Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2522163 A1 2004/11/25

(21) 2 522 163

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2004/05/10
(87) Date publication PCT/PCT Publication Date: 2004/11/25
(85) Entrée phase nationale/National Entry: 2005/10/12
(86) N° demande PCT/PCT Application No.: EP 2004/005001
(87) N° publication PCT/PCT Publication No.: 2004/101905
(30) Priorités/Priorities: 2003/05/16 (MI2003A000985) IT;
2003/10/15 (60/511,085) US

(51) Cl.Int.^{7}/Int.Cl.^{7} E04B 5/02, E04C 2/296, E04C 2/22

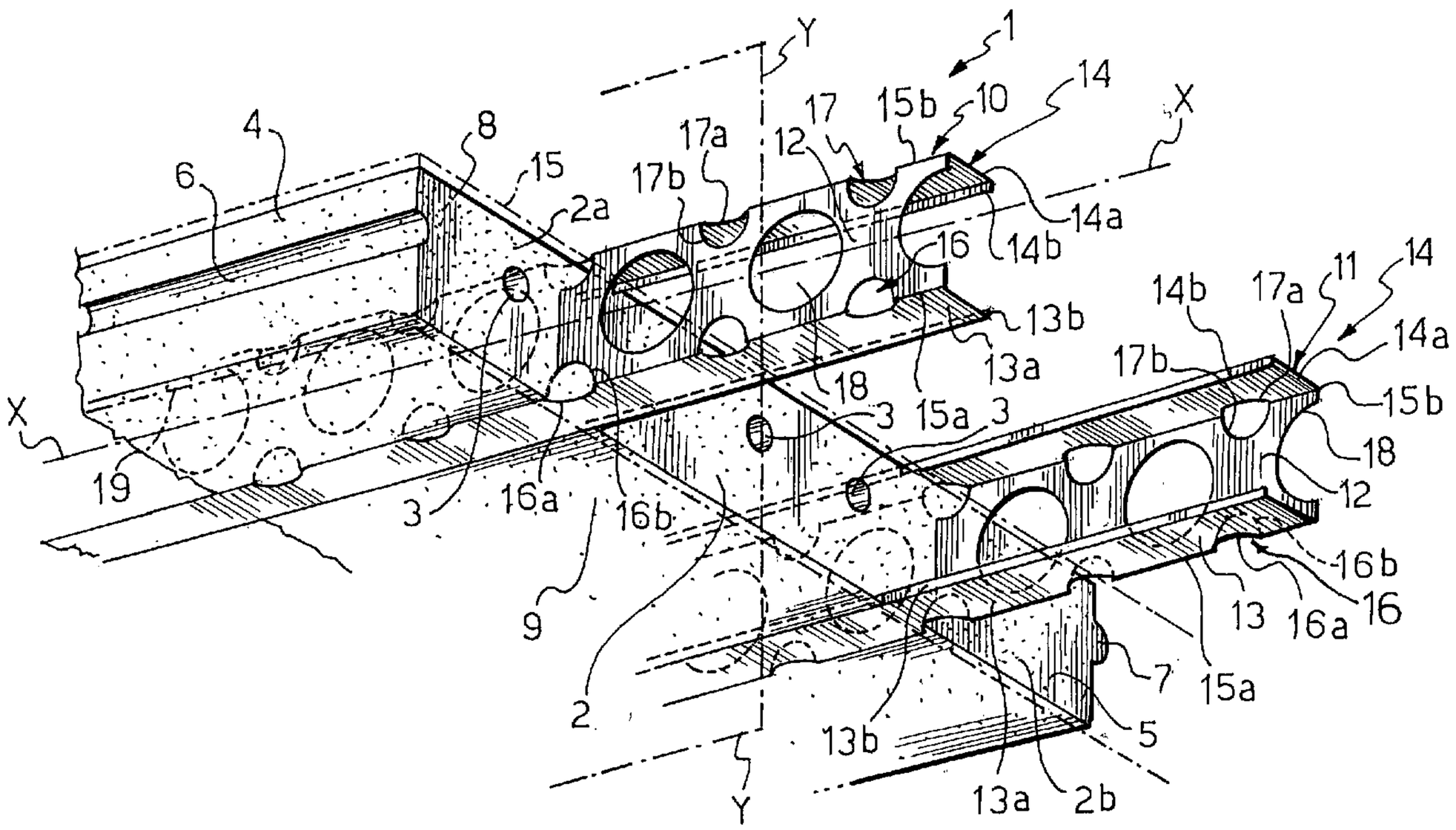
(71) Demandeur/Applicant:
PLASTEDIL S.A., CH

(72) Inventeur/Inventor:
CRETTI, PIERO, CH

(74) Agent: OYEN WIGGS GREEN & MUTALA LLP

(54) Titre : ELEMENT DE CONSTRUCTION COMPOSITE, NOTAMMENT DESTINE A LA FABRICATION DE STRUCTURES DE PAROI POUR DES BATIMENTS, ET PROCEDE DE FABRICATION DE CELUI-CI

(54) Title: COMPOSITE CONSTRUCTION ELEMENT, IN PARTICULAR FOR MAKING WALL STRUCTURES FOR BUILDINGS AND PROCESS FOR ITS MANUFACTURE



(57) Abrégé/Abstract:
A composite construction element (1) is described comprising a body (2) made of expanded plastics material provided with opposite faces (8, 9) and at least one reinforcing section bar (10, 11), transversely extending in the body (2) between the faces (8, 9) and incorporated in the expanded plastic materials. The reinforcing section bar (10, 11) comprises a central portion (12) having at least one fin (13, 14) extending in a cantilevered fashion from the same and forming a longitudinal edge (15a, 15b) therewith and a plurality of openings (16, 17) at least partially formed in the central portion (12) of the section bar (10, 11) at the longitudinal edge (15a, 15b). Advantageously, the construction element (1) has improved self-supporting characteristics and improved characteristics of resistance to bending loads which it is subjected to during installation.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 November 2004 (25.11.2004)

PCT

(10) International Publication Number
WO 2004/101905 A1

(51) International Patent Classification[7]: E04B 5/02, E04C 2/22, 2/296

(21) International Application Number: PCT/EP2004/005001

(22) International Filing Date: 10 May 2004 (10.05.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
MI2003A000985 16 May 2003 (16.05.2003) IT
60/511,085 15 October 2003 (15.10.2003) US

(71) Applicant *(for all designated States except US)*: **PLASTEDIL S.A.** [CH/CH]; Corso San Gottardo, 8A, CH-6830 Chiasso (CH).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **CRETTI, Piero** [CH/CH]; CH-6835 Morbio Superiore (CH).

(74) Agents: **BOTTERO, Claudio** et al.; Porta, Checcacci & Associati S.p.A., Via Trebbia, 20, I-20135 Milano (IT).

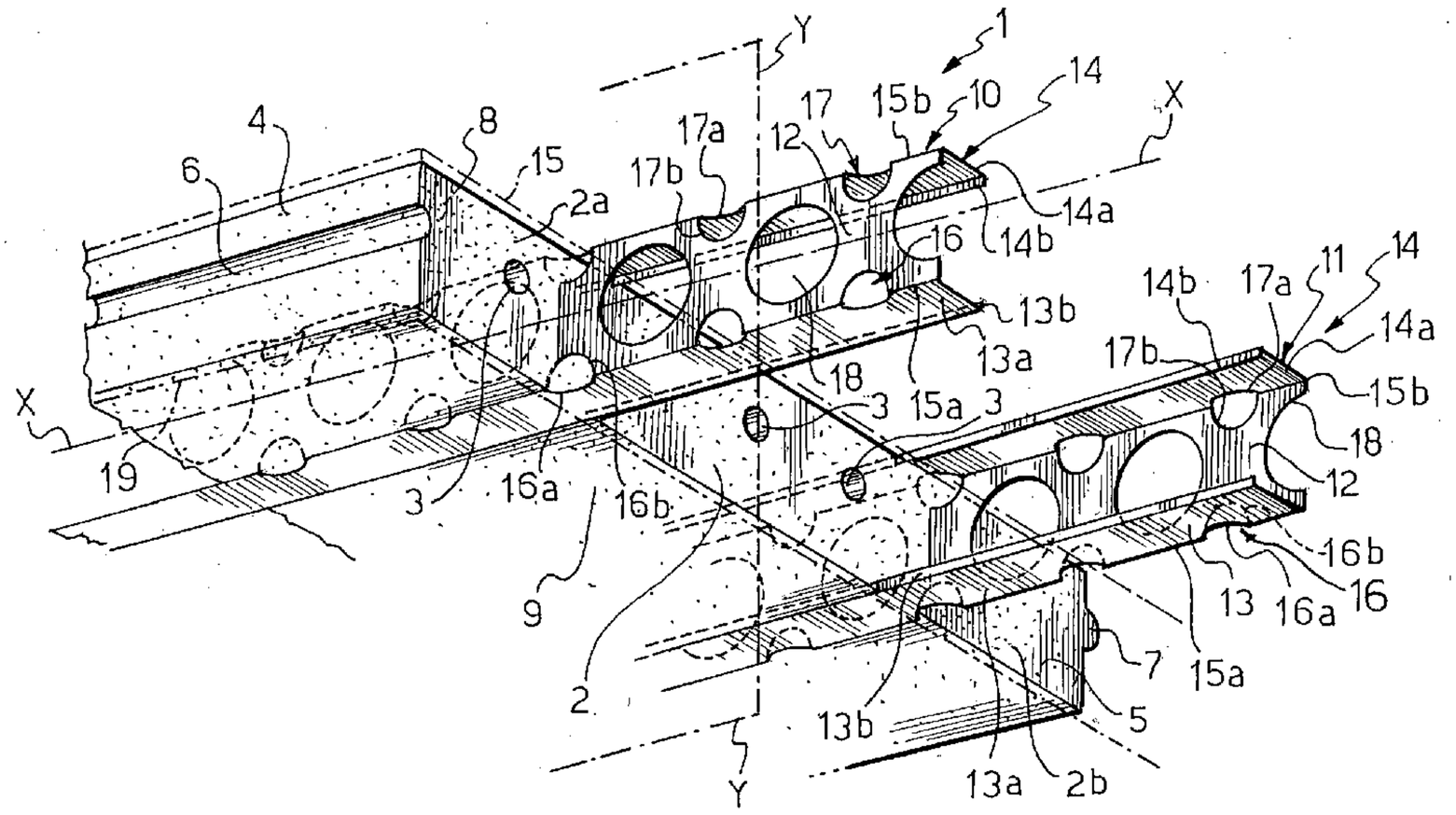
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

[Continued on next page]

(54) Title: COMPOSITE CONSTRUCTION ELEMENT, IN PARTICULAR FOR MAKING WALL STRUCTURES FOR BUILDINGS AND PROCESS FOR ITS MANUFACTURE



(57) Abstract: A composite construction element (1) is described comprising a body (2) made of expanded plastics material provided with opposite faces (8, 9) and at least one reinforcing section bar (10, 11), transversely extending in the body (2) between the faces (8, 9) and incorporated in the expanded plastic materials. The reinforcing section bar (10, 11) comprises a central portion (12) having at least one fin (13, 14) extending in a cantilevered fashion from the same and forming a longitudinal edge (15a, 15b) therewith and a plurality of openings (16, 17) at least partially formed in the central portion (12) of the section bar (10, 11) at the longitudinal edge (15a, 15b). Advantageously, the construction element (1) has improved self-supporting characteristics and improved characteristics of resistance to bending loads which it is subjected to during installation.

WO 2004/101905 A1

WO 2004/101905 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Composite construction element, in particular for making wall structures for buildings and process for its manufacture

DESCRIPTION

Background of the invention

In a general aspect thereof, the present invention refers to a composite construction element, which has preferred although not exclusive use for making vertical or horizontal wall structures or coating structures for housing units, industrial warehouses and buildings in general, as well for making external or dividing walls of bodies for lorries or similar containment structures.

The present invention concerns, more specifically, a composite construction element comprising:

a) a body made of expanded plastics material provided with opposite faces;

b) at least one reinforcing section bar, transversely extending in said body between said faces and incorporated in said expanded plastics material, said at least one reinforcing section bar comprising a central portion having at least one fin extending in a cantilevered fashion from said central portion and forming a longitudinal edge therewith.

Prior art

In the field of construction elements for making walls or containment structures in general and in particular in the field of building constructions, construction elements made of expanded plastics material, preferably expanded polystyrene, in the form of sheets or sections of suitable shape and size, having the function of thermal- and sound-proofing elements, have been used for some time.

In several applications in the building sector and in order to impart adequate self-supporting characteristics to such construction elements, it has become common practice to incorporate one or more suitably shaped reinforcing section bars in the mass of expanded plastics material.

In the following description and in the subsequent claims, the term "self-supporting" is used to indicate the ability of the construction element to withstand without structural yields or permanent deformations the stresses undergone during transportation and/or

installation.

Thus, for example, in European patent EP 0 459 924 a self-supporting construction element made of expanded plastics material is described, in particular a floor element, comprising a substantially parallelepipedic central body in which a reinforcing section bar, made of a thin metal sheet shaped as an I-beam, is integrated during the molding operations.

The Applicant has, however, noted that although the construction elements of this kind have on the one hand characteristics of lightness, relative ease of use and low cost, they could display, on the other hand, self-supporting characteristics not always adequate and, more specifically, an insufficient resistance to bending loads near the reinforcing section bar.

The Applicant has in fact observed that when the zones of the construction element externally positioned with respect to its reinforcing section bar(s) transversely extending in the body of the construction element are bent, cracks or fissures may be formed which are capable of propagating to such an extent capable to cause, in the worst case, the detachment of entire portions of expanded plastics material.

Summary of the invention

The present invention therefore has the object of providing a composite construction element made of expanded plastics material which is provided with improved self-supporting characteristics and, more specifically, with an improved resistance to bending loads applied to the construction element during transportation and/or installation.

According to a first aspect of the invention, this problem is solved by a construction element of the type indicated above, which is characterized in that said at least one reinforcing section bar comprises a plurality of openings at least partially formed in the central portion of the section bar at said longitudinal edge.

According to a second aspect of the invention, this problem is also solved by a construction element of the type indicated above, which is characterized in that said at least one reinforcing section bar comprises a plurality of openings formed in the central portion of the section bar at a predetermined distance from said longitudinal edge comprised between about 1% and about 4% and, more preferably, between about 2% and about 3%, of the width of the central portion of the section bar.

In the following description and in the subsequent claims, the distance between the openings formed in the central portion of the section bar and the aforementioned longitudinal edge is understood to be measured from the peripheral edge of the openings and along a direction substantially perpendicular to the longitudinal edge itself.

The Applicant has perceived in particular that the desired improved self-supporting characteristics and the improved characteristics of resistance to bending loads of a composite construction element of the type indicated above can be achieved by improving the integration of the reinforcing section bar in the mass of expanded plastics material at the zones which may trigger possible cracks or fissures, i.e. at the longitudinal edge formed by the fin with respect to the central portion of the section bar.

According to the invention, this improved integration of the reinforcing section bar in the mass of expanded plastics material can advantageously and effectively be achieved by forming a plurality of openings in the central portion of the section bar at, or immediately adjacent to, the aforementioned longitudinal edge.

The Applicant has observed, in particular, that such openings are able to considerably increase the resistance of the construction element to the bending loads applied to the zones of the body positioned at the outer sides of the reinforcing section bars.

Within the framework of the first embodiment of the invention in which the openings formed in the central portion of the reinforcing section bar are made at the aforementioned longitudinal edge, the openings are preferably formed astride the longitudinal edge so as to comprise a first portion extending in the aforementioned at least one fin and a second portion extending in the central portion of the reinforcing section bar, the first portion of the openings having an area lower than the area of the second portion.

In such a way, an optimal integration of the reinforcing section bar in the body of expanded plastics material of the construction element can advantageously be achieved with a substantial improvement of the resistance to the bending loads of the construction element itself without penalizing at the same time the mechanical characteristics of the fin(s) extending from the central portion of the reinforcing section bar.

Preferably, the area of the first portion of the openings is comprised between about 10% and about 40% of the total area of the openings formed astride the longitudinal edge.

Still more preferably, such an area is comprised between about 20% and about 30% of the total area of the openings formed astride the longitudinal edge.

The Applicant, in fact, has noted that in such a case it is possible to optimize the desired improvement of the resistance to bending loads of the construction element.

Alternatively and still within the framework of the first embodiment of the invention in which the openings formed in the central portion of the reinforcing section bar are made at the aforementioned longitudinal edge, the openings can be substantially tangent to such an edge.

In the following description and in the subsequent claims, the expression "openings substantially tangent to the longitudinal edge", is used to indicate not only openings exactly tangent to such an edge but also openings formed at a maximum distance from the edge equal to about 1% of the width of the central portion of the reinforcing section bar.

Within the framework of the second embodiment of the invention indicated above in which the openings are formed in the central portion of the section bar near the aforementioned longitudinal edge, it is preferred and advantageous that the distance between such openings and the longitudinal edge be comprised between about 2 mm and about 5 mm and preferably between about 3 mm and about 4 mm.

Within the framework of the invention, the shape of the openings formed at or near the aforementioned longitudinal edge is not critical.

The openings, in fact, can have any suitable geometric shape such as for example circular, polygonal (for example triangular, rectangular, square), elliptical and so forth. For reasons of practicality and ease of realization the preferred shape is the circular one.

Preferably, furthermore, the aforementioned openings have a transversal size, measured along a direction substantially perpendicular to the longitudinal axis of the central portion of the section bar, comprised between about 10 mm and about 60 mm and, still more preferably, comprised between about 20 mm and about 50 mm.

In such a way, it has been found that it is possible to optimize the desired improved integration of the reinforcing section bar in the mass of expanded plastics material of the construction element.

Preferably, furthermore, the aforementioned openings are longitudinally spaced apart pitchwise and can be arranged according to one or more rows parallel to the longitudinal edge formed by the aforementioned at least one fin of the reinforcing section bar.

Preferably, the reinforcing section bar is made of any material having suitable structural

characteristics compatible with the expanded plastics material, for example cold laminated steel, preferably galvanized, rigid plastics materials such as for example PVC, polyester polymers, polycarbonate, acrylonitrile-butadiene-styrene (ABS) copolymers and the like.

According to a preferred embodiment of the invention, the reinforcing section bar is transversely extending in the central body of the construction element along the entire thickness thereof.

Preferably, the reinforcing section bar also is longitudinally extending in the central body of the construction element along substantially the entire length thereof.

According to a preferred embodiment of the invention, the reinforcing section bar is provided with a pair of fins perpendicularly extending from axially opposite sides with respect to the central portion of the section bar.

For clear reasons of simplicity of realization and to limit the manufacturing costs, the reinforcing section bar is preferably C-shaped, Z-shaped, Ω-shaped or I-shaped for example by adjoining together two C-shaped elements making the respective central portions fit each other so that the openings formed at or in the immediate vicinity of the longitudinal edge are preferably coaxial with each other, so as to have the desired optimal structural continuity of the expanded plastics material at opposite sides of the reinforcing element.

In this latter case, the construction element is also provided with optimal supporting characteristics.

According to a preferred embodiment of the invention, the fin(s) of the reinforcing section bar extend(s) flush with and substantially parallel to at least one face of the body made of expanded plastics material of the construction element.

According to an alternative preferred embodiment of the invention, the fin(s) of the reinforcing section bar is/are completely incorporated in the expanded plastics material of the body made of expanded plastics material of the construction element.

In such a case, the fin that extends flush with the construction element carries out the function of providing an adequate supporting surface to which possible outer finishing elements may be fixed, whereas the fin(s) completely incorporated in the expanded plastics material carry out the advantageous function of increasing the compression resistance of the reinforcing section bar, increasing the self-supporting characteristics of

the construction element.

Preferably, the fin(s) comprise(s) at least one first rectilinear portion, substantially perpendicular to the central portion of the reinforcing section bar and possibly a second inclined end portion forming an angle of predetermined value with the first rectilinear portion.

Preferably, this second end portion forms an angle comprised between about 40° and about 120° and, still more preferably, equal to about 90° with respect to the first portion of the fin.

In the course of some tests carried out by the Applicant it has been noted that such a configuration of the fin contributes to further increase the stiffness of the reinforcing section bar, further increasing the self-supporting and the compression-resistance characteristics of the construction element.

Preferably, the reinforcing section bar has a thickness comprised between about 0.4 mm and about 1.2 mm and, still more preferably, between about 0.6 mm and about 1.0 mm.

Preferably, the central portion of the reinforcing section bar has, after formation of the fins, a width comprised between about 50 mm and about 180 mm and, still more preferably, between about 60 mm and about 120 mm, whereas the opposite fin(s) of the section bar have a width comprised between about 15 mm and about 60 mm and, still more preferably, comprised between about 30 mm and about 50 mm.

Should the fin(s) comprise a first rectilinear portion, substantially perpendicular to the central portion of the reinforcing section bar and a second inclined end portion, such a first portion has a width comprised between about 15 mm and about 60 mm and, still more preferably, comprised between about 30 mm and about 50 mm, whereas the second portion has a width comprised between about 4 mm and about 10 mm and, still more preferably, comprised between about 4 mm and about 6 mm.

In a particularly preferred embodiment, the reinforcing section bar is advantageously provided with a second plurality of openings formed in the central portion thereof.

Such openings carry out the two-fold advantageous function of lightening the reinforcing section bar improving the self-supporting characteristics of the construction element, and of allowing an even more intimate integration of the reinforcing section bar in the mass of expanded plastics material.

Thanks to the presence of such additional openings, in fact, the mass of expanded

plastics material is able to interpenetrate with the reinforcing section bar during molding, integrating and stably holding in position the reinforcing section bar in the central body of the construction element.

This intimate integration of the reinforcing section bar in the mass of expanded plastics material, furthermore, contributes to prevent undesired deformations or bending along the transversal direction of the reinforcing section bar even if the latter essentially consists, as stated above, of a somewhat thin metal strip.

Preferably and in order to further increase the rigidity of the body of the construction element, these additional openings formed in the central portion of the reinforcing section bar can advantageously be equipped, along the peripheral edge thereof, with a protruding lip or, alternatively, with one or more protrusions distributed along the peripheral edge and angularly offset with one another, adapted to constitute an additional attaching means of the reinforcing section bar to the mass of expanded plastics material.

Such protrusions can extend either from a single side of the reinforcing section bar or from opposite sides thereof.

Preferably, these additional openings are formed astride the longitudinal axis of the central portion of the reinforcing section bar.

Preferably, the total area of all of the openings formed in the reinforcing section bar is comprised between about 10% and about 60% of the total area of the section bar, meaning with this term the area of the overall side surface of the section bar including that of its fin(s) (i.e. the area of the overall side surface before forming the fins and the openings).

Still more preferably, the total area of all the openings formed in the reinforcing section bar is comprised between about 30% and about 40% of the total area thereof.

According to the invention, also the shape of the openings of this second plurality - obtainable in a way known *per se*, such as for example by punching - is not critical; however, it is preferably circular for clear reasons of simplicity of realization.

Preferably, furthermore, the aforementioned additional openings have a transversal size, measured along a direction substantially perpendicular to the longitudinal axis of the central portion of the section bar, comprised between about 15 mm and about 100 mm and, still more preferably, comprised between about 30 mm and about 80 mm.

In a preferred embodiment, the openings are formed in the reinforcing section bar according to three parallel rows: a first central row of circular openings, having a prevailing diameter, arranged pitchwise along the longitudinal axis of the central portion of the reinforcing section bar and two lateral rows of circular openings of smaller diameter, arranged pitchwise at opposite sides of the aforementioned central row and formed at or near the longitudinal edge formed by the fins with the central portion of the section bar.

Preferably, the circular openings of the lateral rows have parallel axes and are positioned between two consecutive openings of the central row, as shall become clearer in the following description.

Advantageously, it is possible in this way to distribute in a particularly effectively manner the aforementioned void areas in the various portions of the reinforcing section bar, lightening its structure without harming its characteristics of mechanical resistance and at the same time obtaining an optimal integration of the reinforcing section bar in the expanded plastics material.

Preferably, the pitch of the openings of the central row is proportional to their size and is equal to that of the lateral rows and is comprised between about 80 mm and about 100 mm and, still more preferably, is equal to about 90 mm.

Within the framework of this preferred embodiment, the openings formed at or at a predetermined distance from the aforementioned longitudinal edge have an overall area comprised between about 15% and about 40% of the total area of all of the openings formed in the reinforcing section bar.

According to a further preferred embodiment of the invention, the construction element can further comprise at least one rigid covering element associated to the reinforcing section bar.

Preferably, such a covering element is a panel of plasterboard, wood, rigid plastics material or another suitable material having a decorative and/or structural function and optionally coated with ceramic tiles.

The construction elements of the invention can also achieve advantageous supporting characteristics, i.e. be able to autonomously support possible static loads applied thereon, as a function of the predetermined covering element chosen, having or not structural characteristics.

According to the invention, the construction elements described above comprising a plurality of openings formed in the central portion of the section bar at or near the longitudinal edge formed between the aforementioned at least one fin and said central portion, can be obtained by means of a process as defined in the attached claim 22 or 23, respectively.

Advantageously, such processes can be carried out by means of shearing, profiling and molding apparatuses which are conventional *per se* and known in the art.

Preferred features of these processes are disclosed in dependent claims 24-32.

According to a third aspect thereof, the invention also relates to a wall structure for buildings comprising at least one composite construction element of the type described above and, preferably, comprising a plurality of such construction elements arranged next to each other.

According to a fourth aspect thereof, the invention finally relates to a coating structure for covering buildings comprising a plurality of composite construction elements of the type described above arranged next to each other on a supporting structure.

Brief description of the drawings

Additional features and advantages of the invention will become more readily apparent from the description of some preferred embodiments of a construction element according to the invention, given hereinafter, for illustrating and not limiting purposes, with reference to the attached drawings.

In the drawings:

- Fig. 1 shows a perspective view, in partial cross-section, of a first embodiment of a construction element according to the invention;

- Fig. 2 shows an enlarged scale perspective view of some details of the reinforcing section bar incorporated in the construction element of figure 1;

- Fig. 3 shows a perspective view, in partial cross-section, of a further embodiment of a construction element according to the invention;

- figs. 4 and 5 show respective enlarged scale perspective views of some details of some alternative embodiments of the reinforcing section bar incorporated in the construction element according to the invention;

- Fig. 6 shows a perspective view, in partial cross-section, of a further embodiment of a construction element according to the invention;

- Fig. 7 shows a cross section view of a further embodiment of a construction element according to the invention;

- Fig. 8 shows a plan view of a strip of structural material that can be used for making a construction element according to the invention;

- Fig. 9 shows an enlarged scale plan view of a detail of the strip of figure 8.

Detailed description of the preferred embodiments

With reference to figures 1 and 2, a composite construction element made of expanded plastics material, for example expanded polystyrene, according to a first embodiment of the present invention is generally indicated at 1.

The construction element 1 of the illustrated example can advantageously be used for making supporting and dividing walls for buildings and comprises a body 2, in which a plurality of parallel recesses 3 are longitudinally defined.

Alternatively, the construction element 1 of the illustrated example can also be advantageously used for making bodies for lorries or similar structures.

In a way known *per se*, the body 2 is also laterally equipped with opposite sides 4, 5 respectively provided with a groove 6 and, respectively, with a rib 7, having a mating shape, longitudinally extending along the entire length of the construction element 1.

In such a way, a plurality of construction elements 1 can be stably connected with each other by means of a substantially mating joint.

The construction element 1 is also provided with opposite, upper and respectively lower, faces 8, 9 and incorporates two structurally identical reinforcing section bars 10, 11, arranged in a mirror-like fashion with respect to a longitudinal plane of symmetry Y-Y of the construction element 1.

Although in the illustrated example the faces 8, 9 are substantially planar, it goes without saying that their shape is not critical for the purposes of the invention; the shape of the faces, in fact, may assume any other geometrical configuration useful for the intended purposes.

The reinforcing section bars 10, 11 are longitudinally extending in the body 2 of the

construction element 1 along substantially the entire length thereof between the aforementioned upper and lower faces 8, 9.

According to the illustrated embodiment, the reinforcing section bars 10 and 11 are substantially C-shaped and each comprise a central portion 12 and a pair of upper and, respectively, lower fins 13, 14, extending in a cantilevered fashion from the central portion 12 and forming axially opposite longitudinal edges 15a, 15b therewith.

In the preferred embodiment illustrated, the fins 13, 14 are extending from the ends of the central portion 10 substantially perpendicularly to the same.

Preferably, the reinforcing section bars 10 and 11 are obtained by suitably shaping a sheet of cold laminated galvanized steel having a thickness of about 0.8 mm, by means of apparatuses known *per se* and as will be better apparent in the following.

In the preferred embodiment illustrated in figures 1 and 2, the reinforcing section bars 10, 11 are transversely extending in the body 2 of the construction element 1 substantially along the entire thickness thereof, so that – as illustrated in figure 1 – the fins 13, 14 extend substantially flush with the faces 8, 9 of the body 2.

Preferably, the opposite fins 13, 14 comprise a first portion 13a, 14a substantially perpendicular to the central portion 12 of the reinforcing section bars 10, 11 and a second inclined end portion 13b, 14b forming an angle having a predetermined value with the first portion 13a, 14a.

Preferably, furthermore, the central portion 12 of the reinforcing section bars 10, 11 has a width equal to about 80 mm, whereas the first portion 13a, 14a of the fins 13, 14 has a width equal to about 45 mm, whereas the end portion 13b, 14b has a width equal to about 5 mm and forms an angle equal to about 90° with respect to the first portion 13a, 14a.

Some tests carried out by the Applicant, showed that a construction element reinforced with section bars shaped in this way has self-supporting and compression-resistance characteristics totally comparable to those possessed by a similar construction element reinforced with section bars having a thickness of about 1.2 mm but not having bent fins 13, 14.

In this preferred embodiment, the reinforcing section bars 10, 11 comprise two rows of openings respectively indicated with reference numerals 16 and 17, substantially parallel to each other and to the longitudinal axis X-X of the central portion 12.

Preferably, the openings 16 and 17 are circular holes obtained by punching and are longitudinally spaced apart pitchwise.

According to the invention, the openings 16 and 17 are at least partially formed in the central portion 12 of the reinforcing section bars 10, 11 at the longitudinal edges 15a, 15b.

Such openings carry out the advantageous function of providing the expanded plastics material which constitutes the body 2 of the construction element 1 with a structural continuity that substantially completely eliminates the problems of insufficient resistance to bending loads which affect the composite construction elements of the prior art.

More specifically, the openings 16 and 17 maximize the resistance of the construction element to bending loads applied on the zones 2a, 2b of the body 2 that are positioned at the outer sides of the reinforcing section bars 10, 11.

The openings 16 and 17 also carry out the additional advantageous functions of lightening the reinforcing section bars 10, 11 and of fixing them as tightly as possibly to the mass of expanded plastics material.

In the preferred embodiment illustrated in figures 1 and 2, the openings 16 and 17 are formed astride the respective longitudinal edges 15a, 15b and comprise a first portion 16a, 17a extending in the fins 13, 14 and a second portion 16b, 17b extending in the central portion 12 of the reinforcing section bars 10, 11.

Preferably, the first portion 16a, 17a of the openings 16, 17 has in this case an area lower than the area of the second portion 16b, 17b.

More specifically, the area of the aforementioned first portion 16a, 17a of the openings 16, 17 is equal to about 30% of the total area of the openings themselves.

According to the preferred embodiment illustrated in figures 1 and 2, the reinforcing section bars 10, 11 are advantageously provided with an additional plurality of openings 18, preferably circular holes obtained by punching, formed in the central portion 12.

The additional openings 18 carry out both the two-fold advantageous function of lightening the reinforcing section bars 10, 11 and of fixing them as tightly as possible to the mass of expanded plastics material and the advantageous function of contributing to increase the resistance of the construction element 1 to bending loads.

In the preferred embodiment illustrated in figures 1 and 2, therefore, the reinforcing section bars 10, 11 are provided with three parallel rows of openings: a first central row including the circular openings 18, having a prevailing diameter, pitchwise arranged astride the longitudinal axis X-X of the central portion 12 of the section bars, and two lateral rows including the circular openings 16, 17 having a smaller diameter, positioned at opposite sides of the aforementioned central row.

Preferably, the circular openings 16, 17 of the lateral rows have parallel axes and are positioned between two consecutive openings 18 of the central row, as illustrated in figure 1.

Preferably, the openings 18 have a diameter equal to about 60 mm, whereas the openings 16 and 17 have a diameter equal to about 30 mm, whereas the pitch of all of the rows of holes 16-18 is equal to about 90 mm.

The aforementioned openings 16-18, therefore, define a perforated area or void area equal to about 30% of the total area of the reinforcing section bars 10 and 11, meaning with the term "total area" the area of the overall side surface of the section bars (central portion 12 and fins 13, 14).

Preferably, furthermore, the openings 16, 17 have an overall area equal to about 30% of the total area of all of the openings 16-18 formed in the reinforcing section bars 10, 11.

Advantageously, the construction element 1 described above is able to achieve the desired improved self-supporting characteristics imparted to the same by the reinforcing section bars 10, 11 suitably integrated without any substantial interruption in the structural continuity of the mass of expanded plastics material ensured by the openings 16, 17.

In a further preferred embodiment, the construction element 1 can further comprise a rigid covering element, such as for example a panel of plasterboard, indicated with reference numeral 19 and illustrated with dotted and dashed lines in the figures, associated to one or both the fins 13, 14 of the reinforcing section bars 10, 11.

Preferably, the construction element 1 comprises a pair of panels 19 associated to the fins 13, 14 of the reinforcing section bars 10, 11 on the faces 8, 9 of the construction element 1 in a way known *per se*, for example by means of a series of screws or pegs which are not shown.

In this case, the construction element 1 of the invention is capable to achieve

advantageous supporting characteristics, i.e. is capable of autonomously supporting possible static loads applied thereon.

In figures 3-7 additional embodiments of the construction element 1 according to the present invention are schematically illustrated.

In the following description and in such figures, the components of the construction element 1 structurally and functionally equivalent to those illustrated with reference to the previous embodiment shall be indicated with the same reference numerals and shall not be described any further.

According to the embodiment illustrated in figure 3, the reinforcing section bars 10, 11 of the construction element 1, fins included, are completely incorporated in the expanded plastics material of the body 2.

Advantageously, the fins 16, 17 carry out in this case the advantageous additional function of increasing the compression resistance of the reinforcing section bars 10, 11, increasing the self-supporting characteristics of the construction element 1.

According to the embodiment of the invention illustrated in figure 4, the openings 16, 17 formed in the central portion 12 of the reinforcing section bars 10, 11 - only the upper part of which being shown in such a figure for clear reasons of symmetry - are substantially tangent to the longitudinal edges 15a, 15b.

The Applicant, in fact, has observed that also with this construction the desired improvement in the characteristics of resistance to bending loads of the construction element 1 can advantageously be achieved.

According to the embodiment of the invention illustrated in figure 5, the openings 16, 17 are formed in the central portion 12 of the reinforcing section bars 10, 11 - only the upper part of which being shown here as well in such a figure for clear reasons of symmetry - at a predetermined distance d from the longitudinal edges 15a, 15b comprised between about 1% and about 4% of the width of the central portion 12 of the section bars themselves.

Preferably, such a distance d is equal to about 3 mm.

The Applicant has observed that also with this alternative construction the desired improvement in the characteristics of resistance to bending loads of the construction element 1 can advantageously be achieved.

According to the embodiment of the invention illustrated in figure 6, the reinforcing section bars 10, 11 of the construction element 1 are substantially Z-shaped and each comprise a pair of lower and, respectively, upper fins 16, 17 perpendicularly extending from the ends of the central portion 12 from opposite sides thereof.

Preferably, the reinforcing section bars 10, 11 are transversely extending in the body 2 of the construction element 1 substantially for its entire thickness, so that - as illustrated in figure 6 - the fins 13, 14 extend substantially flush with the opposite faces 8, 9 of the body 2.

In the same way as the embodiments illustrated hereinabove, the fins 13, 14 comprise also in this case a first rectilinear portion 13a, 14a substantially perpendicular to the central portion 12 of the reinforcing section bars 10, 11 and a second inclined end portion 13b, 14b forming an angle of predetermined value with the first portion 13a, 14a.

Preferably, the first portion 13a, 14a of the fins 13, 14 has a width equal to about 45 mm, whereas the end portion 13b, 14b has a width equal to about 5 mm and forms an angle equal to about 90° with respect to the first portion.

Advantageously, the characteristics of resistance to bending loads of the construction element 1 are further improved in this additional embodiment.

According to the embodiment of the invention illustrated in figure 7, the substantially Z-shaped reinforcing section bars 10, 11 of the construction element 1 are completely incorporated in the expanded plastics material of the body 2.

Advantageously, the fins 13, 14 carry out also in this case the advantageous additional function of increasing the compression resistance of the reinforcing section bars 10, 11, increasing the self-supporting characteristics of the construction element 1.

With reference to the embodiments of the construction element 1 described above and to figures 8 and 9, a preferred embodiment of a process according to the invention shall now be described, for example for manufacturing the construction element 1 illustrated in figures 1 and 2.

In a preliminary step, carried out in a way known *per se*, a strip 20 of rigid structural material, for example galvanized steel, intended to form the reinforcing section bars 10, 11, is provided.

Advantageously, the strip 20 has a predetermined thickness and width for example equal

to about 0.8 mm and to about 180 mm, respectively.

The strip 20 comprises a central portion 21 and a pair of side portions 22, 23 extending from axially opposite sides with respect to the central portion 21, which portions are intended to constitute the central portion 12 and, respectively, the fins 13, 14 of the reinforcing section bars 10, 11 being manufactured, as shall become clearer hereafter.

In a subsequent step, the process according to the invention comprises the formation in the strip 20 of the openings 16 and 17 extending at least partially in the central portion 21 at the opposite side portions 22 and 23.

Preferably, the openings 16 and 17 are circular and form a pair of parallel rows extending in the longitudinal direction along the strip 20.

In this preferred embodiment, furthermore, the additional row including the openings 18, also preferably circular, is also simultaneously formed astride the longitudinal axis X-X of the strip 20.

Such a forming operation of the openings 16-18 can be carried out in a conventional way known *per se*, for example by punching.

In an alternative embodiment of the process of the invention, it is also possible to manufacture the construction element 1 starting from a pre-perforated strip wound in a reel and positioned upstream of the bending station.

In a subsequent step, the strip 20 is bent in a way known *per se* - for example by means of a profiler - along a pair of longitudinal bending lines 24, 25 substantially parallel to each other and intersecting the openings 16 and 17.

In such a way, the reinforcing section bars 10, 11 are formed comprising the aforementioned central portion 12 and the fins 13, 14 extending in a cantilevered fashion from the same both below or above the lying plane of the strip 20 and forming the opposite longitudinal edges 15a and 15b.

Preferably, the bending step is carried out in such a way that the fins 16 and 17 form an angle of about 90° with respect to the lying plane of the central portion 21 of the strip 20.

Preferably, the bending lines 24, 25 extend parallel to the row of openings 16, 17 at a distance d' from the longitudinal axis Z-Z of the row comprised between about 15% and about 50% of the maximum transversal size D of the aforementioned openings (in this

case equal to the diameter of the circular openings) measured along a direction substantially perpendicular to the longitudinal axis X-X of the central portion 21 of the strip 20.

In the case of the construction element 1 illustrated in figures 1 and 2, the distance d' is preferably equal to about 5 mm.

It goes without saying that the alternative embodiments of the construction element 1 of the invention, in which the openings 16 and 17 are substantially tangent to the longitudinal edges 15a and 15b or are positioned in their immediate vicinity, can be produced by bending the strip 20 along bending lines 24, 25 that are suitably positioned with respect to the aforementioned openings.

In the case in which it is desired to position the openings 16 and 17 in the immediate vicinity of the longitudinal edges 15a and 15b of the reinforcing section bars 10, 11, it is preferable and advantageous that the distance between the longitudinal bending lines 24 and 25 and the openings 16, 17 is between about 1% and about 4% of the width of the central portion 12 of the resulting section bar, in this case coinciding with the width of the central portion 21 of the strip 20.

In the case of the reinforcing section bar illustrated in figure 5, the distance d is preferably equal to about 3 mm.

Preferably, furthermore, the bending step of the strip 20 can be carried out, still using apparatuses known *per se*, in such a way as to further bend the fins 13, 14 by about 90° so as to obtain the aforementioned first portion 13a, 14a substantially perpendicular to the central portion 21 of the strip 20 and the second inclined end portion 13b, 14b forming an angle of predetermined value with respect to the first portion 13a, 14a.

In an alternative preferred embodiment, the bending step of the strip 20 can be carried out, still using apparatuses known *per se*, in such a way as to further bend the fins 13, 14 respectively over and under the lying plane of the strip 20 itself, so as to obtain the construction element structures 1 illustrated in figures 6 and 7.

In a subsequent step, the reinforcing section bars 10, 11 thus obtained are positioned in a molding seat of a suitable apparatus for molding plastics material that is conventional *per se* and not shown.

Once the positioning of the reinforcing section bars 10, 11 in the molding seat has taken place, the steps of feeding granules of expandable plastics material into said space and

of subjecting the granules of plastics material in the molding seat to expansion and subsequent welding are then carried out, so as to form the body 2 of the construction element 1 incorporating reinforcing section bars 10, 11.

In a preferred embodiment, the forming step of the body 2 made of expanded plastics material is carried out in such a way that the fins 13, 14 of the reinforcing section bars 10, 11 extend flush with and substantially parallel to the faces 8, 9 of the body 2 itself, so as to obtain the construction element structures 1 illustrated in figures 1, 2 and 6.

In an alternative preferred embodiment, the forming step of the body 2 made of expanded plastics material can be carried out in such a way that the fins 13, 14 of the reinforcing section bars 10, 11 are completely incorporated in the body 2 itself, so as to obtain the construction element structures 1 illustrated in figures 3 and 7.

Should the manufacture of the construction element 1 be carried out continuously, the process finally comprises a final step, also carried out with apparatuses known *per se*, in which the body 2 is cut to size so as to obtain a construction element having the desired length.

Obviously, a man skilled in the art may introduce changes and variants to the invention described above in order to satisfy specific and contingent application requirements, changes and variants which anyway fall within the scope of protection as defined by the following claims.

CLAIMS

1. Composite construction element (1) comprising:

a) a body (2) made of expanded plastics material provided with opposite faces (8, 9);

b) at least one reinforcing section bar (10, 11), transversely extending in said body (2) between said faces (8, 9) and incorporated in said expanded plastics material, said at least one reinforcing section bar (10, 11) comprising a central portion (12) having at least one fin (13, 14) extending in a cantilevered fashion from said central portion (12) and forming a longitudinal edge (15a, 15b) therewith;

characterized in that said at least one reinforcing section bar (10, 11) comprises a plurality of openings (16, 17) at least partially formed in the central portion (12) of the section bar (10, 11) at said longitudinal edge (15a, 15b).

2. Composite construction element (1) comprising:

a) a body (2) made of expanded plastics material provided with opposite faces (8, 9);

b) at least one reinforcing section bar (10, 11), transversely extending in said body (2) between said faces (8, 9) and incorporated in said expanded plastics material, said at least one reinforcing section bar (10, 11) comprising a central portion (12) having at least one fin (13, 14) extending in a cantilevered fashion from said central portion (12) and forming a longitudinal edge (15a, 15b) therewith;

characterized in that said at least one reinforcing section bar (10, 11) comprises a plurality of openings (16, 17) formed in the central portion (12) of the section bar (10, 11) at a predetermined distance from said longitudinal edge (15a, 15b) comprised between about 1% and about 4% of the width of the central portion (12) of the section bar (10, 11).

3. Construction element (1) according to claim 1, wherein said openings (16, 17) are formed astride said longitudinal edge (15a, 15b) and comprise a first portion (16a, 17a) extending in said at least one fin (13, 14) and a second portion (16b, 17b) extending in said central portion (12) of the reinforcing section bar (10, 11), said first portion (16a, 17a) of the openings (16, 17) having an area lower than the area of said second portion (16b, 17b).

4. Construction element (1) according to claim 3, wherein the area of the first portion (16a, 17a) of the openings (16, 17) formed astride the longitudinal edge is between about 10% and about 40% of the total area of said openings (16, 17).

5. Construction element (1) according to claim 1, wherein said openings (16, 17) are formed in the central portion (12) of the reinforcing section bar (10, 11) and are substantially tangent to said longitudinal edge (15a, 15b).

6. Construction element (1) according to claim 1 or 2, wherein said openings (16, 17) have a transversal size, measured along a direction substantially perpendicular to the longitudinal axis (X-X) of the central portion (12) of the section bar (10, 11), comprised between about 10 mm and about 60 mm.

7. Construction element (1) according to claim 1 or 2, wherein said openings (16, 17) are longitudinally spaced apart pitchwise.

8. Construction element (1) according to claim 1 or 2, wherein said reinforcing section bar (10, 11) is transversely extending in the body (2) of the construction element (1) along the entire thickness thereof.

9. Construction element (1) according to claim 1, 2 or 8, wherein said reinforcing section bar (10, 11) is longitudinally extending in said body (2) along substantially the entire length thereof.

10. Construction element (1) according to claim 1, 2, 9 or 10, wherein said reinforcing section bar (10, 11) comprises a pair of fins (13, 14) extending from opposite sides of the central portion (12) of the reinforcing section bar (10, 11).

11. Construction element (1) according to claim 10, wherein said reinforcing section bar (10, 11) is substantially C-shaped or Z-shaped.

12. Construction element (1) according to claim 1, 2, 9 or 10, wherein said at least one fin (13, 14) of the reinforcing section bar (10, 11) extends flush with and substantially parallel to at least one face (8, 9) of said body (2) made of expanded plastics material.

13. Construction element (1) according to claim 1, 2, 9 or 10, wherein said at least one fin (13, 14) of the reinforcing section bar (10, 11) is completely incorporated in the expanded plastics material of the body (2) of the construction element (1).

14. Construction element (1) according to claim 1 or 2, wherein said at least one fin

(13, 14) comprises at least one first rectilinear portion (13a, 14a) substantially perpendicular to the central portion (12) of the reinforcing section bar (10, 11).

15. Construction element (1) according to claim 1 or 2, wherein said reinforcing section bar (10, 11) has a thickness comprised between about 0.4 mm and about 1.2 mm.

16. Construction element (1) according to claim 1 or 2, wherein said reinforcing section bar (10, 11) further comprises a second plurality of openings (18) formed in said central portion (12) of the section bar (10, 11).

17. Construction element (1) according to claim 16, wherein the total area of all of the openings (16, 17, 18) formed in the reinforcing section bar (10, 11) is comprised between about 10% and about 60% of the total area of the reinforcing section bar (10, 11).

18. Construction element (1) according to claim 16, wherein the openings (18) of said second plurality have a transversal size, measured along a direction substantially perpendicular to the longitudinal axis (X-X) of the central portion (12) of the section bar (10, 11), comprised between about 15 mm and about 100 mm.

19. Construction element (1) according to claim 16, wherein the openings (16, 17) formed in the central portion (12) of the section bar (10, 11) at said longitudinal edge (15a, 15b) or at a predetermined distance from said longitudinal edge (15a, 15b), have an overall area comprised between about 15% and about 40% of the total area of all of the openings (16, 17, 18) formed in the reinforcing section bar (10, 11).

20. Construction element (1) according to claim 1 or 2, further comprising at least one rigid covering element (19) associated to said reinforcing section bar (10, 11).

21. Construction element (1) according to claim 20, wherein said rigid covering element (19) is a panel of plasterboard, wood, rigid plastics material or another suitable material optionally coated with ceramic tiles.

22. Process for manufacturing a construction element (1) according to claim 1, comprising the steps of:

a) providing a strip (20) of a rigid material having a predetermined thickness and width, said strip (20) having a central portion (21) and a pair of opposite side portions (22, 23) extending from opposite sides of said central portion (21);

b) forming in said strip (20) a plurality of openings (16, 17) extending at least partially in said central portion (21) at at least one of said opposite side portion (22, 23);

c) bending said strip (20) along at least one longitudinal bending line (24, 25) intersecting or being substantially tangent to said plurality of openings (16, 17), in such a way as to form a reinforcing section bar (10, 11) comprising a central portion (12) having at least one fin (13, 14) extending in a cantilevered fashion from said central portion (12) and forming a longitudinal edge (15a, 15b) therewith;

d) positioning the reinforcing section bar (10, 11) thus obtained in a molding seat of a suitable apparatus for molding plastics material;

e) feeding granules of expandable plastics material into said molding seat;

f) expanding and then bonding together the plastics granules in said molding seat, so as to form a body (2) made of expanded plastics material provided with opposite faces (8, 9) incorporating said reinforcing section bar (10, 11).

23. Process for manufacturing a construction element (1) according to claim 2, comprising the steps of:

a) providing a strip (20) of a rigid material having a predetermined thickness and width, said strip (20) having a central portion (21) and a pair of opposite side portions (22, 23) extending from opposite sides of said central portion (21);

b) forming in said strip (20) a plurality of openings (16, 17) extending in said central portion (21) near to at least one of said opposite side portion (22, 23);

c) bending said strip (20) along at least one longitudinal bending line (24, 25) extending at a predetermined distance from said plurality of openings (16, 17), in such a way as to form a reinforcing section bar (10, 11) comprising a central portion (12) having at least one fin (13, 14) extending in a cantilevered fashion from said central portion (12) and forming a longitudinal edge (15a, 15b) therewith, the distance between said bending line (24, 25) and said plurality of openings (16, 17) being between about 0.1% and about 1% of the width of the central portion (12) of the resulting section bar (10, 11);

d) positioning the reinforcing section bar (10, 11) thus obtained in a molding seat of a suitable apparatus for molding plastics material;

e) feeding granules of expandable plastics material into said molding seat;

f) expanding and then bonding together the plastics granules in said molding seat, so as to form a body (2) made of expanded plastics material provided with opposite faces (8, 9) incorporating said reinforcing section bar (10, 11).

24. Process according to claim 22 or 23, wherein said openings (16, 17) form at least one row extending in the longitudinal direction along said strip (20).

25. Process according to claim 24, wherein said bending line (24, 25) extends parallel to the row of openings (16, 17) at a distance from the longitudinal axis (Z-Z) of the row comprised between about 15% and about 50% of the maximum transversal size of said openings (16, 17) measured along a direction substantially perpendicular to said longitudinal axis (Z-Z).

26. Process according to claim 22 or 23, wherein said bending step c) is carried out in such a way that said at least one fin (13, 14) forms an angle of about 90° with respect to the lying plane of the central portion (21) of said strip (20).

27. Process according to claim 22 or 23, wherein said bending step c) is carried out by bending said strip (20) along two longitudinal bending lines (24, 25) substantially parallel to each other so as to form a pair of fins (13, 14) extending in a cantilevered fashion from axially opposite sides with respect to the central portion (21) of the strip (20).

28. Process according to claim 27, wherein said fins (13, 14) extend in a cantilevered fashion both above or both below the lying plane of the strip (20).

29. Process according to claim 27, wherein said fins (13, 14) extend in a cantilevered fashion respectively above and below the lying plane of the strip (20).

30. Process according to claim 22 or 23, further comprising the step of forming a second plurality of openings (18) in the central portion (21) of the strip (20).

31. Process according to claim 22 or 23, wherein said step f) is carried out in such a way that said at least one fin (13, 14) of the reinforcing section bar (10, 11) extends flush with and substantially parallel to at least one face (8, 9) of said body (2) made of expanded plastics material.

32. Process according to claim 22 or 23, wherein said step f) is carried out in such a way that said at least one fin (13, 14) of the reinforcing section bar (10, 11) is completely incorporated in said body (2) made of expanded plastics material.

33. Wall structure comprising at least one construction element (1) according to any one of claims 1-21.

34. Coating structure for covering buildings comprising a plurality of composite construction elements (1) according to any one of claims 1-21 arranged next to each other on a supporting structure.

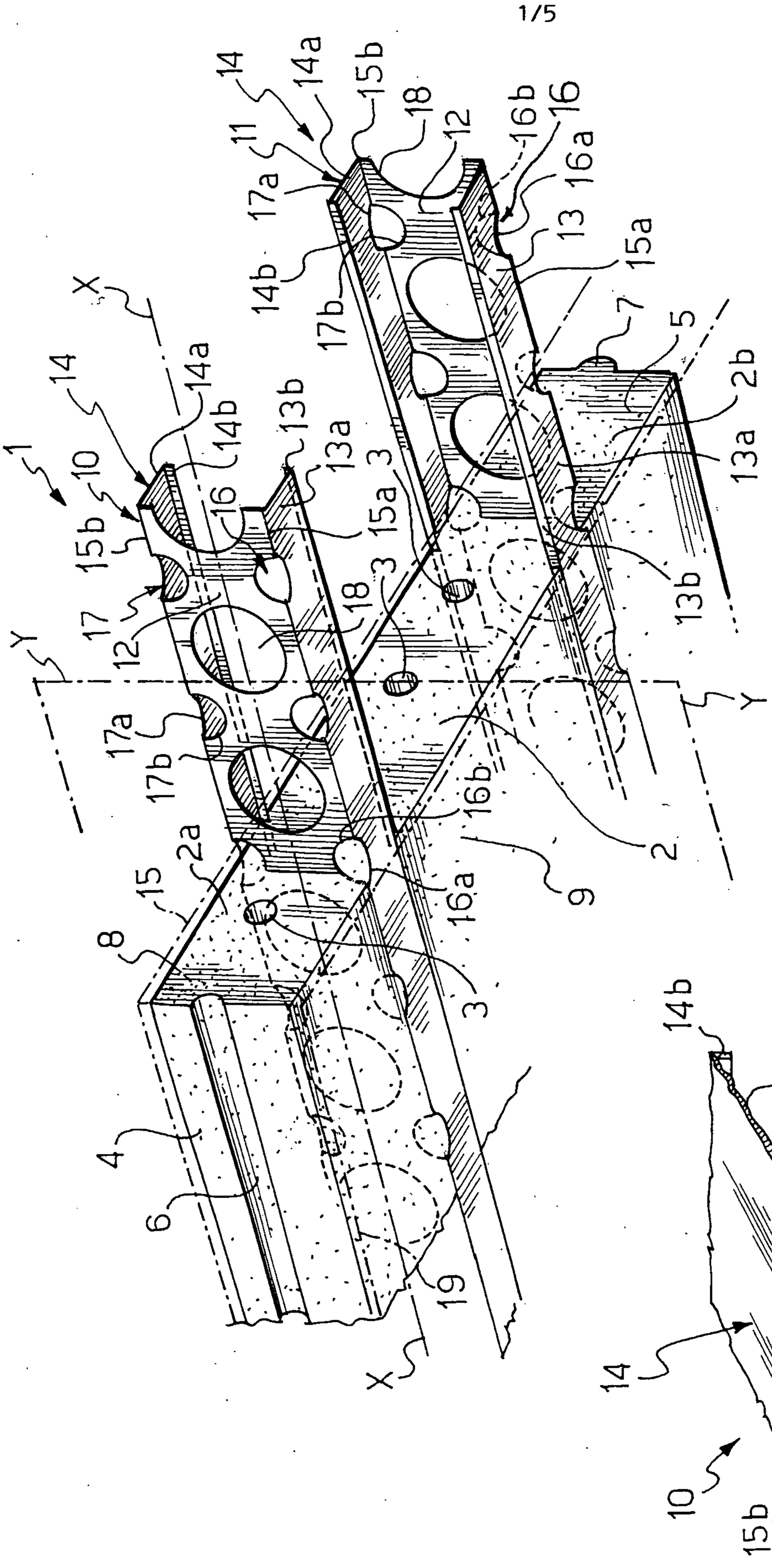

14
14a
15b
18
12
16b
16
11
17a
16a
13
15a
14b
17b
X
7
5
2b
13a
13b
Y
1
10
3
9
2
15
8
4
6
19

FIG.1

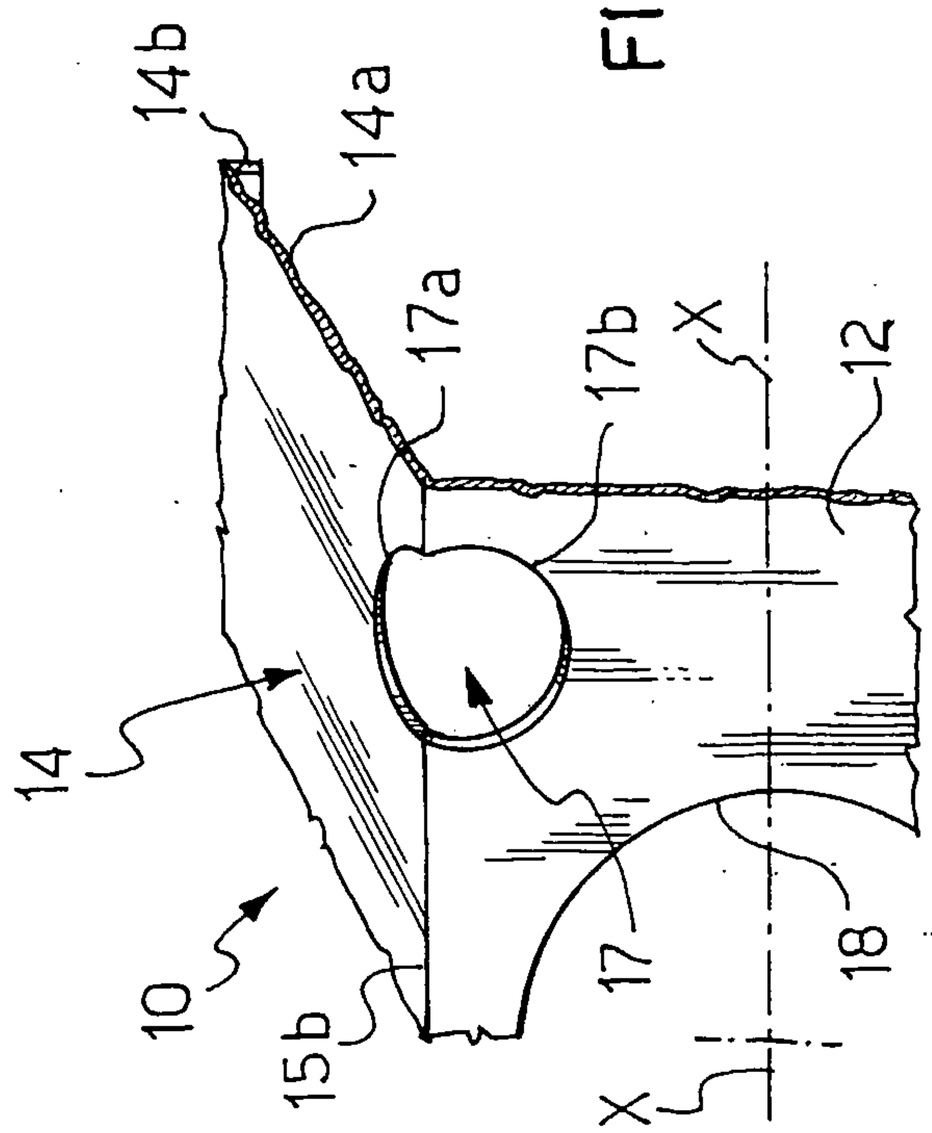

14b
14a
17a
17b
X
12
14
10
15b
17
18

FIG.2

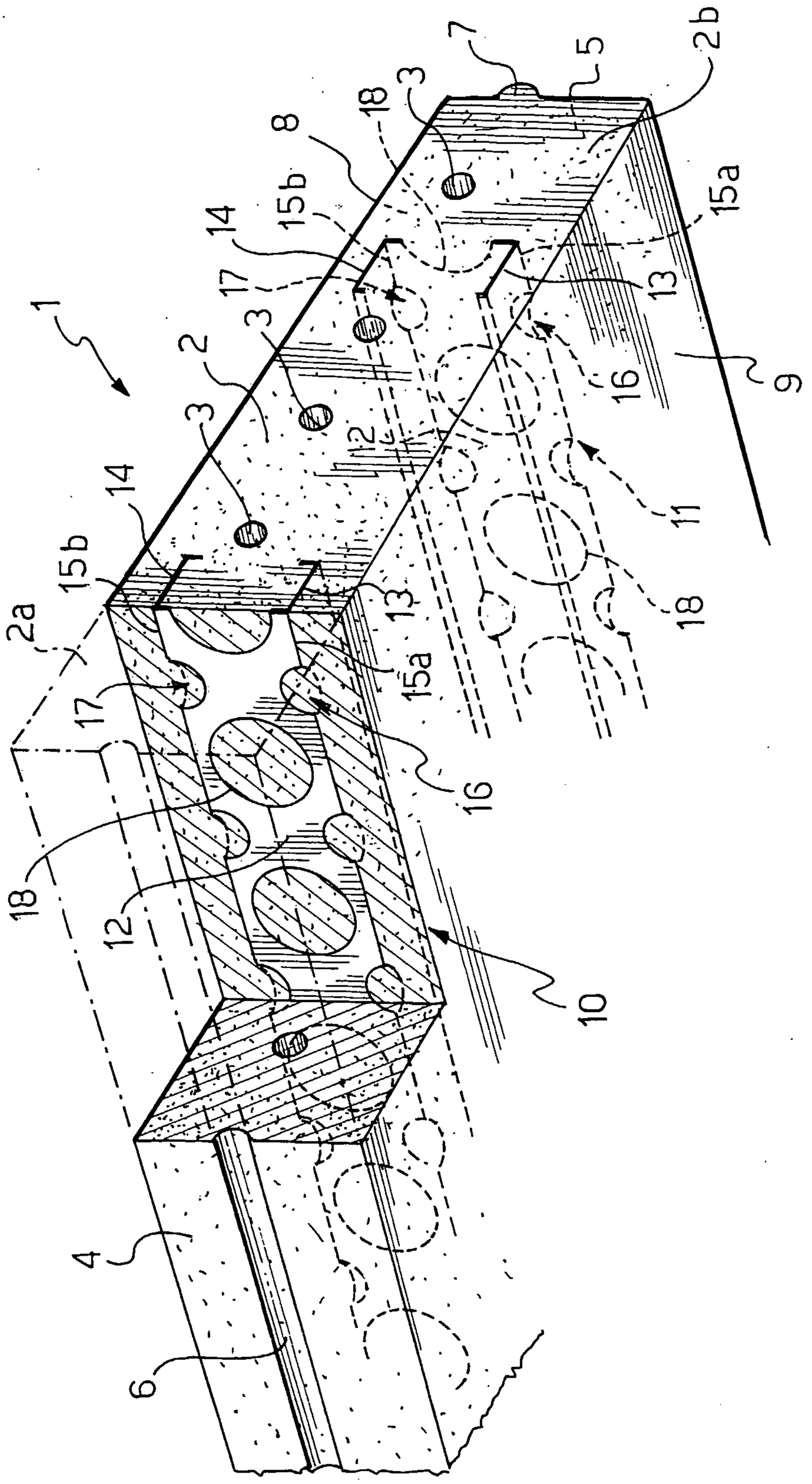


FIG.3

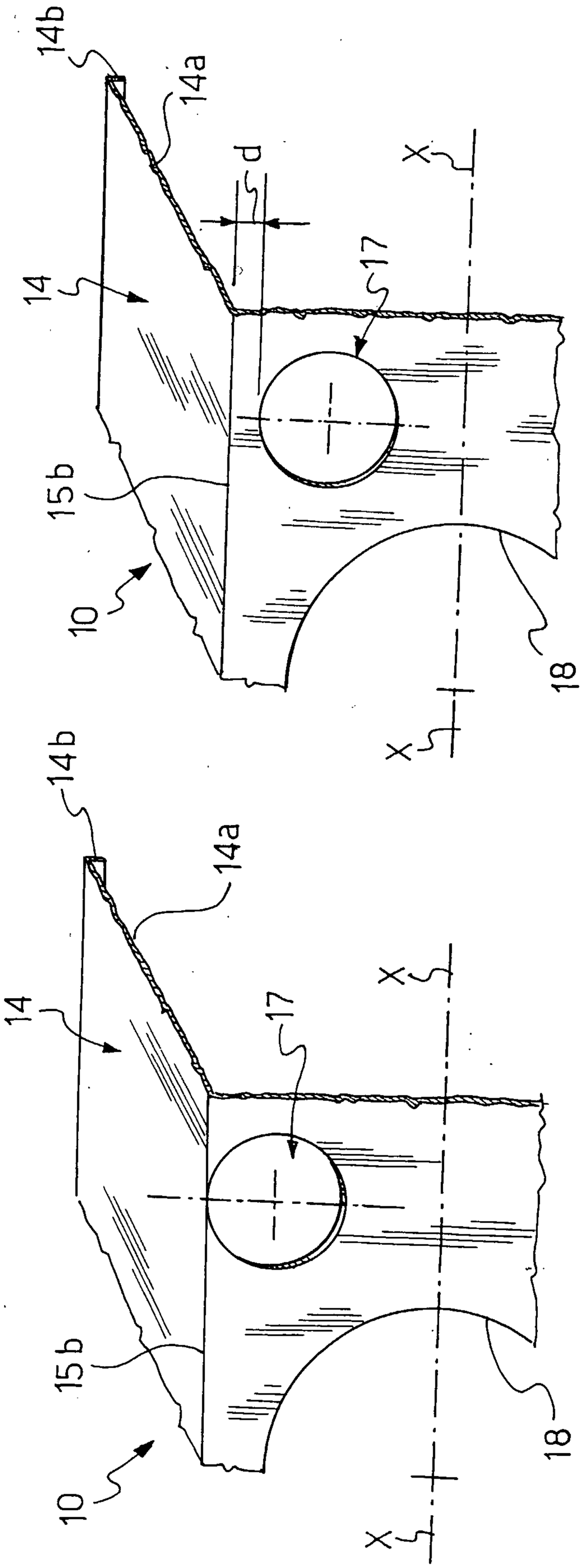


FIG. 5

FIG. 4

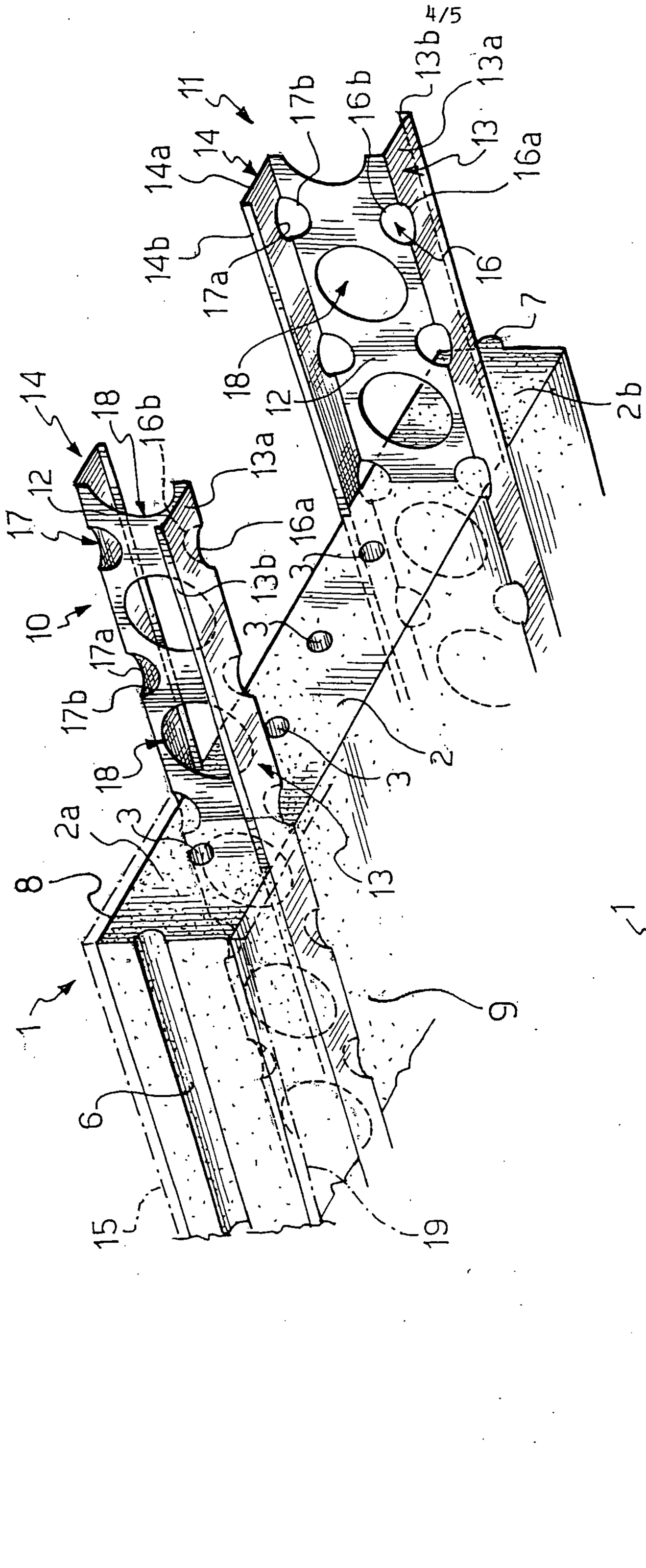

11
14
14a
17b
16b
13b
13a
13
16a
14b
17a
16
18
7
12
2b
14
18
16b
13a
12
17
16a
13b
3
10
17a
17b
2
18
2a
3
13
8
1
9
6
15
19

FIG. 6

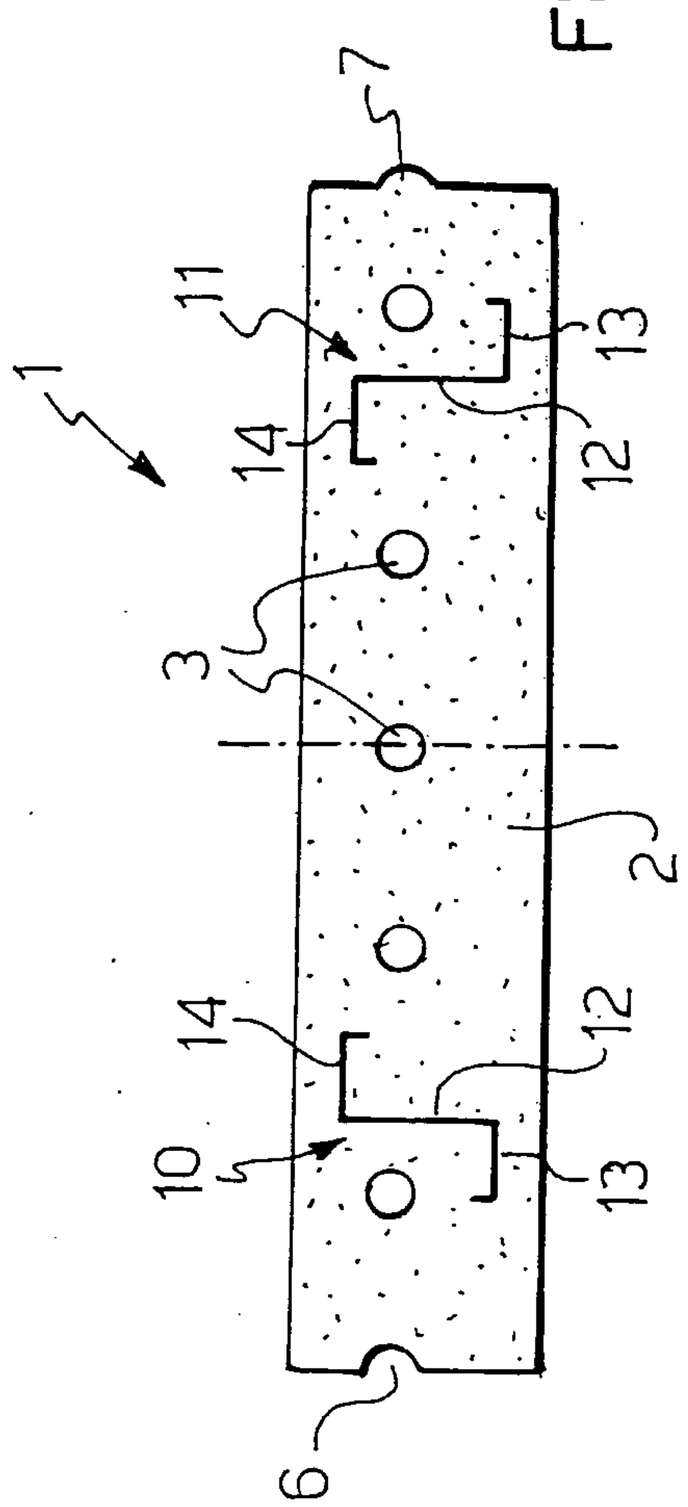

7
11
13
1
14
12
3
2
10
13
14
12
6

FIG.7

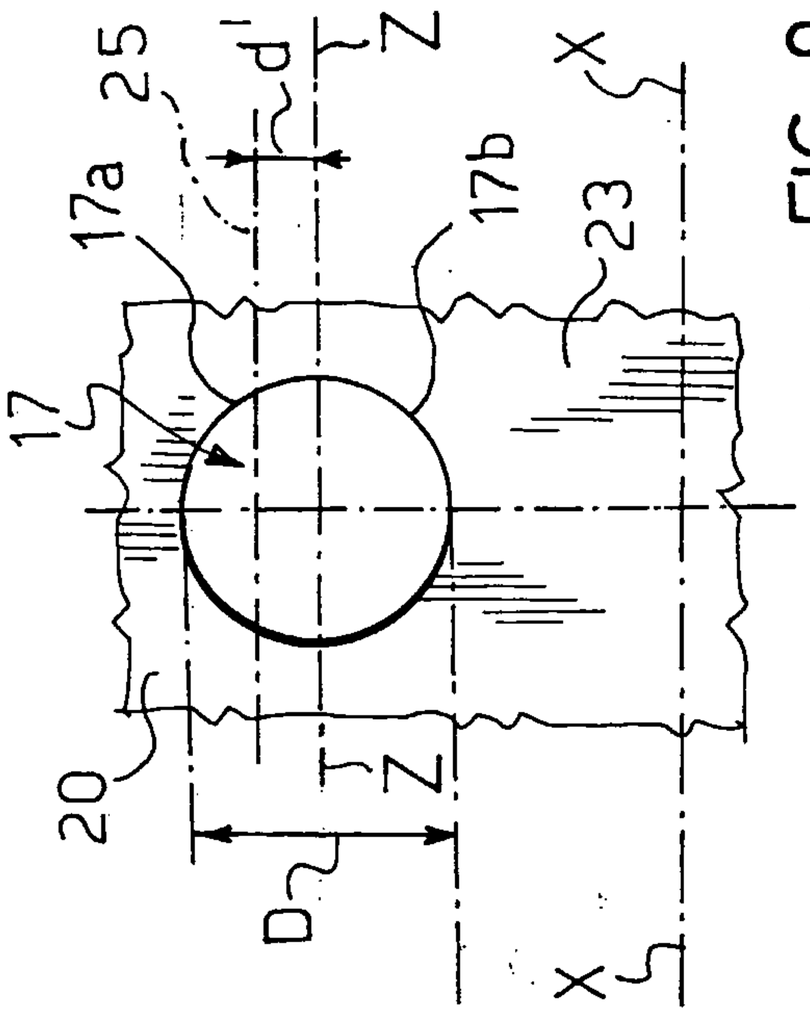

17a
25
d'
Z
17b
X
23
17
20
Z
D
X

FIG. 9

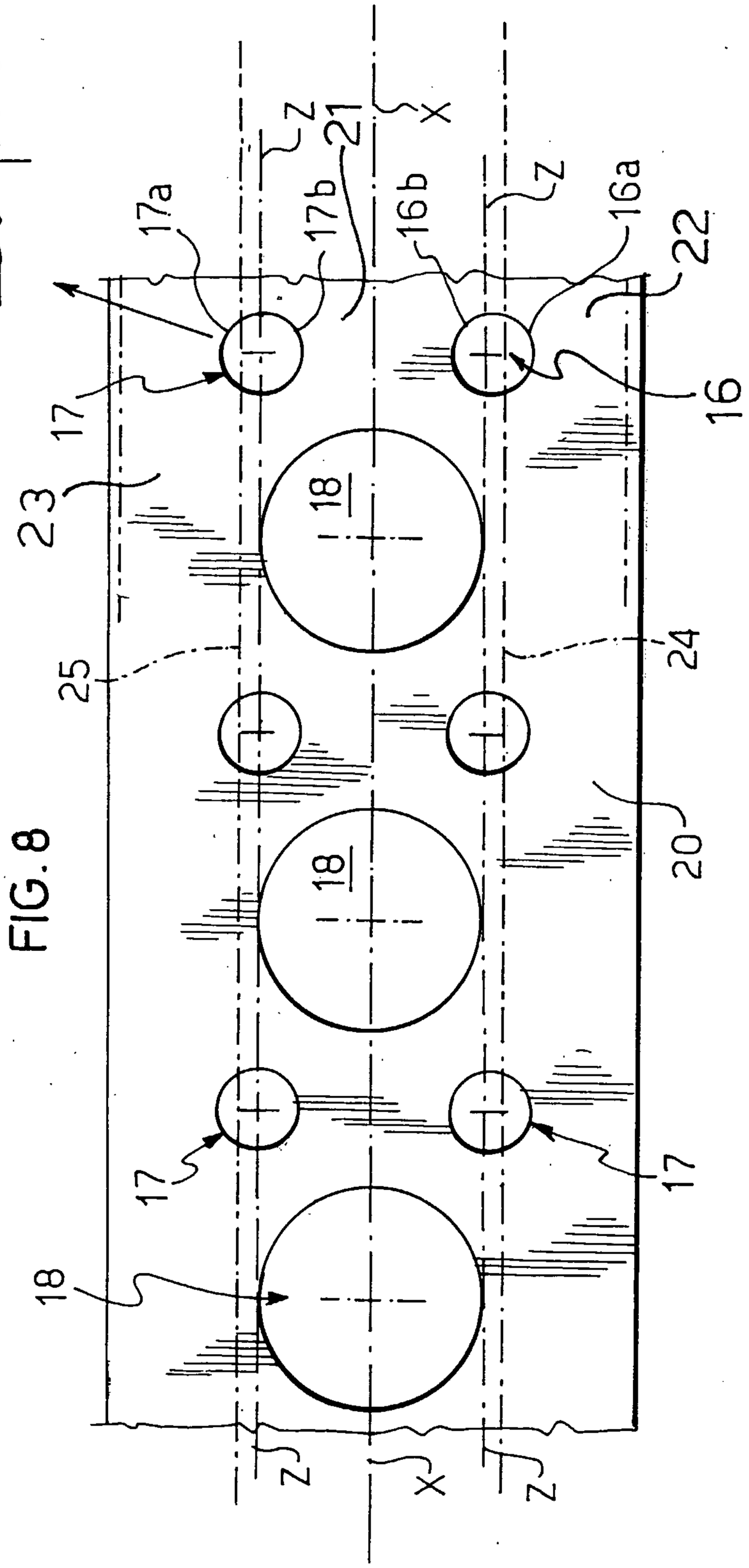
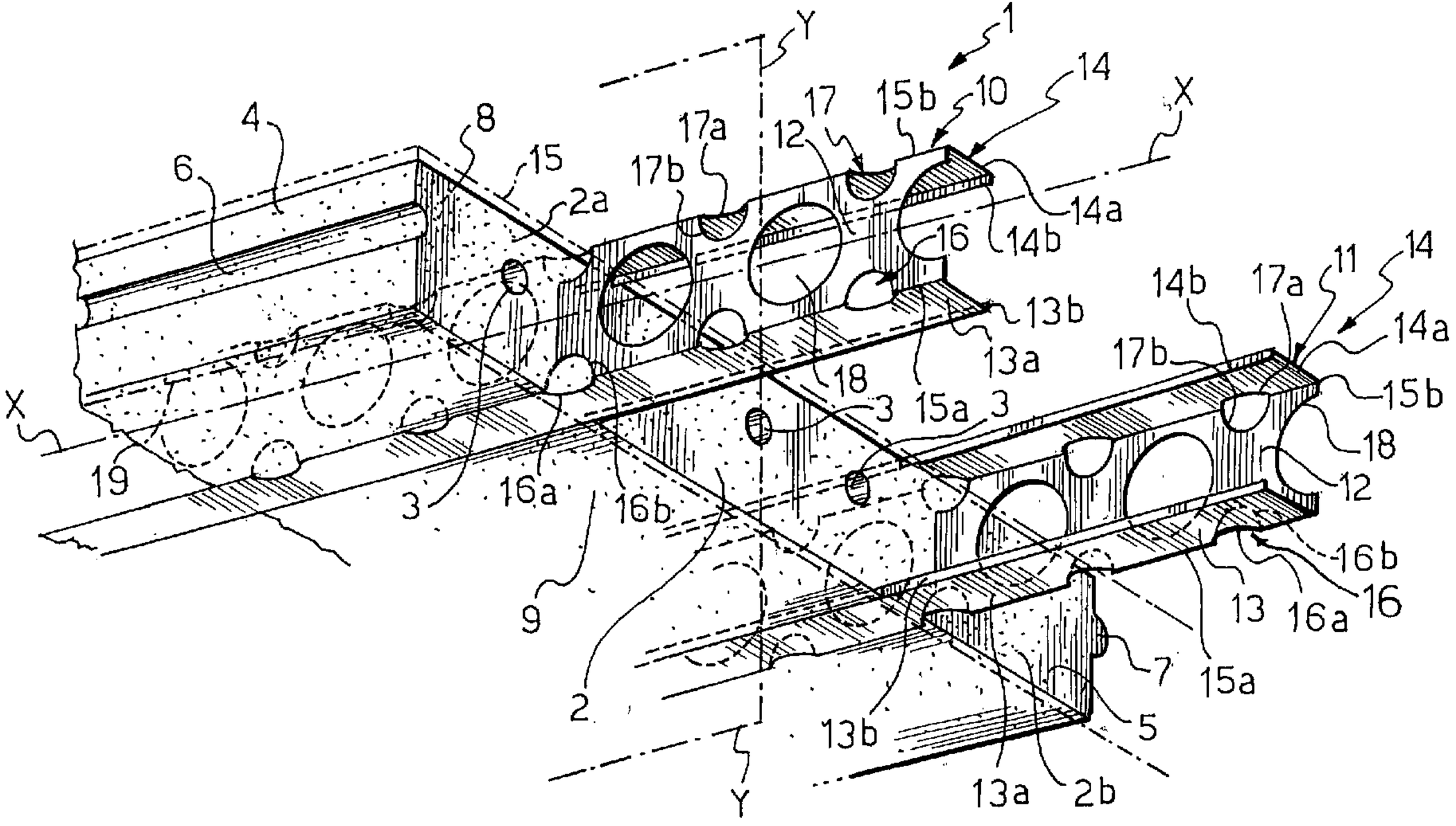

Z
21
X
17a
17b
16b
Z
16a
22
17
16
23
18
25
24
18
20
17
17
18
Z
X
Z

FIG. 8


Y
1
14
X
4
8
17
15b
10
17a
12
6
15
17b
2a
14a
16
14b
13b
13a
14b
17a
11
14
14a
17b
15b
X
18
3
15a
3
18
19
12
3
16a
16b
16b
16
13
16a
9
7
15a
2
5
13b
Y
13a
2b