant ancrée à une fondation par une pluralité de tirefonds (22).

12. Tour selon l'une quelconque des revendications pré-

cédentes, dans laquelle les barres (10 ; 110) d'une section inférieure sont supportées par des étançons (120) reposant sur le sol, les extrémités supérieures des étançons étant fixées aux appendices d'accouplement (12, 112) de barres adjacentes.

13. Tour selon l'une quelconque des revendications précédentes, dans laquelle une tige de support d'antenne (40) est ancrée à au moins deux appendices d'accouplement (12 ; 112) côte à côte de barres adjacentes.

14. Tour selon l'une quelconque des revendications précédentes, dans laquelle une échelle à barreaux (50) est fixée à au moins deux appendices d'accouplement (12 ; 112) côte à côte de barres adjacentes (10 ; 110), ladite échelle à barreaux comprenant une pluralité de plaques d'ancrage (51) qui s'étendent en surplomb à partir d'appendices côte à côte de barres adjacentes, les barreaux d'échelle (52) étant vissés auxdites plaques d'ancrage.

15. Tour selon l'une quelconque des revendications précédentes, dans laquelle chaque barre (10 ; 110) a au moins une rangée verticale de fenêtres d'éclairage (60) obtenues dans le corps de barre, les rangées de fenêtre de deux barres adjacentes étant décalées en hauteur de manière que, au niveau de la fenêtre d'une barre, l'autre barre présente une portion totalement pleine, c'est-à-dire sans fenêtre.

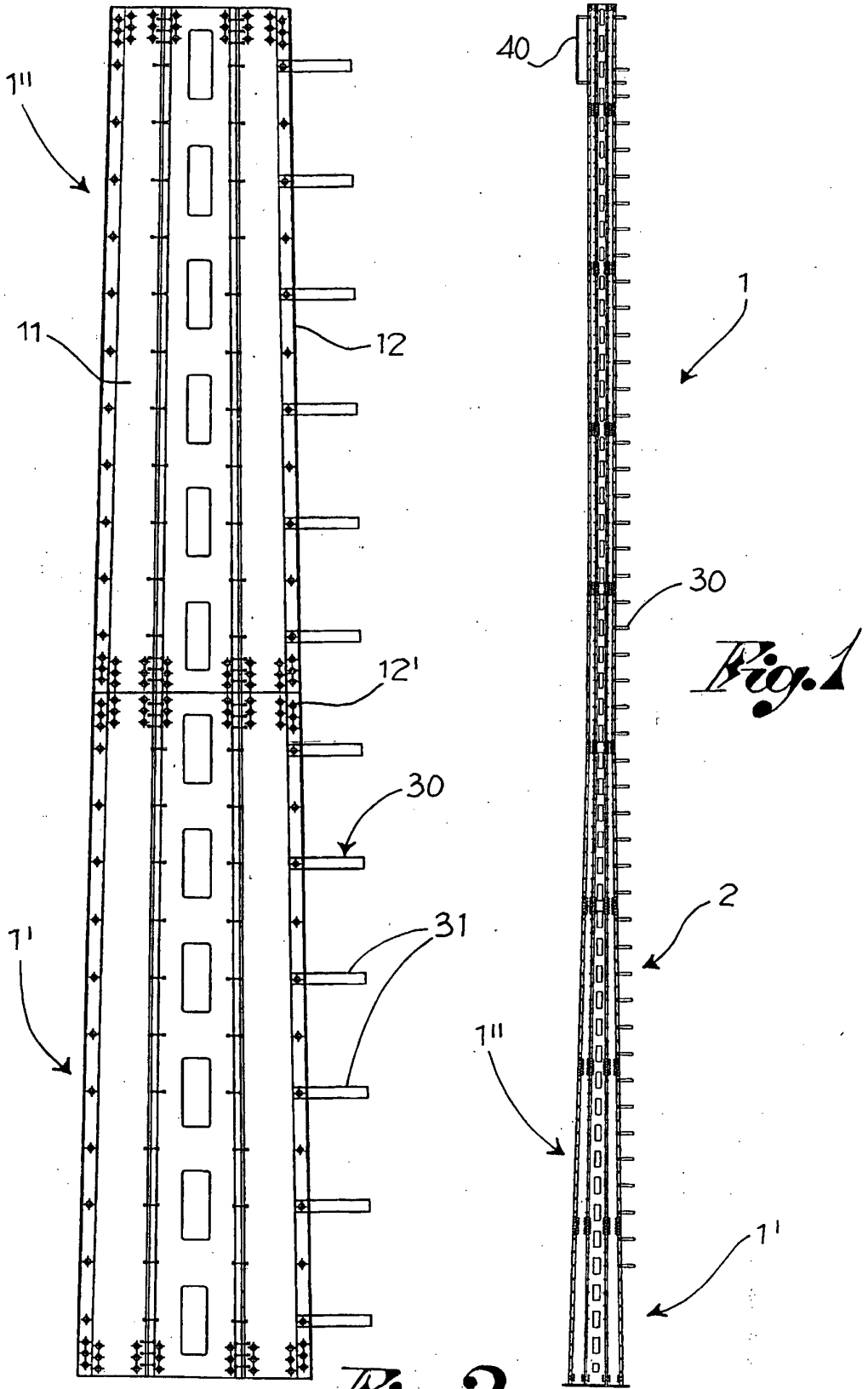


Fig. 1

Fig. 2

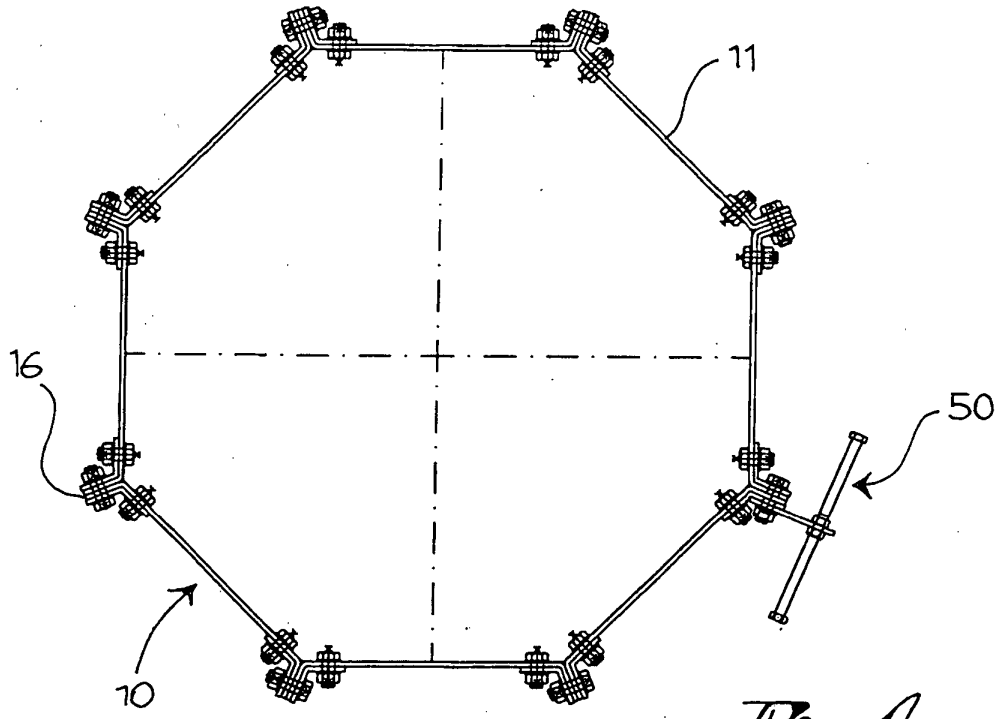


Fig.4

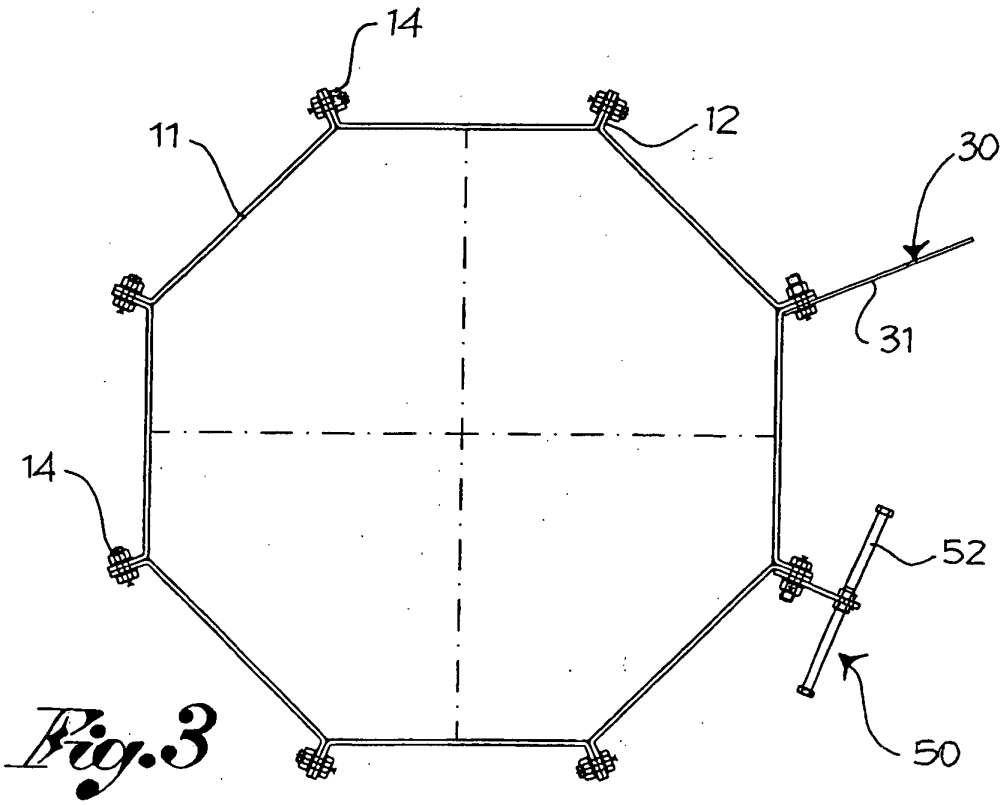


Fig.3

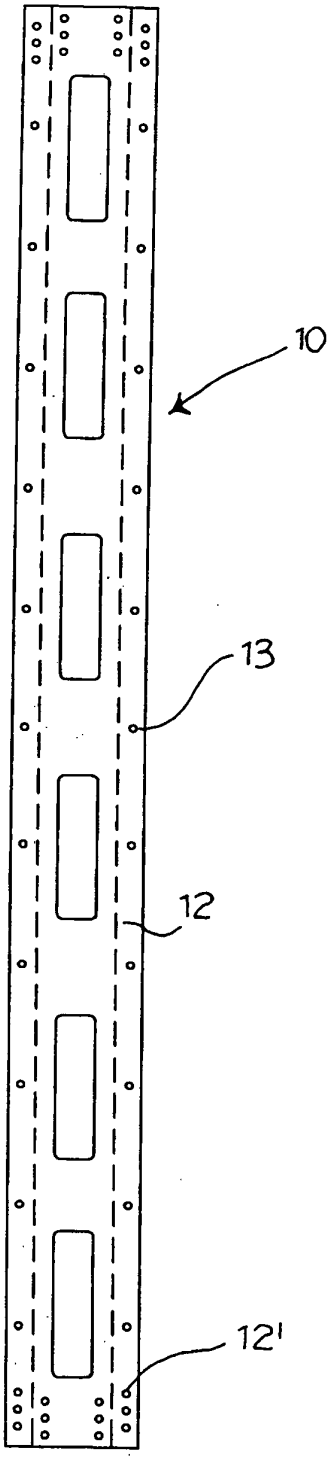


Fig. 5a

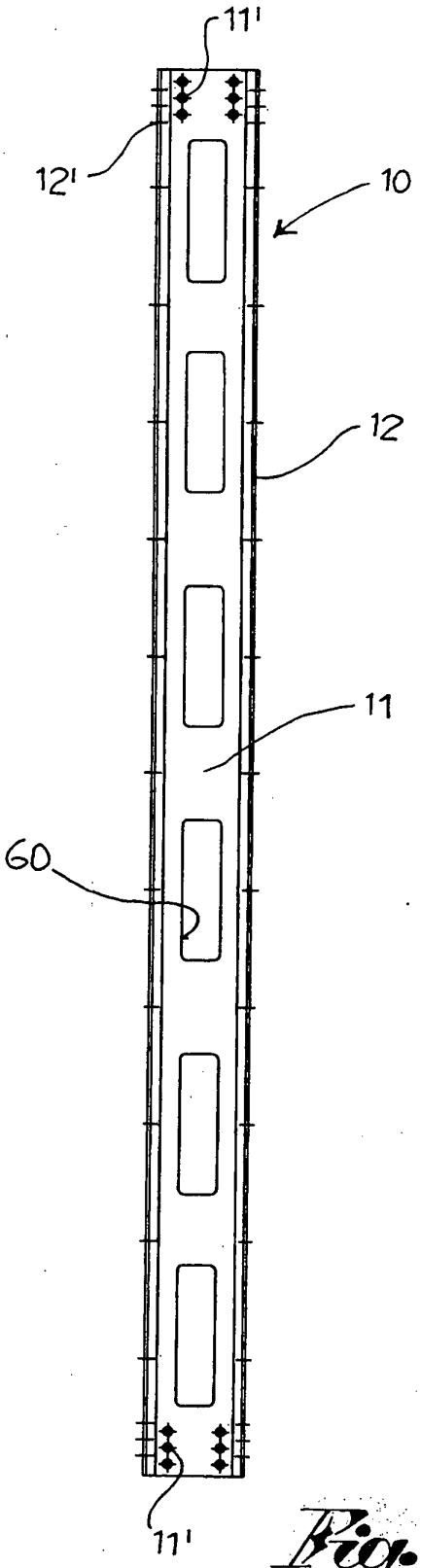


Fig. 5

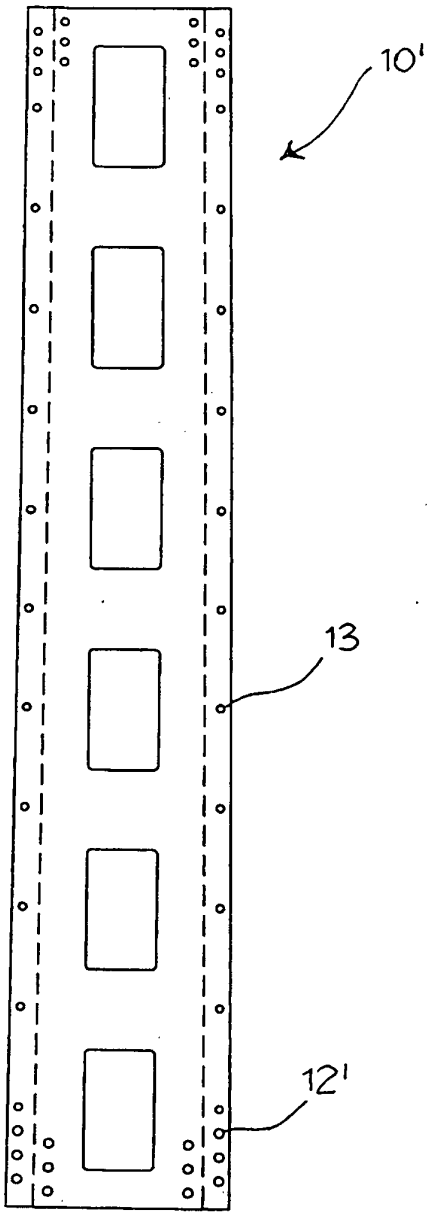


Fig.6a

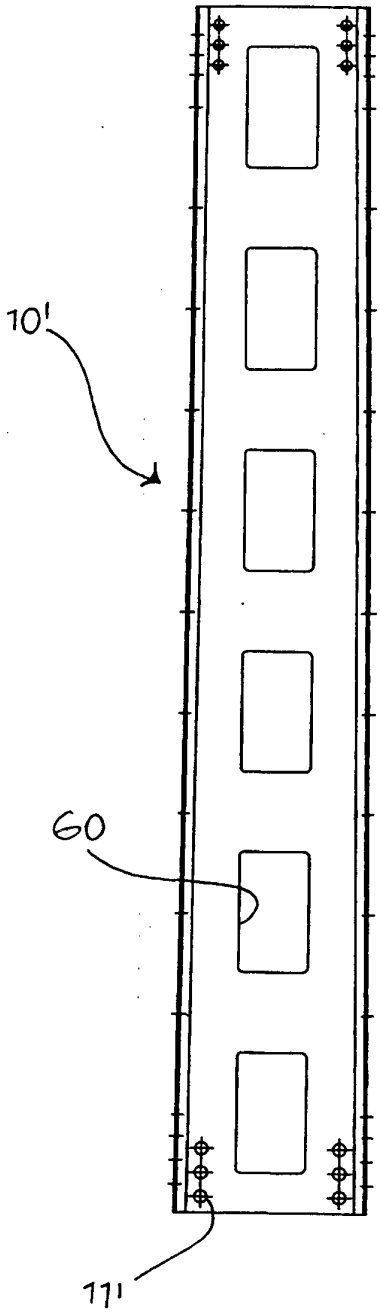
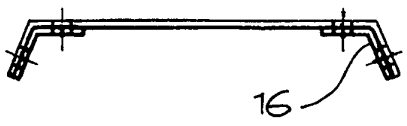


Fig.6

Fig.7



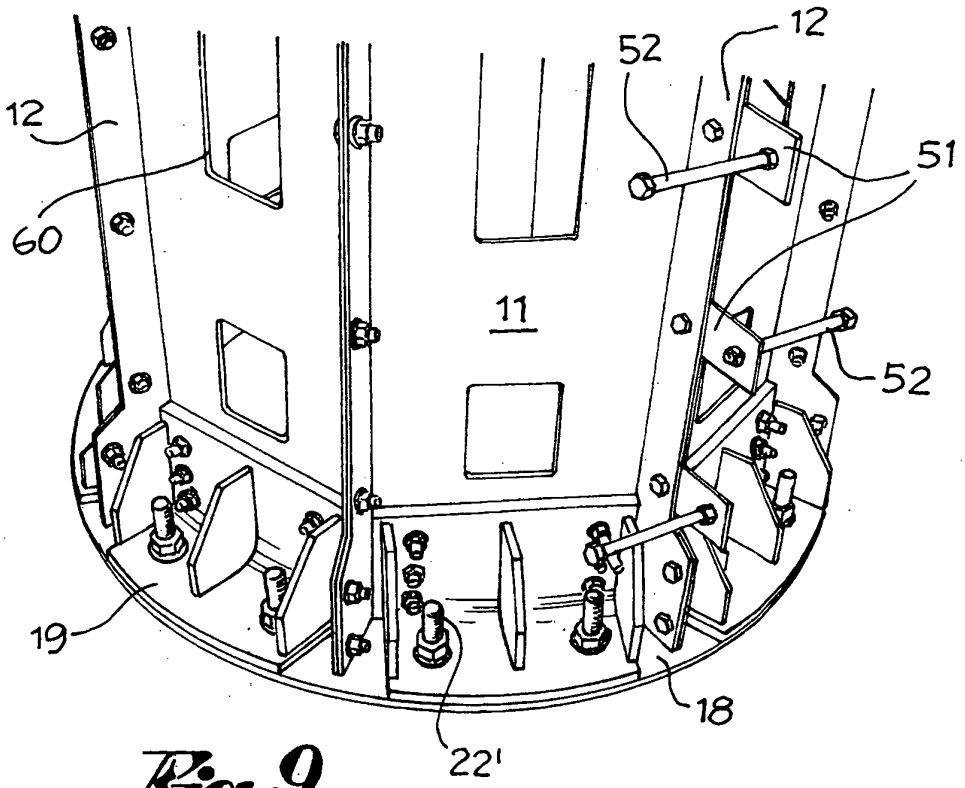


Fig.9

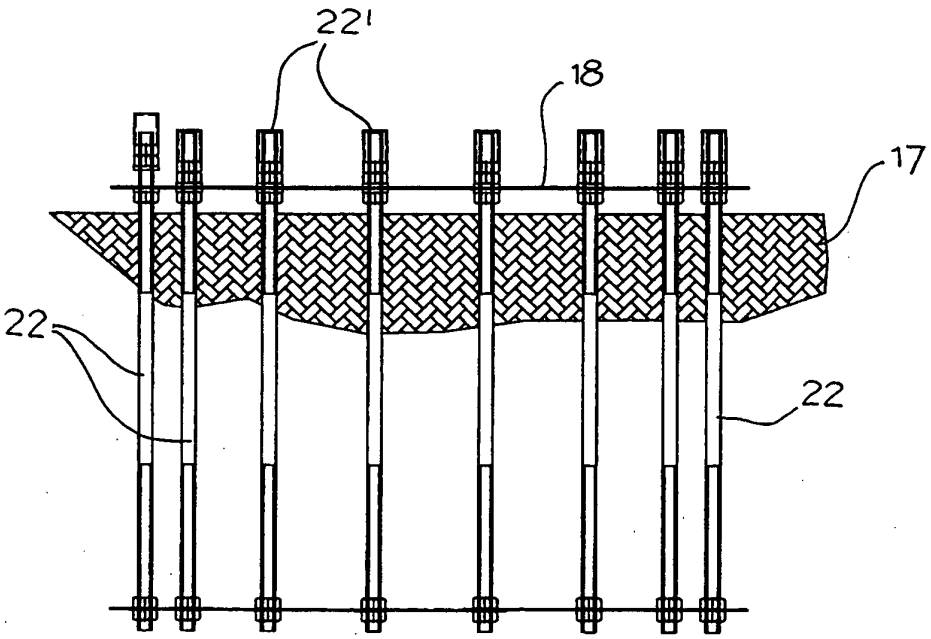


Fig.10

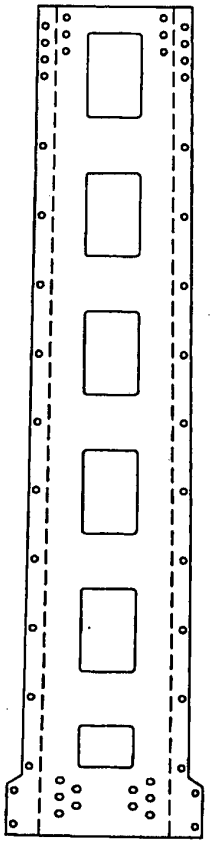


Fig.8a

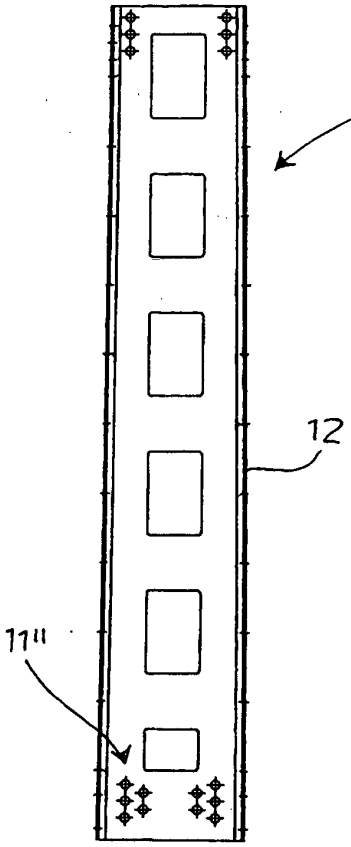


Fig.8

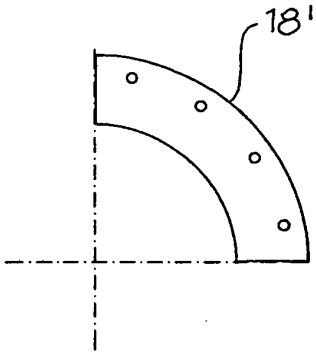


Fig.12

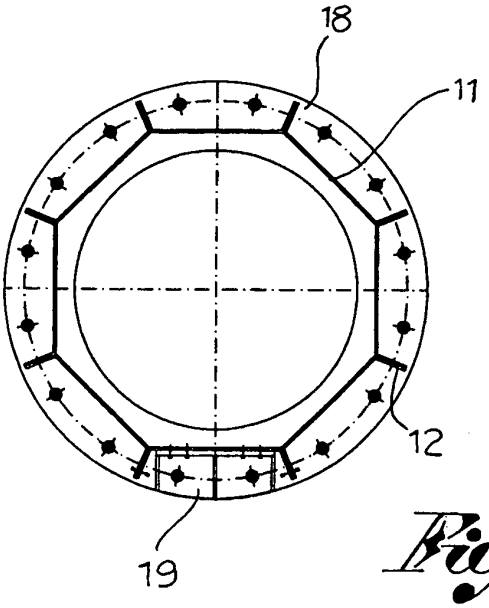


Fig.13

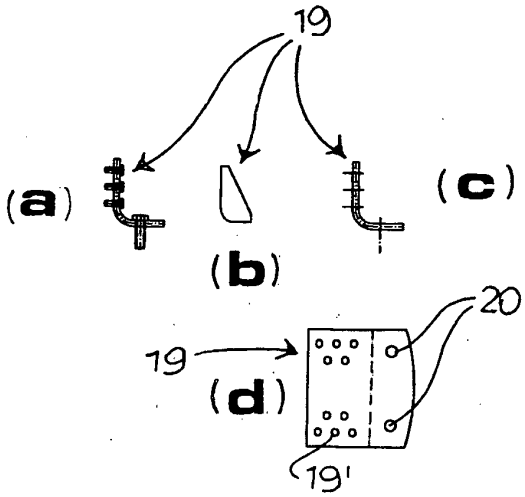


Fig.11

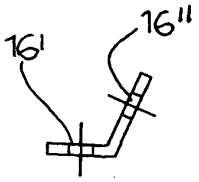


Fig.14a

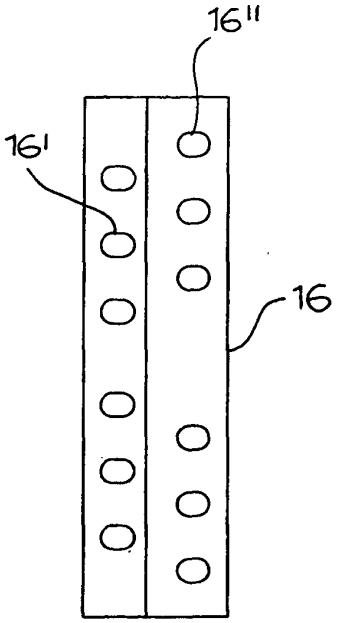


Fig.14b

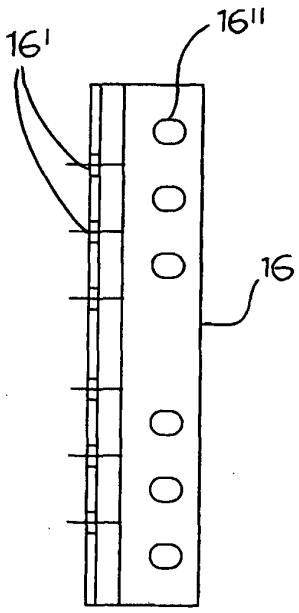


Fig.14

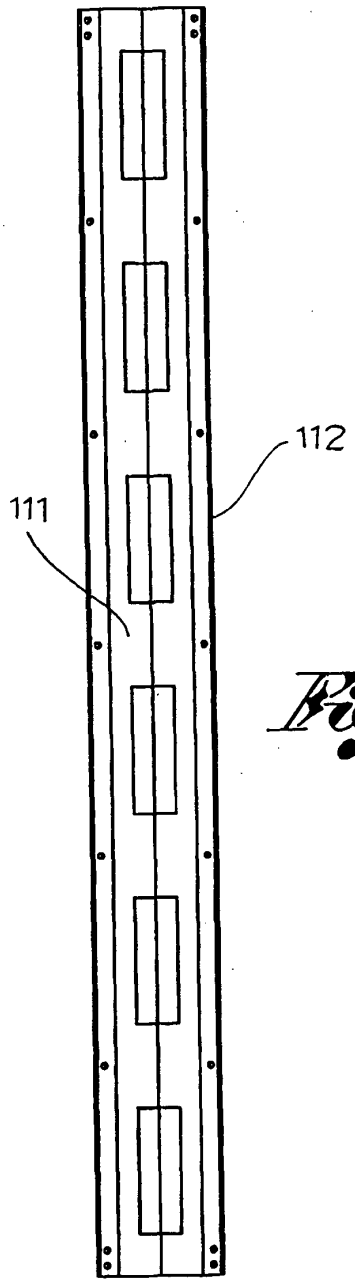


Fig.16

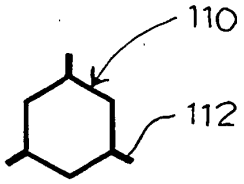


Fig.17

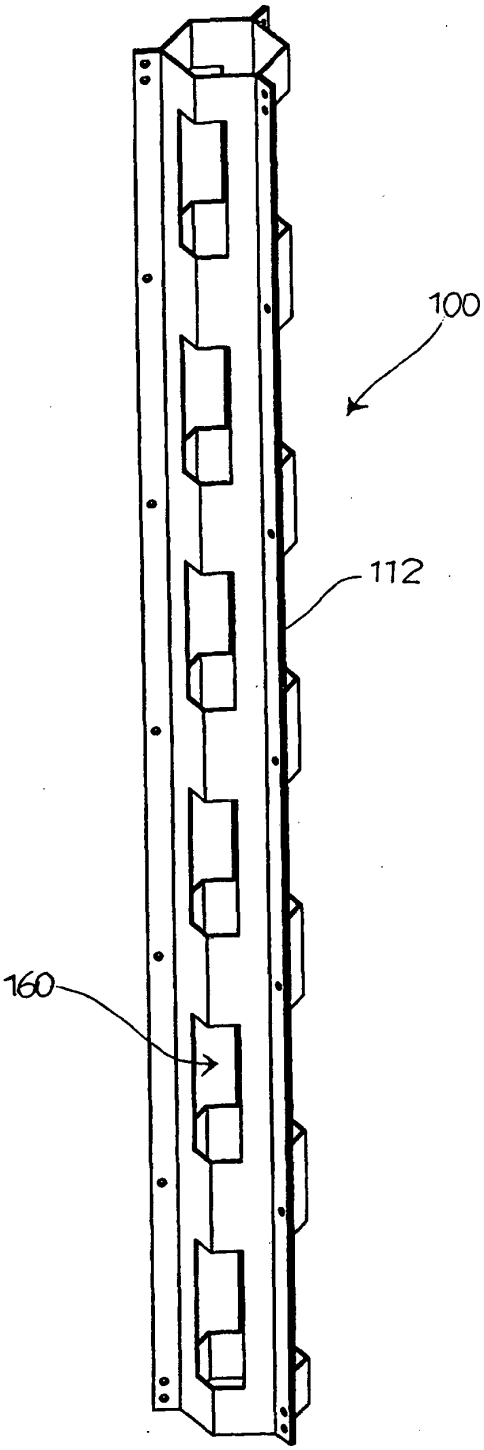


Fig.15

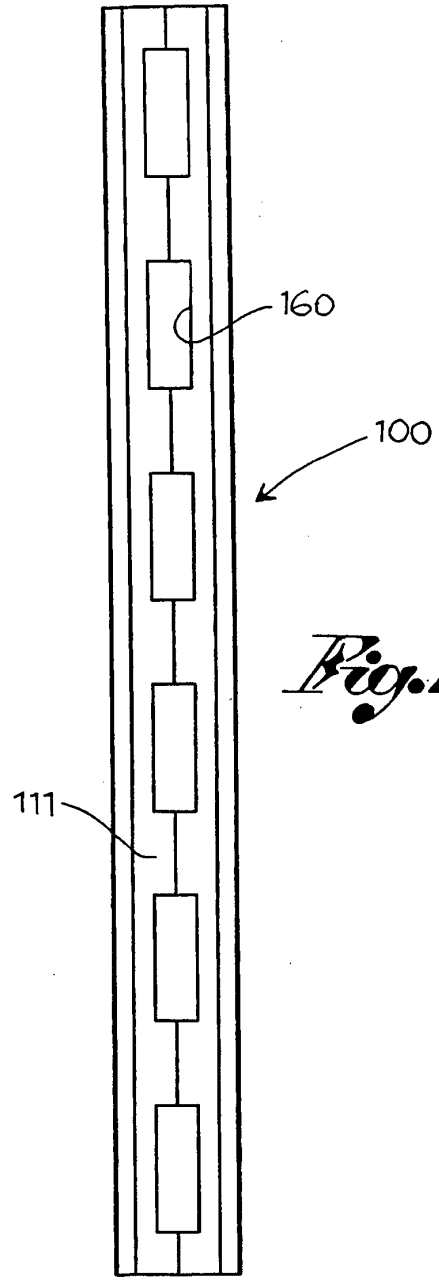


Fig.18a

Fig.18b

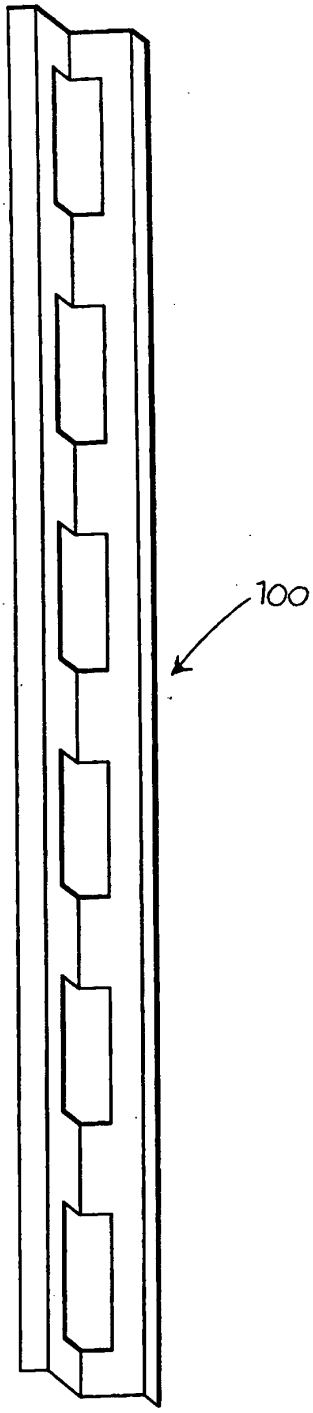


Fig.18

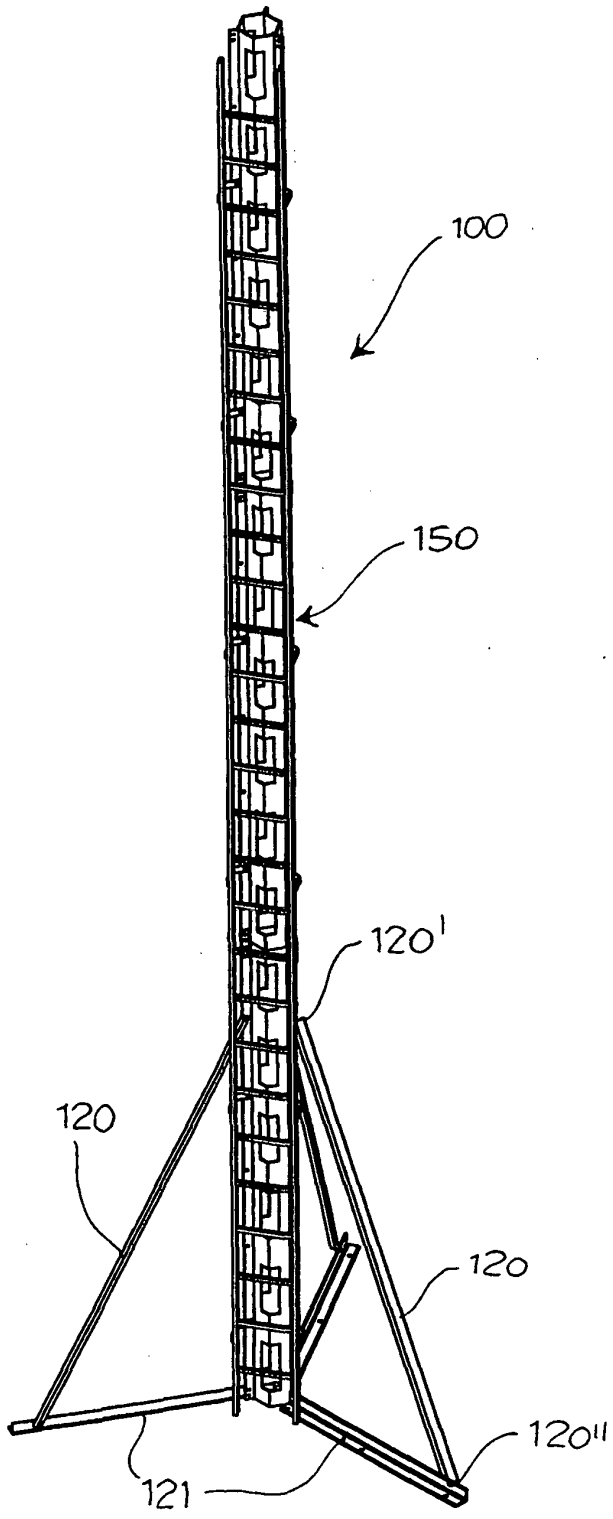


Fig. 19

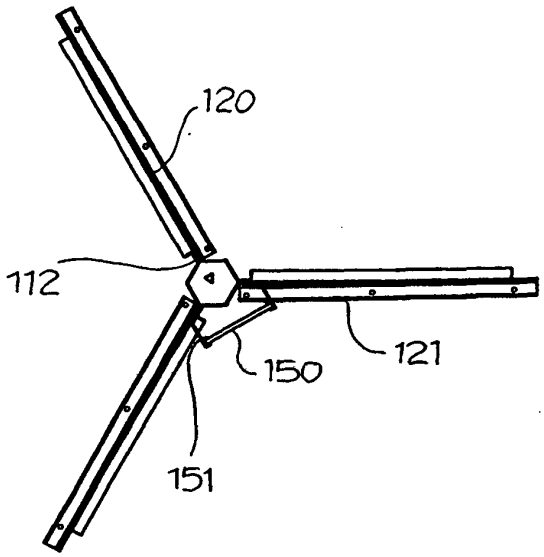


Fig. 20

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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