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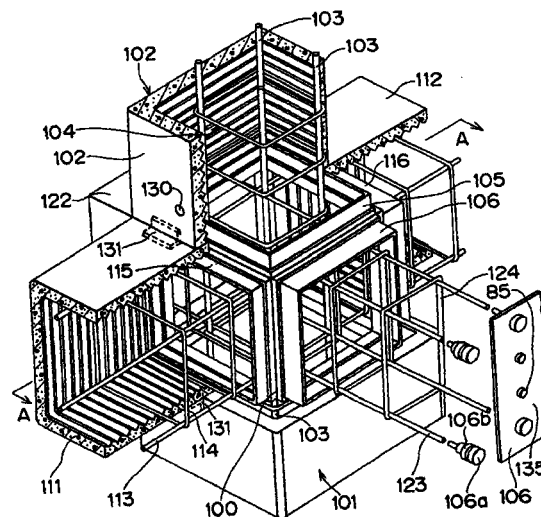
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(54) **STRUCTURAL MATERIAL AND METHOD OF JOINING THE SAME**

(57) The structure member comprises a hollow tube made of concrete or a material similar thereto, and two or more structure members (101, 102, 111, 112, 122) each having an irregular portion on an inner surface thereof are faced with one another, then a filler is introduced into the hollow portion of the structure member to be solidified so as to joint the structure members. Reinforcing members (103, 113, 123) etc. are put in the hollow portions of the structure members, or steel frames and bag bodies (106, 115), etc. are fixed by a jointing frame (100) and a filler is introduced therein. It is also possible to joint two or more structure members by way of a jointing member. Workers other than technical workers can easily joint beams and beams, beams and pillars respectively made of concrete and also can construct sonorous buildings.

**FIG. 33**



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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to structure members constituting pillars and beams of buildings, more particularly to a technical field for jointing structure members made of concrete and a material similar to concrete. The structure members are used for ordinary building, bridges, sand guard structures, piles, utility-line poles, etc.

### BACKGROUND TECHNOLOGY

**[0002]** The structures in the fields of earth working and building are generally made mainly materials of timbers, reinforced concrete and steel frames, and which are however not a little resorting to manual working in the site thereof. Particularly, jointing parts between beams and beams, beams and pillars are complex in a construction thereof, and stress is applied much to such jointing parts, and which leads to frequent manual working if they are finished with sufficient quality. Among them, in case of the structure members concreted in the site, the manual operation and technical workers are required when constructing the jointing parts. However, there are found many buildings which are roughly constructed owing to the labor short, high aging of the technical workers, and further a low-cost consciousness. On the other hand, as is reported in Hanshin (Osaka, Kobe and neighborhood) great earthquake which occurred on January of 1995, 30 to 40 % of the buildings in Kobe city which were built a decay ago have collapsed owing to the construction error although such buildings were constructed by the technical workers. Meanwhile, it is evident that the buildings which are built recently are deteriorated in quality since it is built by the technical workers whose level are lower than those of the decay ago.

**[0003]** In addition to the deterioration of the quality, the design of the building per se has been simplified recently. Accordingly, sonorous buildings like the medieval European buildings are not found recently, which makes a city space bleak. If the design of the construction is not excellent, people are neither relax nor feel at ease, which lowers the level of culture, resulting in devastation of cities.

### DISCLOSURE OF THE INVENTION

**[0004]** It is an object of the present invention to provide structure members enabling even ordinary workers except technical workers to joint beams and beams and beams and pillars with ease, and capable of constructing sonorous buildings, and it is another object of the present invention to provide a method of jointing the structure members.

**[0005]** To achieve the above objects, the structure

member of the present invention is usable to pillars or beams and formed of a hollow tube made of concrete or a material similar to concrete, wherein the hollow tube has an irregular portion on an inner surface thereof. Each irregular portion on the inner surface may have a helical shape or an inner formwork may be embedded in the inner surface. Further, the hollow tube may have an attachment portion to which an attachment is fixed or may have an aesthetic irregular portion respectively provided at an outside thereof. Still further, the structure member may comprise a plurality of hollow tubes which are integrated with one another while they are bundled, or the hollow tube may be notched at a part or an entire thereof. A reinforcing plate may be attached to the inner surface of the hollow tube. Further, a decorative member or a reinforcing member may be attached to a part or an entire surface of the structure member. Further, an air discharge passage may be defined in the irregular portion on the inner surface of the hollow tube.

**[0006]** The method of jointing structure members of the present invention thus constructed as set forth above is characterized in comprising butt-jointing ends of two or more structure members, then introducing a filler into the structure members so as to be solidified. Further the method is characterized in comprising attaching cover members so as to be fixedly attached to portions adjacent to ends of the structure members which are to be jointed, facing the ends of two or more structure members having respectively cover members attached thereto, then introducing a filler into a space partitioned by the cover members so as to be solidified, so that both structure members are jointed with one another. In the latter method, it is preferable to use the cover member having an elastic body at the periphery thereof.

**[0007]** Another method of jointing structure members of the present invention thus constructed as set forth above is characterized in comprising attaching a bag body to one of the structure members at a portion adjacent to an end thereof to be jointed with an end of another structure member, butt-jointing the end of the one structure member with the end of the another structure member, then introducing a filler into the bag body so as to be expanded, so that both structure members are jointed with one another. It is preferable as the provision of the bag body that the bag body is fixed to another end of the reinforcing member or the cover members, or the bag body may be restrained from being extended by way of the cover members, the reinforcing member or a restriction member so as to stop the end of the bag body at a given position. Further, a jointing frame may be provided at another end of the bag body. Still further, when the jointing member is jointed with the structure members, the structure members are butt-jointed with the jointing member, then the filler is filled utilizing any of the above mentioned methods. It is preferable that the air change passage and air discharge port are respectively defined in the irregular portion on

the inner surface of the hollow tube, wherein air inside the structure member is discharged from the air discharge port through the air discharge passage when the filler is introduced into the structure member.

## BRIEF DESCRIPTION OF THE DRAWINGS

### [0008]

Fig. 1 is a perspective view of a structure member according to a first embodiment of the present invention.

Fig. 2 is a perspective view showing an example of an inner formwork to be used when the structure member in Fig. 1 is manufactured.

Fig. 3 is perspective view showing another example of an inner formwork.

Fig. 4 is a cross-sectional view of a structure member according to a first modification of the first embodiment of the present invention.

Fig. 5 is a cross-sectional view of a structure member according to a second modification of the first embodiment.

Fig. 6 is a cross-sectional view of a structure member according to a third modification of the first embodiment.

Fig. 7 is a cross-sectional view of a structure member according to a fourth modification of the first embodiment.

Fig. 8 is a cross-sectional view showing an example of a structure member according to a second embodiment of the present invention in which an inner formwork is embedded.

Fig. 9 is a cross-sectional perspective view showing another example of a structure member according to the second embodiment of the present invention in which an inner formwork is embedded.

Fig. 10 is a cross-sectional view showing still another example of a structure member according to the second embodiment of the present invention in which an inner formwork and a surface member are embedded.

Fig. 11 is a cross-sectional view of a structure member according to a third embodiment of the present invention.

Fig. 12 is a perspective view of a structure member according to a fourth embodiment of the present invention showing an example where the structure member has an attachment member which is attached to an outside thereof.

Fig. 13 is a perspective view of a structure member according to a fifth embodiment of the present invention showing an example where the structure member comprises a plurality of bundled hollow tubes.

Fig. 14 is a cross-sectional view showing another example of a structure member having a plurality of bundled hollow tubes.

Fig. 15 is a cross-sectional view showing a modification of the structure member shown in Fig 14.

Fig. 16 is a cross-sectional view showing another modification of the structure member shown in Fig 15.

Fig. 17 (A) to Fig. 17 (C) are cross-sectional views each showing a structure member according to a sixth embodiment.

Fig. 18 is a cross-sectional view of a structure member according to a seventh embodiment.

Fig. 19 is a cross-sectional view of a structure member according to an eighth embodiment which is subject to reinforcement.

Fig. 20 (A) and Fig. 20 (B) are cross-sectional views for explaining an example of a jointing method of structure members.

Fig. 21 (A) and Fig. 21 (B) are cross-sectional views for explaining another example of a jointing method of structure members.

Fig. 22 (A) and Fig. 22 (B) are cross-sectional views for explaining still another example of a jointing method of structure members.

Fig. 23 (A) and Fig. 23 (B) are cross-sectional views for explaining more still another example of a jointing method of structure members.

Fig. 24 is a cross-sectional view for explaining a jointing method of structure members in jointing parts.

Fig. 25 is a cross-sectional view showing an example of a cover member.

Fig. 26 is a cross-sectional view showing an example of a rim frame to which a bag body is attached.

Fig. 27 is a perspective view showing a bag body and core rods respectively attached to the rim frame.

Fig. 28 is a cross-sectional view showing another example of a rim frame to which a bag body is attached.

Fig. 29 is a cross-sectional view of a structure member to which bag bodies are attached.

Fig. 30 is a cross-sectional view showing a jointing state using the structure member of Fig. 29.

Fig. 31 is a perspective view showing an example of a jointing frame.

Fig. 32 is a cross-sectional view showing an example of a part of the bags which are attached to the jointing frame of Fig. 31.

Fig. 33 is a partly cut perspective view of structure members for explaining a jointing method of structure members in the jointing parts.

Fig. 34 is a cross-sectional view taken along lines A - A in Fig. 33.

Fig. 35 is a cross-sectional view of the structure members of Fig. 33 in which a filler is filled.

Fig. 36 is a perspective view of reinforcing members to be used in the jointing parts.

Fig. 37 (A) and Fig. 37 (B) are perspective views each showing a structure member having a hollow

tube a part of which is notched.

Fig. 38 is a perspective view of a reinforcing member in a jointing part.

Fig. 39 is a perspective view showing assembly of the reinforcing member in another jointing parts.

Fig. 40 (A) and Fig. 40 (B) are perspective views each showing a jointing member.

Fig. 41 is a vertical cross-sectional view of the jointing member in Fig. 40 (B).

Fig. 42 (A) and Fig. 42 (B) are perspective and vertical cross-sectional views showing another example of a jointing member.

Fig. 43 (A) and Fig. 43 (B) are vertical cross-sectional views respectively showing still another example of the jointing member.

Fig. 44 is a perspective view for explaining a jointing part of the jointing members under assembling thereof.

Fig. 45 (A) is a perspective view of the jointing part of the jointing members after built up thereof in Fig. 44 and Fig. 45 (B) is a cross sectional view taken along the line A-A in Fig. 45 (A).

Fig. 46 (A) and Fig. 46 (B) are perspective views showing that at the top or neighborhood of a beam is turned upside down.

Fig. 47 is a perspective view for explaining a jointing part of another jointing members.

#### BEST MODE FOR CARRYING OUT THE INVENTION

**[0009]** Fig. 1 is a perspective view showing an example of a structure member according to the present invention. The structure member 1 is formed of a hollow tube manufactured by concrete or a similar material (ceramic, etc.) and has a plurality of irregular portions 2 at the inner surface thereof as shown in Fig. 1. The structure member 1 is manufactured as follows in a factory. That is, an inner formwork 3 made of extendible rubber is positioned inside an outer formwork, and the inner formwork 3 has an air hole 3a through which air is introduced to be in an expandable state, and the outer formwork having a surface shape corresponding to that of the structure member 1 is paced outside the inner formwork 3 at given intervals, then concrete is introduced into a space between the inner and outer formworks, successively air is extracted after concrete is hardened, and at the same time the outer formwork 3 is removed. Accordingly, it is possible to manufacture the structure member 1 having the irregular portions 2 corresponding to pleats 3b of the inner formwork 3. It is preferable to add a reinforcing rod, nonferrous metals, organic or inorganic fibers (e.g. fibers such as nylon, aramid, glass, carbon) when concreted to reinforce the structure member 1. It is preferable to form aesthetic irregular portions on the external surface of the structure member 1 depending on uses thereof.

**[0010]** If an inner formwork 4 made of extendible rubber shown in Fig. 3 is used, the structure member 1 hav-

ing discontinuous irregular portions at the inner surface thereof corresponding to irregular portions 4b of the inner formwork 4 is manufactured. Denoted by 4a in Fig. 3 is an air hole which is the same as the air hole 3a in Fig. 2.

**[0011]** A structure member 5 shown in Fig. 4 is a cross-sectional view of a structure member 5 having helical irregular portions 6 which are formed at an inner surface of a hollow tube. This structure member 5 is manufactured in the following method in a factory. That is, an outer formwork having the surface shape corresponding to that of the structure member 5 is provided and helical pipes are disposed inside the structure member 5 at given intervals, then concrete is introduced into a space between the helical pipe and the outer formwork, thereafter the helical pipe is turned and extracted at an appropriate time before concrete is hardened, thereby manufacturing the structure member.

**[0012]** The irregular portions provided on the inner surface of the structure member can be arbitrarily shaped using an inner formwork having an appropriate shape. Modifications of such structure member are illustrated in Fig. 5 to Fig. 7. In a structure member 51 shown in Fig. 5, irregular portions 61 are formed of continuous trapezoidal helical screw grooves, while in a structure member 52 shown in Fig. 6, irregular portions 62 are formed of discontinuous trapezoidal grooves. Irregular portions 63 of a structure member 53 shown in Fig. 7 are formed of a combination of semicircular grooves and projections in cross sections corresponding to an outer shape of bellows.

**[0013]** It is possible to manufacture structure members of the present invention using an inner formwork which is extendible in a mechanical manner and has irregular portions at the outside thereof in addition to the inner formwork made of rubber set forth above. Alternatively, it is possible to manufacture the structure members by using an inner formwork which can be burnt or corroded, and removing the inner formwork after concrete is hardened, and in case of necessity, the inner formwork is embedded and the inner surface thereof can be utilized as the irregular portions.

**[0014]** An example of a structure member having an inner formwork embedded therein is shown in Fig. 8. A structure member 531 has an inner formwork 631 having trapezoidal irregular portions embedded in the inner surface of a hollow tube. The shape of the inner formwork is not limited to that shown in Fig. 8 but it may be corrugated like irregular portions as shown in Fig. 4 to Fig. 7. The inner formwork may include irregular portions 4b as shown in Fig. 3 depending on the uses of the structure member. In this case, there are one method of forming the irregular portions by permitting an irregular member provided outside the inner formwork to be corrugated, and another method of forming the irregular portions by pressing a hollow frame so as to permit the hollow frame to be corrugated. As the inner formwork or

the irregular member, iron, nonferrous metals, resins, cement, cellulose, ceramics can be used, or organic or inorganic fibers such as carbon, glass and nylon may be used when they are formed into a plate shape or they are mixed with cement. Strength of the structure member is enhanced when a high strength member such as iron is used as the inner formwork.

**[0015]** A structure member having the inner formwork embedded therein is illustrated in Fig. 9. Fig. 9 is a cross-sectional perspective view showing the structure member in a cutting state from which the shape of the embedded inner formwork is understood. This structure member 532 has an inner formwork 632 which includes a plurality of projecting members 632a fixed to the inside thereof and which is embedded in the inner surface of the hollow tube. The projection members 632a may be rod-shaped and may have tip ends each having appropriate shape. Materials of the projection members 632a may be the same as or different from those of the inner formwork 632. The projecting members may be directly fixed to the inner surface of the hollow tube depending on the uses of the structure member without using the inner formwork.

**[0016]** Still another example of a structure member 533 having an inner formwork which is embedded therein is shown in Fig. 10. An inner formwork 633 embedded in a structure member 533 is formed by braiding vertical rods and horizontal rods in square cylinders, and anchors 633a are provided at appropriate positions so that the inner formwork 633 is fixed to the hollow tube with an excellent condition. The shapes of the vertical and horizontal rods are arbitrary and materials thereof are the same as those of the inner formwork. Decorative members such as tiles or surface members 633b as reinforcing members of the structure member may be attached to the front surface of the structure member. The surface member 633b may be made of the same material as the inner formwork 633, and it may be bonded partially or wholly on the surface of the inner formwork 633, or may be utilized as an outer formwork or embedded into the inner formwork 633. Such surface members can be utilized for the structure members as shown in Fig. 1 to Fig. 19. The inner formworks shown in Fig. 9 and Fig. 10 may be corrugated or helically shaped.

**[0017]** The irregular portions of the structure members may be formed on the entire of the hollow tube, or irregular portions 64 may be formed on a portion adjacent to an end portion forming a jointing part like a structure member 54 as shown in Fig. 11. A structure member having irregular portions provided on the entire surface thereof may be used while it is cut in an appropriate length.

**[0018]** The structure members of the present invention may be formed to have an attached portion such as a groove to which an attachment such as a wall member, a door, a sash is attached when they are manufactured in a factory. For example, in a structure member

55 shown in Fig. 12, one or more than two dovetails are provided as the attachment portion at the external surface thereof in which a panel 66 can be engaged. Projections 65a are provided at the side opposite to the dovetails 65. It is possible to provide appropriate irregular portions on the surface of the structure member, in a vertical or lateral direction (not shown), if need be. Further, it is possible to permit the structure member to have various external shapes on the external surface of the structure member such as a sonorous shape like sculptures or patterns.

**[0019]** Like structure members 56, 57 shown in Fig. 13 and Fig. 14, a plurality of hollow tubes which are bundled to be integrated with each other can be utilized. Further, structure members may have cross-sectional shapes as shown in Fig. 15 and Fig. 16. A structure member 571 shown in Fig. 15 has a shape removing an intermediate wall 2a in the structure member 57 in Fig. 14. A structure member 572 shown in Fig. 16 has a shape removing intermediate walls 2b in the structure member 571 in Fig. 15. In the structure members of the types shown in Fig. 13 to Fig. 16, the irregular portions 2 are not necessarily provided on the entire inner surface thereof but hollow portions having no irregular portion may be provided depending on the uses thereof. Further, the structure members may have a solid structure at a part of hollow portion which is concreted in a factory instead of having an actual hollow part.

**[0020]** The structure members comprising the hollow tube of the present invention are not limited to hollow shaped ones which are completely closed at portions other than both ends thereof. As exemplified in Fig. 17 (A) to Fig. 17 (C), there are structure members 58a, 58b, 58c each having a cut portion 581 formed at one or more than two positions along a part or entire length of one or more sides thereof. Appropriate irregular portions 2 are provided on the hollow portion. Although a width of the cut portion 581 and a size of an inner hollow width 582 are determined depending on uses of the structure members and shapes of the irregular portions 2, it is preferable that the width of the cut portion 581 is smaller than the size of the hollow width 582 so as to assure the jointing condition between the adjoining structure members.

**[0021]** Still another example of a structure member is shown in Fig. 18. A structure member 59 is U-shaped, and has a corresponding inner formwork 69 fixed to the inner surface thereof. The inner formwork 69 is embedded in the structure member 59 when concreted. Projecting portions 69a are formed on the inner formwork 69 by punching. Holes 69b bored by punching the inner formwork may be closed by appropriate means, if need be, since concrete flows out depending on sizes of the holes 69b. The inner formwork forming the projecting portions by punching can be used for the structure members shown in Fig. 8 to Fig. 10. It is needless to say that inner formworks 631, 632, 633 shown in Fig. 8, Fig. 9 and Fig. 10, and the inner formwork 69 as shown in

Fig. 18 can be used for the structure members shown in Fig. 17 (A) to Fig. 17 (C).

**[0022]** Although various types of structure members are exemplified, these structure members need be reinforced depending on shapes or uses thereof. An example of a structure member which was subject to reinforcement is shown in Fig. 19. In the structure member, there are provided reinforcing parts 591a at appropriate positions inside a hollow tube thereof. The reinforcing part 591a may have one or plural openings 591b at a belly portion thereof. The reinforcing parts 591a may be integrated with the hollow tube or it may be made of a material which is the same as or different from that of the hollow tube wherein the reinforcing parts 591a are engaged with the hollow tube. A formwork 691 may be embedded in a space between two reinforcing parts 591a. Alternatively, it is possible to use an inner formwork made of a material which can be burnt and corroded, and the inner formwork may be removed after it is hardened. There is still another method to use an inner formwork made of rubber which is expanded by air, wherein the inner formwork can be taken out from the openings 591b after concrete is hardened. It is needless to say that such reinforcing parts may be formed in any type of structure member.

**[0023]** Described hereinafter are jointing methods of the structure members as set forth above.

**[0024]** In an example of the method shown in Fig. 20, end surfaces of two structure members 11, 12 are butt-joined with each other, and a filler A is introduced from a filling port 12a. In this case, the filler A is filled in the entire hollow portions of the structure members 11, 12. Temporary fixing members 13 are used for temporarily fixing the structure members 11, 12, if need be. As the filler, concrete, mortar, resin, ceramics, rubber, etc. are used, and molten nonferrous metals such as zinc and aluminum, and molten iron are also used. Further, iron, nonferrous metals, organic or inorganic fibers, etc. which are mixed in the structure member 1 as a reinforcing material may be mixed in the filler set forth immediately before. The kind of the filler may be determined depending on uses of the structure member. In an example shown in Fig. 21, covers 14 are attached to each of the structure members 11, 12 at end portions thereof to be jointed to each other by way of elastic members 14a at the peripheries thereof. A reinforcing member 15 having hooped rods is inserted into one structure member 12 and it is fixed by spacers 16, etc., thereafter, the end surfaces of the structure members 11, 12 are butt-joined with each other, and the filler A is introduced into a space partitioned by the cover members 14. In case that the hollow portion of the structure members is small or when the cover members 14 are provided at the innermost portion of the structure member, an assistant rod 17 shown in Fig. 22 is used. The assistant rod 17 is fixed to one of the cover members 14.

**[0025]** In an example shown in Fig. 23, two structure

members 11, 12 respectively having helical irregular portions 6 are jointed with each other. Central portions of the cover members 18 in this example have respectively spherical surfaces which are expanded toward end portions of the structure members 11, 12, wherein an adhesive, which has lubrication property when the adhesive is not hardened, is coated on the outer peripheries of the elastic members 18a, then the elastic members 18a of the cover members 18 are screwed along the irregular portion 6 until they reach predetermined positions. After the adhesive is hardened, the end surfaces of the structure members 11, 12 are butt-joined with each other, and the filler A is introduced so that the central portions of the cover members 18 are expanded at the circumference thereof owing to the pressure at that time and the elastic members 18a are brought into contact with the irregular portions 6. Accordingly, there is no possibility that the filler A is leaked from gaps defined between the elastic members 18a and the irregular portions 6.

**[0026]** In Fig. 21 to Fig. 23, if air in the space in which the filler A is introduced is not escaped from a gap between the jointing parts, exhaust ports having appropriate sizes may be provided inside the cover members 18 or the structure members 11, 12, and further there may be provided check valves or fillers 85, described later, in the exhaust ports for preventing the filler A from being leaked therethrough.

**[0027]** An example of constructing jointing by the structure members of the present invention using the aforementioned jointing methods is now described in succession with reference to Fig. 24. Base plates 21 are fixed to anchors 22 which are embedded in concrete of foundation. A reinforcing member 15 is welded to the base plates 21, if need be, then a lower pillar 23 comprising the structure member is built up and temporary fixed at a given position of the lower pillar 23. Thereafter, the filler A is introduced into a filling port 24 defined in the lower pillar 23 by a predetermined amount, if it is defined in the lower pillar 23, or from an upper opening of the lower pillar 23, if the filling port is not defined in the lower pillar 23, then the lower pillar 23 is fixed to the base plates 21. As another method, the reinforcing member 15 may be directly embedded in the concrete of foundation without providing the base plates 21 and the anchors 22. Successively, the cover member 26 which is attached to one end of an assistance rod 25 is engaged in the inside from the upper opening of the lower pillar 23. In this example, although springs 27 are provided at the periphery of the cover member 26 to reduce the gap between the cover member 26 and the irregular portions 6, so as to support the cover member 26 with the resiliency of the springs 27, the upper end of the assistance rod 25 may be supported using an appropriate method, if there is a likelihood that the cover member 26 falls down owing to the weight of the filler A.

**[0028]** Then, beams 30 respectively comprising the structure member are provided on the lower pillar 23 at

both sides of the lower pillar 23 using a temporary fixing member 31, if need be. At this time, although cover members 33 respectively disposed on both ends of a connecting rod 32 need be inserted into the beams 30, 30, it is preferable that the cover members 33 are inserted into the innermost part of one of the beams 30 so as to be out of the way of the opposite beam 30, then the opposite beam 30 is provided or installed, and thereafter the cover members 33 may be returned to their given positions. The cover members 33 may be provided at a factory or building sites, and the reinforcing member 15 may be attached to the cover members 33, if need be, in the manner as described with reference to Fig. 21. Finally, after an upper pillar 35 is provided, the filler A is filled into the space defined between the cover member 26 and the cover members 33, 33 through a filling port 36 and it is solidified, then the lower pillar 23, the upper pillar 35, and the beams 30, 30 which are respectively composed of structure members are jointed with each other. The beams 30 may be disposed or provided at three or more than four positions, or in a slanting direction, if need be,

**[0029]** In the aforementioned example, the upper pillar 35 does not use the cover member. The reason is that the filling port 36 is defined in the upper pillar at the upper portion over a given filling range, so that the filler A can be filled in the space owing to the gravity thereof. However, when the filler A is introduced through the filling port 36 under a given pressure while the cover member is fixed to the upper pillar 35 over the filling port 36, the strength of the filler A can be enhanced after it is solidified, and hence it is a preferable method. The filler A may be introduced into the upper space of the lower pillar 23 before the beams 30 are provided.

**[0030]** In the example as set forth above, as a method of attaching the cover members to the structure members so as to be fixed thereto, the elastic members to be attached to peripheries of the cover members are made hollow like a tire-shape of a vehicle, then the cover members are provided at given positions, successively compressed air is supplied inside the hollow portion of the elastic members so as to expand thereof, finally the elastic members are brought into contact with the irregular portions.

**[0031]** Fig. 25 is a cross sectional view for explaining another method for attaching a cover member to the inside of a structure member so as to be fixed thereto. In this example, a cover member 40 comprises a plate member 41, and rim frames 42 provided at the periphery of the plate member 41, and ring-shaped bag bodies 43 attached to the rim frames 42, and an introduction pipe 44 which is connected to the rim frame 42. After the cover member 40 is inserted into the structure member 1 at a given position using an assistant rod 17, then a filler B is introduced from the introduction pipe 44 into the bag bodies 43 so that the bag bodies 43 are expanded to engage with the irregular portion 6 in the structure member 1. When the filler B is solidified,

the cover member 40 is in a fixed state. According to this method, the cover member 40 can be brought into contact with and fixed to the inside of the structure member 1 even if the irregular portion 6 has a complex shape. It is also possible to employ a method for introducing the filler B from the rim frames 42 to the bag bodies 43 by way of the assistant rod 17 and the inside of the plate member 41.

**[0032]** In such a manner, the cover member 40 is attached to the inside of the structure member 1 while it is fixed thereto, and end portions of two or more structure members are butt-joined with one another according to the aforementioned method, then the filler A is introduced into the space partitioned by the cover member 40 and is solidified thereafter so as to joint the structure members with one another.

**[0033]** The bag bodies 43 are made of woven fabrics or unwoven fabrics formed by an organic or inorganic material such as rubber, ceramics, nylon, aramid, carbon, glass fibers, and they may be coated with an organic polymeric material. The bag bodies 43 are attached to the rim frames 42, for example, as shown in Fig. 26 and Fig. 27. The tip end of each rim frame 42 can be divided and opened into two parts, as shown in Fig. 26 and it is hollow. As shown in Fig. 27, the tip ends of the rim frames 42 are arranged in a manner that core members 46 can be wrapped by end portions of the bag bodies 43 and they can be inserted into hollow portions 45 of the rim frame 42, then the bag bodies 43 and the rim frame 42 are fixed to each other by screws 47. When the core members 46 are inserted into the hollow portions 45, the rim frame 42 may be narrowed when the elastic opening of the hollow portions 45 is inferior depending on a material of the rim frames 42 as illustrated by dotted lines 42a. In case of providing such rim frames 42 to be adjoined with each other, a square member having dovetails and tenons may be added to the rim frame 42 as shown in Fig. 28. There are provided only plural square members which are combined with one another, if need be, and which can be utilized for regulating the interval between the frames. The material of the rim frame 42 may be iron, nonferrous metals, inorganic or organic fibers such as resins, ceramics, carbon fiber and aramid, which is solidified.

**[0034]** In the method of jointing the structure members using the cover member as explained in the aforementioned embodiments, although each cover member need be fixed to the inside of each structure member in a fixed state, an embodiment for attaching the cover member to only one side of the structure member is described next.

**[0035]** Fig. 29 is a cross sectional view of a structure member 71 to which bag bodies 73 are attached in a contracted state at the portion adjacent to the end portion of the structure member 71 to be jointed. The bag bodies 73 are clamped by plate members 74, 75 from the front and rear portions thereof and they are maintained in a contracted state by retaining members 83,

84 or adhesive tapes 83a, wherein binding members 77 like bendable cords such as chains, wires, and ropes attached to the plate members 74, 75 are accommodated into the bag bodies 73 while they are contracted. The middle portion of the bag body 73 is connected to an introduction pipe 78 fixed to the rear plate member 75. The introduction pipe 78 is arranged in parallel with another introduction pipe 79 which is connected to a ring-shaped bag body 80 provided at the periphery of the plate member 75. The bag bodies 73 remained positioned at the center of the hollow portion by spacers 81, 82 which are provided at several portions of the front plate member 74 and the rear plate member 75.

**[0036]** Fig. 30 is a cross sectional view showing a jointing state between the structure member 71 and another structure member 72. When the structure members 71, 72 are jointed with each other, both end portions thereof are butt-jointed with each other, then the filler B is introduced into the bag body 80 from the introduction pipe 79 so as to expand the bag body 80 while the rear plate member 75 is made in a fixed state, then the filler A is introduced into the bag bodies 73 through the introduction pipe 78 so as to expand the bag bodies 73. Accordingly, the bag bodies 73 extend into the confronted structure member 72, and at the same time, they are engaged with the irregular portion formed at the inner surface of the hollow portion, wherein the filler A filled in the bag bodies 73 is solidified to become in the illustrated jointing state. There are provided filters 85 in the front plate member 74 for permitting air to pass therethrough but not permitting the filler A to pass therethrough, wherein when the filler A is introduced under pressure into the bag bodies 73, air remaining in the bag bodies 73 is discharged so as to prevent the bag bodies 73 from being hollow locally. When introducing the filler A, the retaining members 83, 84 or the adhesive tapes 83a are removed by the filling pressure. The shape of the irregular portion formed inside the structure member 71 is arbitrary. Accordingly, depending on the shape of the irregular portion, if a thickness of the plate member 74 is increased, the plate member 74 and the binding members 77 are not necessarily provided. Even if the thickness of the plate member 74 is not increased, it is possible to restrain the bag bodies from extending in a longitudinal direction of the structure member when using the cover members 14, etc. as illustrated in Fig. 21 to Fig. 23.

**[0037]** The method for jointing the structure members by introducing the filler into the single bag body so as to be solidified is troublesome in respect of jointing and supporting the bag bodies in the manner of jointing the structure members if the jointing becomes complex, for example, in the case of providing the beams at the jointing points between the upper and lower pillars. In such a case, a jointing frame 90 shown in Fig. 31 is employed to joint the bag bodies. The jointing frame 90 comprises one or more frame bodies 91 which can be attached thereto with an arbitrary angle, wherein the bag bodies

can be attached to the structure member in the manner as illustrated in Fig. 26 and Fig. 27, wherein each of the frame bodies 91 has an appropriate shape depending on the number of and angles defined at the jointing points between the structure members. The rim frames 48 having the square members as shown in Fig. 28 are connected and built up with each other utilizing dovetails and tenons as shown in Fig. 32 so as to form the jointing frame 90 instead of employing the frame bodies 91.

**[0038]** Described next is a method of jointing three or more structure members utilizing such jointing frames. The method of jointing the jointing structures shown in Fig. 33 is a case where beams are jointed between lower and upper pillars in four directions, wherein a cross section of a main portion taken along the line A-A of Fig. 33 is shown in Fig. 34 and a case where the filler is filled in the structure members in Fig. 34 is illustrated at the lower half portion of Fig. 35. Jointing frames 100 are provided on the upper end of a structure member 101 comprising lower pillars, and main pillar rods 103, main beam rods 113, 123 are respectively disposed to be accommodated inside the jointing frames 100. The jointing frames 100 are supported by the main pillar rods 103 when there are provided the main beam rods, and they are supported by the structure member by way of the spacer 16 when there are not provided the main beam rods. At this time, the main rods are respectively reinforced by stirrup rods 104, 114, 124. Successively, each one end of the bag bodies 105, 106, 115, 116, 125 is attached to open surfaces of the jointing frames 100. These bag bodies are aligned with these main rods while they are contracted, and these bag bodies are clamped by nuts 106a attached to distal ends of the main rods so as to prevent the bag bodies from moving in an extending direction of the structure member. In such a manner, the bag bodies serve as a cover member 135. The nuts 106a are screwed into fixed plates 106b fixedly connected to the main beam rods 123. Thereafter, structure members 111, 112, 121, 122 of the beams are temporarily fixed to the structure member 101 of the lower pillar using the temporary fixing members 131, and a structure member 102 is provided temporarily on the structure members 111, 112, 121, 122, and the upper structure member 102 is temporarily fixed to the structure members 111, 112, 121, 122 using the temporary fixing members 131.

**[0039]** Since a filling pipe is provided in a filling port 130 by penetrating bag bodies and frame bodies, when the filler A is filled into the bag bodies through the filling port 130, each of the bag bodies 105, 106, 115, 116, 125 is expanded to be brought into contact with the irregular portions 6 of each structure member. When the filler A is solidified, the structure members are integrally jointed to one another. Since expansible material is mixed with the filler A, the pressure inside the bag bodies is increased to increase an application force with respect to the irregular portions of the structure mem-

bers. In the cases shown in Fig. 33 to Fig. 35, the bag body is not utilized by the lower pillar 101 but it is utilized by the structure member 102. As mentioned in the foregoing, in the jointing between the pillars and beams, it is possible to embed or not embed the reinforcing members and bag bodies in the structure members, to combine any of these members or to select an appropriate method depending on the object of that structure.

**[0040]** In Fig. 35, there is shown an example of the use of the jointing frames 100a comprising two rim frames 48 having square members which are overlaid one with another as shown in Fig. 32. The edges of a partition plate 16a defining holes therein having appropriate sizes, at need, are engaged with dovetails and tenons of the jointing frames 100a along the four sides thereof. This is provided for enhancing strength of the jointing frame 100a so that the filler can be filled in each of beams.

**[0041]** Fig. 36 is a perspective view showing jointing parts between the beams and pillars, namely, reinforcing members to be used at the jointing parts. In Fig. 33 to Fig. 35, the reinforcing members comprise the main pillar rods 103 and main beam rods 113, 123 and the stirrup rod 104 to be attached to these rods. There is a case that steel frames 39a are used so as to increase the cross sectional areas of the structure members or enhance strength of the jointing of the structure members. Fig. 36 is a case where the steel frame is used as a reinforcing member. When the jointing frame 100 is attached to a reinforcing member 39 made of a steel frame, at need, it may be provided as shown by dotted lines, or other ends of the bag bodies may be directly fixed to the steel frame or reinforcing rod. The reinforcing member 39 can use the main pillar rods 103 and the main beam rods 113 shown in Fig. 33. Further, the shape of the reinforcing member may be rectangular, circular or L-shaped or the material of the reinforcing member may have irregular portions, if need be. The material of the reinforcing member is not limited to iron, but it may be nonferrous metals, concrete, ceramics or inorganic or organic fibers such as carbon and nylon which are bundled.

**[0042]** A structure member as illustrated in Fig. 37 may be used in case that the structure members 111 of the beams, etc. can not be fixed while the main beam rod 113, etc. are moved appropriately when the structure members of the beams are provided after a plurality of structure members comprising pillars are built up to provide the reinforcing member of the jointing members shown in Fig. 33, and in case that the reinforcing member 39 made of steel frame shown in Fig. 36 is used.

**[0043]** Fig. 37 (A) is a perspective view of a structure member 150 comprising a hollow tube a part of which is notched, and Fig. 37 (B) is a perspective view of a double hollow tube 152 which is notched at two parts. An extent of lengths of notches 151, 153 of each structure member may be limited to a part or an entire of the reinforcing member depending on the object of the structure

member. A formwork 151a may be applied to a portion where a filler is leaked out when the filler is introduced into the jointing parts. If the bag bodies are used, the formwork 151a may be used or not used depending on object and shape of the bag bodies. If the bag bodies are fixed to the reinforcing members, the notches 151, 153 of the structure members may be positioned at any part thereof, namely, up or down, or left or right and these positions may be determined depending on the object of use of the structure member. If such structure members 150, 152 are used, the beams can be easily built up.

**[0044]** It is preferable to adopt the structure as illustrated in Fig. 38, if the site where the structure members are used is a location to which a stress is mechanically applied or the structure members having the notches 151, 153 are not intended to be used. Fig. 38 is a perspective view of the structure member having a jointing frame of the jointing part is positioned at a crossing part between the pillar and the beam. In Fig. 38, the jointing frame 100 having the jointing frame 90 to which a bag body is attached and fixed to the jointing part of the steel frame 99 by an appropriate method.

**[0045]** The bag bodies 115, 125 are folded and accommodated in the jointing formwork 100, and then they are temporarily fixed by the adhesive tape 83a. The restraining member 77 are fixed to the covers 135 by bolts 106a as explained in Fig. 29. The opposite side is fixed to the plate member 75 attached to the jointing formwork 100 by the bolt 106a or directly fixed to the jointing frame 100 or directly fixed to the steel frame 99 by the bolts 106a, etc.

**[0046]** Even in case of the jointing shown in Fig. 33, the jointing method shown in Fig. 38 can be utilized. After the cover members 135, etc. are provided on the lower pillar 101 at an appropriate position thereof, the steel frame 99 is built up in the hollow portion of the lower pillar 101, and a filler is filled, at need. Then, after the beams 111, etc. are disposed at the position of the jointing frame 100, the upper pillar 102 is disposed. The filling pipe is disposed to penetrate the bag body and the formwork through the filling port 130, and the filler A is filled therethrough. The cover member is provided on the upper pillar 102, at need, and the adhesive tape 83a is peeled off by the filling pressure so that the bag body is opened to introduce the filler A therethrough. When the cover member is provided on the beam, the bag body 135 and the restraining member 77 are unnecessary. If this jointing method is used, the notch 151, etc. are unnecessary.

**[0047]** Fig. 39 is a perspective view for explaining the attachment of another jointing part. In the same figure, the notches 15b having the shapes corresponding to those of beams are defined in the lower pillar 101a at the portion where the beams are jointed to the lower pillar 101a, and projecting plates 15a are provided at the lower ends thereof, at need. The projecting plates 15a support the load applied to the beams and they may be

replaced by the formwork if notches 15b, etc. are provided. In Fig. 39, a reinforcing member 15 formed by a reinforcing rod is provided. That is, holes through which the reinforcing rods penetrate, are defined in the web surfaces of the steel frame by a given number at regular intervals. After the steel frame is built up, the iron rods are inserted into the holes. The jointing frame 100 shown in Fig. 38 is attached to a flange surface of the steel frame by an appropriate method. Accordingly, the reinforcing rod and the bag body can be used together in the jointing of the beams. After the beams 150 and the beams 150a are respectively disposed and temporarily fixed, the upper pillar is placed on and temporarily fixed to the lower pillar 101a, then the filler is introduced through the filling port. In this jointing method, if the beam 150, etc. are engaged into the notches 15b of the pillar, a firm jointing can be formed.

**[0048]** The jointing as shown in Fig. 40 and Fig. 41 is used for constructing medieval European style sonorous buildings. Fig. 40 (A) is a perspective view of the external appearance of the jointing, Fig. 40 (B) is a perspective view of the jointing removing the upper pillar 162 and three beams 163 from that of Fig. 40 (A), and Fig. 41 is a vertical cross sectional view of the jointing of Fig. 40 (B).

**[0049]** The jointing member 160 is manufactured by concrete, pottery, ceramics, iron, nonferrous metals, inorganic or organic fibers such as carbon, aramid which are solidified or manufactured by working a natural stone. The jointing member 160 includes grooves 168 for receiving edge ends of the structure members 161, 162 comprising an upper and lower pillar at the upper and lower surfaces thereof, and grooves 165 for receiving structure members 163 comprising beams at the side surface thereof depending on the number of the beams respectively at predetermined positions. Main pillar rods 166 are embedded in the jointing member 160 in the vertical direction thereof to project therefrom, and frame bodies 167 are also embedded in an appropriate manner at the edge end surfaces of main beam rods 169 which are also embedded in the jointing member 160 at the left and right directions thereof.

**[0050]** When the jointing is formed, the grooves 168 of the jointing member 160 are engaged and provided in the upper end of the structure member 161, then the filler is introduced under pressure into the hollow portion of the structure member 161 through the filling port 161a so as to joint both. Successively, structure members 163 of the beams are respectively inserted into respective grooves 165, then the filler A is introduced under pressure into the inside of bag bodies 171 through an introduction port 163a, then the filler A is solidified. Finally, structure member 162 of the upper pillar is engaged in the upper grooves 168 of the jointing member 160, and the filler A is introduced into the lower part of the hollow portion of the structure member 162 to be solidified, thereby completing the jointing.

**[0051]** Fig. 42 shows a jointing of a structure member

according another jointing block, wherein Fig. 42 (A) is a perspective view of a portion adjacent to a jointing member, Fig. 42 (B) is a vertical cross-sectional view of the jointing member of Fig. 42 (A).

**[0052]** The jointing member in Fig. 40 is solid while a jointing member 200 in Fig. 42 is hollow, but the jointing method of the jointing member 200 in Fig. 42 is similar to that of the jointing member in Fig. 39. A vertical penetrating hole 206 which penetrates vertically the jointing member 200 is defined in the jointing member 200, and irregular portions are provided on the inner surface of the jointing member 200, at need. Lateral holes 205 are defined in the jointing member 200 by the number of the beams, and irregular portions are provided on the inner surfaces of the lateral holes 205 at need, wherein the lateral holes 205 communicate with the vertical penetrating hole 206.

**[0053]** In the method of constructing the jointing members, the jointing member 200 is placed on the lower pillar 201 which is built up in the aforementioned manner. Although the lower surface of the jointing member 200 contacts upper end surface of the lower pillar 201 in the figure, it is possible to provide a receiving groove 204 like an upper pillar 202. Then, beams 203 are engaged in the lateral holes 205. Thereafter, the upper pillar 202 is built up in the receiving groove 204, then the filler is introduced into the receiving groove 204 through a filling port 209. The reinforcing members 166 are embedded or the jointing frame 100, etc. are provided, or the cover members 14, etc. are provided, which are appropriately selected depending on the object of the uses thereof. When the beams are built up in the jointing, there are utilized the jointing method as illustrated in Fig. 33, Fig. 39, or the grooves 165 may be disposed in a lateral direction shown in Fig. 40.

**[0054]** The jointing member used by the present invention includes that which is a compromise between that in Fig. 40 and that in Fig. 42. Fig. 43 (A) is a vertical cross-sectional view of such jointing member, and Fig. 43 (B) is a vertical cross-sectional view of another jointing member.

**[0055]** A jointing member 210 shown in Fig. 43 (A) has a vertically penetrating hole 218 which penetrates the jointing member 210 and also has irregular portions at the center thereof. The pillar head of the lower pillar 211 is built up in a hole 215 defined in the jointing member 210 in the lower direction thereof, and the former is temporarily fixed to the latter, at need. Jointing frames 216 of the beams are respectively embedded in the jointing member 210, and the receiving grooves 217 are respectively provided like those in Fig. 40. After the beams 213 are provided on the jointing member 210 by the necessary number, a filler is introduced into the jointing member 210 through a filling port 218a provided in the vertically penetrating hole 218. Thereafter, the upper pillar 212 is built up in a hole 214 of the pillar, and a filler is introduced through a filling port of the upper pillar.

**[0056]** A jointing member 220 in Fig. 43 (B) is different

from the jointing member 210 in Fig. 43 (A) in respect of the provision of a laterally penetrating hole 228. Reinforcing rods 227 are embedded in the jointing member 220 in a vertical direction. A hole 225 of the jointing member 220 is placed on the pillar head of a lower pillar 221, then a filler is introduced through a filling port 225a. Successively beams 223 are respectively provided on a beam placement table 226 of the jointing member 220, and a filler A is introduced through a filling port 226a provided in a hole 224 defined in an upper pillar 222. Finally, the upper pillar 222 is provided in the hole 224 of the upper pillar 222, then the filler A is introduced.

**[0057]** Fig. 44 and Fig. 45 show another jointing method when jointing the beam and the pillar, wherein Fig. 44 is a perceptive view for explaining the jointing part between a beam and a pillar under assembling thereof, Fig. 45(A) is a perspective view of the jointing between beams and pillars and Fig. 45(B) is a cross sectional view taken along the line A-A in Fig. 45(A).

**[0058]** Although the notches 15b are defined in the lower pillar 101a in the jointing part in Fig. 39, notches 303a to 303d (notches 303c, 303d are opposite to the notches 303b, 303a) are defined in the jointing part in Fig. 44. That is, the notches having shapes corresponding to hollow portions of the pillars and the beams are provided in the beam 303 at a crossing part between pillars 301, 302 and beams 304, 305 by the number of members to be jointed. The structure members are jointed as follows. That is, a flat-plate shaped jointing member 230 having a notch 230a at the portion adjacent to the center thereof is placed on the pillar 301, then the notch 303d of the beam 303 is aligned with the notch 230a of the jointing member 230 and they are set up, thereafter hollow portions of the beams 304, 305 and the hollow portion of the pillar 302 are aligned with the notches 303c, 303b, 303a of the beam 303 and they are set up. These members are temporary fixed, if need be, then the filler is introduced from the filling port 310.

**[0059]** Also is the jointing part in Fig. 45, the cover member 14, the reinforcing member 15 and the bag body, etc. are disposed or constructed in the same manner as set forth above. The jointing member 230 is provided, if need be, and the disposing position is not limited to the head of the pillar 301 and it can be disposed at the bottom of the pillar 302 or both the head and bottom thereof. Further, the shape of the jointing member may be modified as illustrated in Fig. 40 to Fig. 43. When the beam 303 is to be extended, another beam 306 is brought into contact with the end 307 of the beam 303, then the filler is introduced into the beams 303, 306 in the same manner as set forth above, thereby connecting them.

**[0060]** Fig. 46 is a perspective view of the top of the beam 303 or the neighborhood thereof, which is turned upside down for facilitating the understanding. In the example shown in Fig. 46(A), the structure member 1 shown in Fig. 1 is used as the beam 303, and the irregular portions 2 are cut at the top or the neighborhood

thereof so as to provide a substantially straight air discharge passage 121b, and an air discharge port 12b communicating with the air discharge passage 121b defined in the structure member 1 in front of the cover member 14. Air in the structure member 1 is collected in the top thereof as the filler is introduced inside the structure member 1 and there is a case where air stays after the filler is hardened depending on the shapes of the irregular portions 2. Accordingly, air collected in the top of the structure member 1 during the introduction of the filler is naturally or forcibly discharged from the air discharge port through the air discharge passage 121b. If air is short even in such a structure, for example, an air discharge pipe 122b having small holes 123b is disposed in the air discharge passage 121b as illustrated so as to discharge air from the introduction port of the filler or from the air discharge port 12b. Thereafter, the air discharge pipe is extracted or embedded depending on the circumstances of the site. It is preferable that air is collected in the air discharge passage while the hollow portion is circular, oval, or the like even if the outer shape of the structure member 1 is rectangular to prevent air from staying in the irregular portions 2 provided at the inner surface thereof. In the case as illustrated in Fig. 46(B), the air discharge passage 121b is defined in the manner that the crests of the irregular portions 2 are penetrated and the roots thereof are continuous with one another. As other air discharge methods, the air discharge passage 121b is notched similar to the notches 151, 153 which are formed by partially penetrating the upper portions of the beam or the air discharge port 12b is formed in a rectangular shape similar to the notch 303a in Fig. 44.

**[0061]** Fig. 47 is a perspective view for explaining other jointing methods in the jointing part between the beam and the pillar. The jointing method employs those as explained in Fig. 24 to Fig. 46 appropriately. The method of constructing the jointing members is performed by disposing the jointing member 230 on the upper part of the pillar 331, aligning the end surfaces of the beams 313 to 316 with one another to form a jointing opening 317, then disposing the pillar 312. In constructing the jointing members, the temporary fixing member 31 may be used similar to the case in Fig. 44 in the same manner as explained in Fig. 24. The jointing member 230 may be disposed on the boundary between the lowermost end of the pillar 312 and the upper sides of the beams 313 to 316, or may be disposed on the upper and lower sides thereof. Further, it is possible to employ a structure that the jointing member 230 is omitted.

**[0062]** Although the embodiments of the kinds of structure members and jointing methods thereof are described in detail with reference to Fig. 1 to Fig. 47, the present invention is not limited to these embodiments, and it is needless to say that the present invention can be embodied by appropriately combining the concrete structure members as set forth above with one another

or by changing the concrete structure thereof in detail within a scope of claims.

**[0063]** For example, if the projecting plates 15a, the reinforcing members 15, the jointing frame 100, the notches 15b of the pillar in Fig. 39 and the grooves 165 of the beam and the grooves 168 of the pillar in Fig. 40 are respectively inclined, a structure building having the inclined beams and pillars can be constructed. Further, new jointing members prepared by combining the jointing members 210, 220 as shown in Fig. 43 (A) and Fig. 43 (B), i.e. the jointing member 200 in Fig. 42 is turned 180° and the lower surface 207 of the jointing member 200 is placed on the upper pillar 202, thereby preparing the jointing member. Still further, a jointing member having such a shape that the upper half or lower half of the penetration hole 218 is embedded in the jointing member 210 in Fig. 43 (A) may be prepared in a factory. Alternatively, in the jointing member 220 shown in Fig. 43 (B), the hollow part of the lower pillar 221 communicate with the penetration hole 228 or the hollow part of the upper pillar 222 communicate with the penetration hole 228.

#### INDUSTRIAL APPLICABILITY

**[0064]** Since the structure members of the present invention include hollow tubes made of concrete or a material similar thereto, and the irregular portions formed at the inner surface of the hollow tube, if the filler which can be solidifying is introduced while the structure members are butt-joined with each other, so that the structure members can be jointed with each other utilizing the irregular portions. Further, the jointing members can be surely jointed with each other adopting the expansible filler appropriately depending on the object of the structure members. Since the working in the site is easy and simple, a worker having no special skill can engage in the work. Still further, it is possible to achieve economical efficiency and enhance diversity of design since the structure members having arbitrary shapes can be used.

**[0065]** When the structure bedding comprising the structure members is completed, the stress is applied to the jointing parts of the structure members. At this time, although stress is generated between edge ends of the irregular portions of the structure members and those of the filler, the inner formwork having the irregular portion at the inner surface of the structure members is embedded, or the reinforcing member is embedded in the jointing part of the structure members, or bag bodies are embedded in the structure members, or fibers of grass, carbon, and aramid are mixed with the filler depending on the degree of the stress applied to the edge ends of the irregular portions. Accordingly, it is possible to coat the surface of the structure member with a surface member or to subject the surface of the structure member to an enforcing treatment. As a result the present invention can cope with the structure of complex joint-

ing. Further, an ordinary jointing member is used or a sonorous jointing member is used depending on the object of the structures, thereby permitting construction to be simple and also the design to be diversified.

#### Claims

1. A structure member usable to pillars or beams and formed of a hollow tube made of concrete or a material similar to concrete, said hollow tube having an irregular portion on an inner surface thereof.
2. The structure member according to Claim 1, wherein said irregular portion is helical.
3. The structure member according to Claim 1 or 2, wherein an inner formwork is embedded in the inner surface of said hollow tube.
4. The structure member according to any of Claims 1 to 3, wherein said hollow tube has an attachment portion to which an attachment is fixed or an aesthetic irregular portion respectively provided at an outside thereof.
5. The structure member according to any of Claims 1 to 4, wherein said structure member comprises a plurality of hollow tubes, said tubes integrated with one another while they are bundled.
6. The structure member according to any of Claims 1 to 5, wherein said hollow tube is notched at a part or an entire thereof.
7. The structure member according to any of Claims 1 to 6, wherein a reinforcing plate is attached to the inner surface of said hollow tube.
8. The structure member according to any of Claims 1 to 7, wherein a surface member is attached to a part or an entire surface of said hollow tube.
9. The structure member according to any of Claims 1 to 8, further including an air discharge passage defined in said irregular portion on the inner surface of said hollow tube.
10. A method of jointing structure members each comprising a hollow tube made of concrete or a material similar thereto, said hollow tube having an irregular portion on an inner surface thereof, said method comprising butt-jointing ends of two or more structure members, then introducing a filler into said structure members so as to be solidified, thereby jointing said structure members with one another.
11. A method of jointing structure members each comprising a hollow tube made of concrete or a material

similar thereto, said tube having an irregular portion on an inner surface thereof, said method comprising attaching cover members so as to be fixedly attached to portions adjacent to ends of said structure members which are to be jointed, facing said ends of at least two or more structure members having respectively cover members attached thereto, then introducing a filler into a space partitioned by said cover members so as to be solidified, thereby jointing said structure members with one another.

12. A method of jointing structure members each comprising a hollow tube made of concrete or a material similar thereto, said tube having an irregular portion on an inner surface thereof, said method comprising attaching a bag body to a portion adjacent to an end of one structure member to be jointed, facing ends of said one and other structure members one another, then introducing a filler into said bag body so as to be expanded, thereby jointing said structure members with one another.

13. The method of jointing structure members according to any of Claims 10 to 12, wherein a reinforcing member is put in jointing parts of said structure members.

14. The method of jointing structure members according to any of Claims 11 to 13, wherein another end of said bag body is fixed to said reinforcing member or said cover members.

15. The method of jointing structure members according to any of Claims 11 to 14, wherein said bag body is restrained from being extended by way of said cover members, said reinforcing member or a restriction member so as to prevent a tip end of said bag body from being extended in an extension direction of said structure member without exceeding a given length when said filler is introduced into said bag body to be expanded after said bag body is attached to a portion adjacent to an end of one structure member to be jointed, then one and other structure members are faced with one another at ends thereof.

16. The method of jointing structure members according to any of Claims 11 to 15, wherein one end of said bag body is fixed to a jointing frame when said bag body is fixed to a portion adjacent to said end of said one structure member to be jointed.

17. A method of jointing structure members, a jointing member is jointed with said structure members to be jointed by way of jointing parts formed by said method according to any of Claims 10 to 16.

18. The method of jointing structure members according to any of Claims 10 to 17, wherein said structure member has an air discharge passage, said air discharge port communicating with said air discharge passage, said air discharge passage and air discharge port respectively defined in said irregular portion on the inner surface of said hollow tube, wherein air inside said structure member is discharged from said air discharge passage through said air discharge port when said filler is introduced into said structure members.

#### Amended claims

1. (Amended) A structure member usable to pillars or beams of an earth working structure or a building structure and formed of a hollow tube made of concrete or a material similar to concrete, said hollow tube having an irregular portion on an inner surface of a hollow portion thereof, said irregular portion serving for jointing hollow tubes when introducing a hardening filler into the hollow portion of said hollow tube to be solidified while adjacent hollow tubes are butt-jointed with one another.

2. (Added) The structure member according to Claim 1, wherein said irregular portion on the inner surface of the hollow portion of said hollow tube has an annularly continuous shape.

3. (Amended) The structure member according to Claim 1, wherein said irregular portion on the inner surface of the hollow portion of said hollow tube has a helical shape.

4. (Added) The structure member according to any of Claims 1 to 3, wherein said irregular portion on the inner surface of the hollow portion of said hollow tube has a discontinuous shape formed by cutting said irregular portion in a lateral sectional direction with a given width.

5. (Amended) The structure member according to any of Claims 1 to 4, wherein an inner formwork is embedded in the inner surface of the hollow portion of said hollow tube.

6. (Amended) The structure member according to any of Claims 1 to 5, wherein said hollow tube has an attachment portion to which an attachment is fixed or an aesthetic irregular portion respectively provided at an outside thereof.

7. The structure member according to any of Claims 1 to 6, wherein said structure member comprises a plurality of hollow tubes, said tubes being integrated with one another while they are bundled.

8. The structure member according to any of Claims 1 to 7, wherein said hollow tube is notched at a part or an entire thereof.

9. (Amended) The structure member according to any of Claims 1 to 8, wherein a reinforcing plate is attached to the inner surface of the hollow portion of said hollow tube.

10. The structure member according to any of Claims 1 to 9, wherein a surface member is attached to a part or an entire surface of said hollow tube.

11. (Added) The structure member according to any of Claims 1 to 10, wherein a filling port or an air discharge port is defined in the irregular portion on the inner surface of the hollow portion of said hollow tube.

12. (Amended) The structure member according to any of Claims 1 to 11, wherein an air discharge passage is defined in the irregular portion on the inner surface of the hollow portion of said hollow tube.

13. (Amended) A method of jointing structure members each comprising a hollow tube made of concrete or a material similar to concrete, said hollow tube having an irregular portion on an inner surface of a hollow portion thereof, said method comprising butt-jointing ends of two or more structure members or ends and side surfaces thereof, then introducing a filler into said structure members so as to be solidified, thereby jointing said structure members with one another.

14. (Amended) A method of jointing structure members each comprising a hollow tube made of concrete or a material similar to concrete, said tube having an irregular portion on an inner surface of a hollow portion thereof, said method comprising attaching cover members so as to be fixedly attached to portions adjacent to said structure members to be jointed, butt-jointing said ends of at least two or more structure members or ends and side surfaces thereof having respectively cover members attached thereto, then introducing a filler into a space partitioned by said cover members so as to be solidified, thereby jointing said structure members with one another.

15. (Amended) A method of jointing structure members each comprising a hollow tube made of concrete or a material similar to concrete, said tube having an irregular portion on an inner surface of a hollow portion thereof, said method comprising attaching a bag body to a portion adjacent to one structure member to be jointed, and butt-jointing ends of said one and other structure members or the end of said one structure member with side surfaces of said other structure members, then introducing a filler into said bag body so as to be expanded, thereby jointing said structure members with one another.

16. The method of jointing structure members according to any of Claims 13 to 15, wherein a reinforcing member is put in jointing parts of said structure members.

17. The method of jointing structure members according to any of Claims 14 to 16, wherein another end of said bag body is fixed to said reinforcing member or said cover members.

18. (Amended) The method of jointing structure members according to any of Claims 14 to 17, wherein said bag body is restrained from being extended by way of said cover members, said reinforcing member or a restriction member so as to prevent a tip end of said bag body from being extended in an extension direction of said structure member without exceeding a given length when said filler is introduced into said bag body to be expanded after said bag body is attached to a portion adjacent to and end of one structure member to be jointed, and butt-jointing ends of one and other structure members or the end of said one structure member with side surfaces of said other structure members, then introducing said filler into said bag body so as to be expanded.

19. The method of jointing structure members according to any of Claims 14 to 18, wherein one end of said bag body is fixed to a jointing frame when said bag body is fixed to a portion adjacent to said end of said one structure member to be jointed.

20. A method of jointing structure members comprising jointing a jointing member with said structure members to be jointed by way of jointing parts formed by said method according to any of Claims 13 to 19.

21. (Added) A method of jointing structure members according to any of Claims 13 to 20, further comprising using a jointing member having an air discharge passage provided on an irregular portion on the inner surface of the hollow portion of said hollow tube, and discharging air inside the structure member through the air discharge passage when introducing a filler in the structure members.

22. (Amended) The method of jointing structure members according to any of Claims 13 to 21, wherein the structure member has an air discharge passage, said air discharge port communicating with said air discharge passage, said air discharge passage and air discharge port respectively defined in the irregular portion on the inner surface of the hollow portion of said hollow tube, wherein air inside said structure member is discharged from said air discharge passage through said air discharge port when the filler is introduced into said structure members.

#### Statement under Art. 19.1 PCT

Claim 1 clarifies the use of the structure member wherein the place to provide the irregular portion in the structure member comprising a hollow tube is the inner surface of a hollow portion of the hollow tube. Further, claim 3, claim 5, claim 6, claim 9, claim 12, claim 13, claim 14, claim 15 and claim 22 respectively clarify that the inner surface to provide the irregular portion in the structure member com-

prising the hollow tube is the inner surface of the hollow portion of the hollow tube.

The first cited reference discloses a steel pile wherein a second steel tube which is larger than a first steel tube in diameter is disposed concentrically around the first steel tube, and a filling layer made of concrete is formed between the first steel tube and second steel tube, wherein helical projections are continuously provided on the outer peripheral surface of the first steel tube and the inner peripheral surface of the second steel tube, thereby increasing the connecting strength between concrete and steel tubes. As a result, the first cited reference is fundamentally different from the invention of the present application in respect of an object and a construction. Further, other cited references have no irregular portion on the inner surface of a hollow portion of a hollow tube.

Claim 13, claim 14, claim 15 and claim 18 respectively clarify the portions to be jointed.

Still further, claim 2, claim 4, claim 11 and claim 21 are respectively added.

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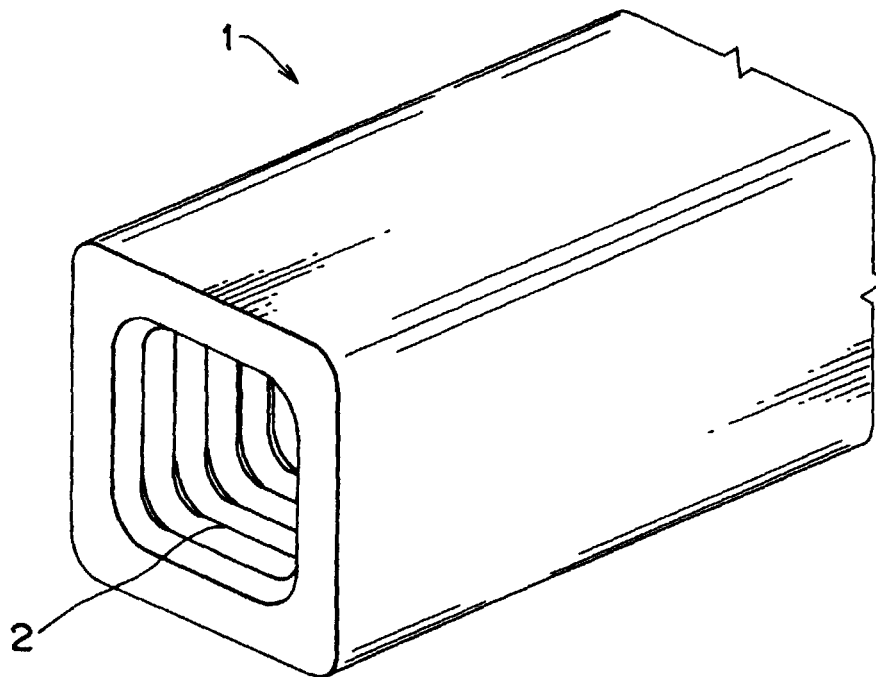
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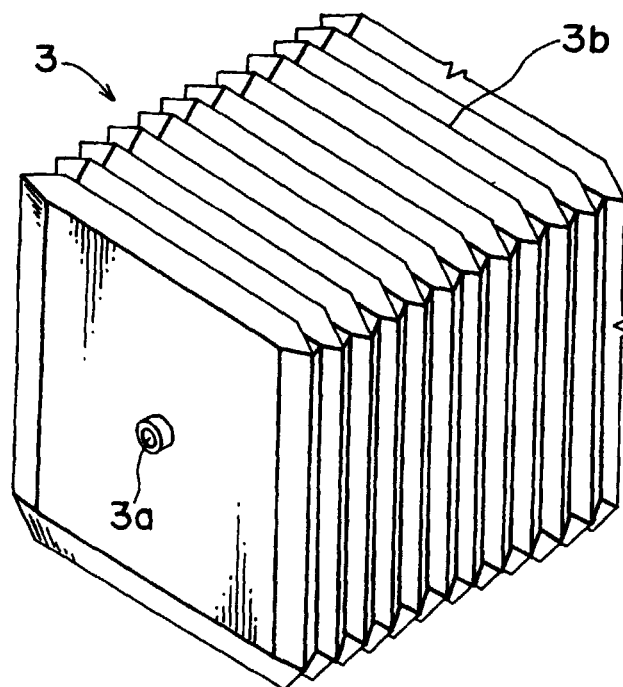
50

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FIG. 1



**FIG. 2**



**FIG. 3**

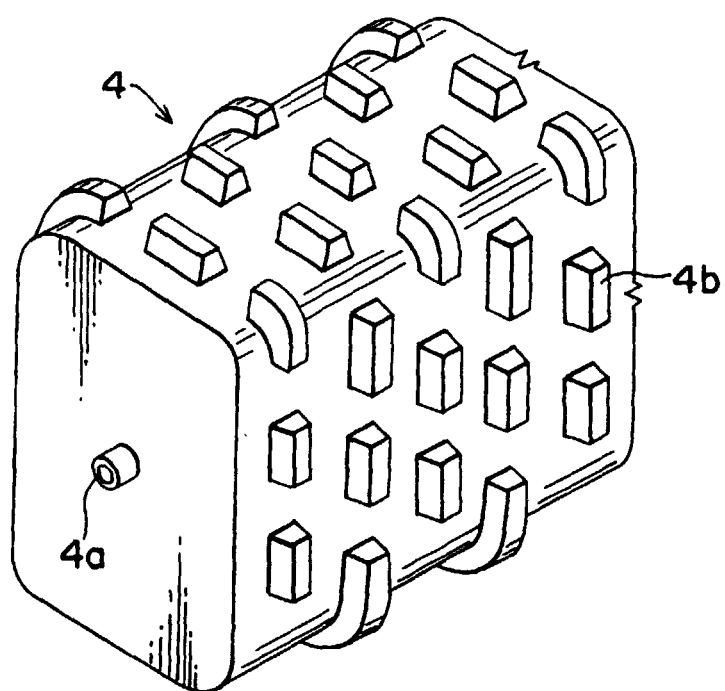


FIG. 4

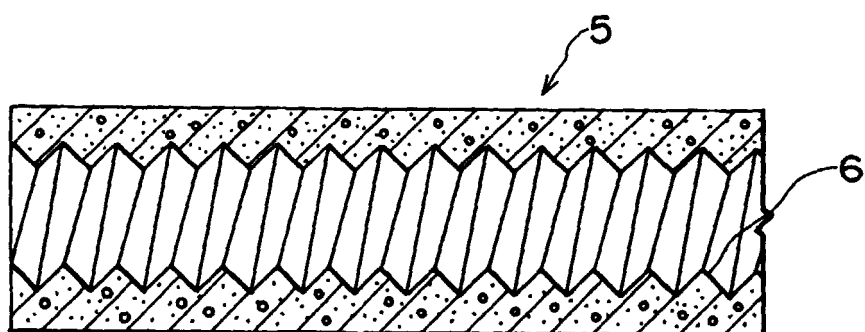


FIG. 5

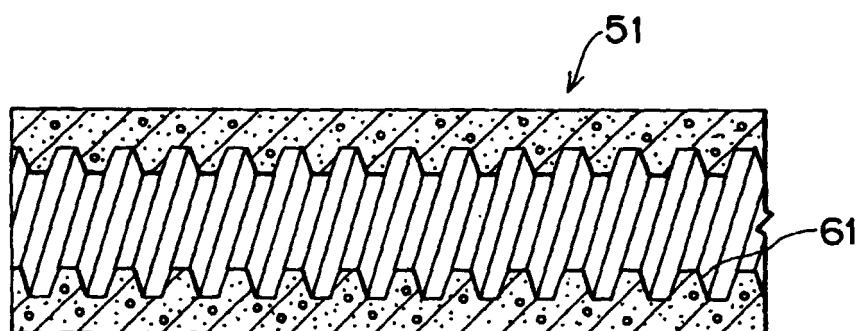


FIG. 6

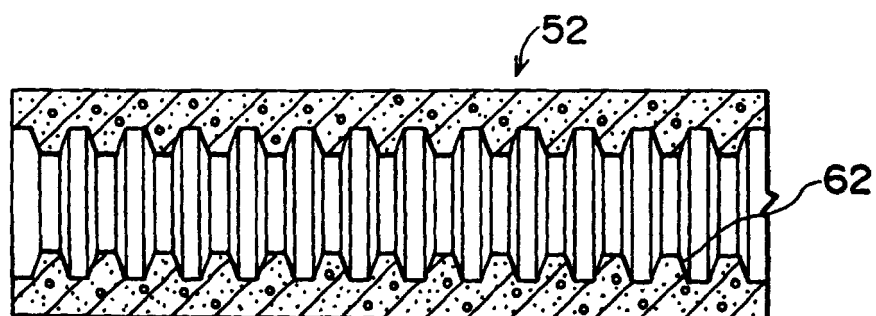


FIG. 7

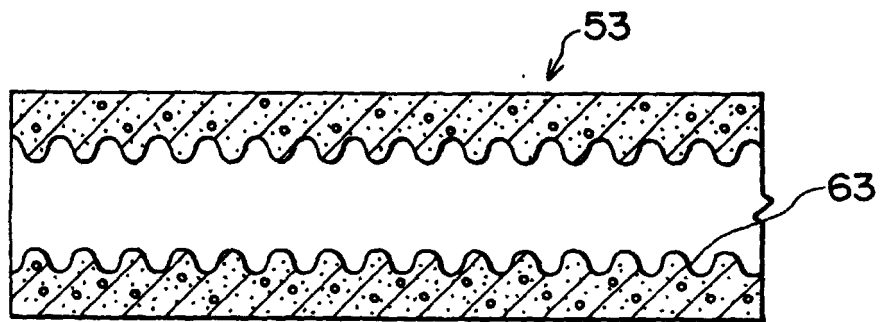


FIG. 8

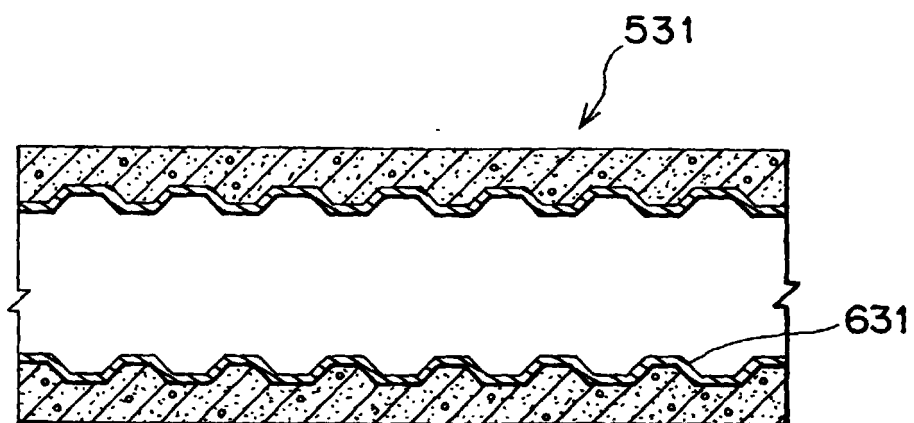


FIG. 9

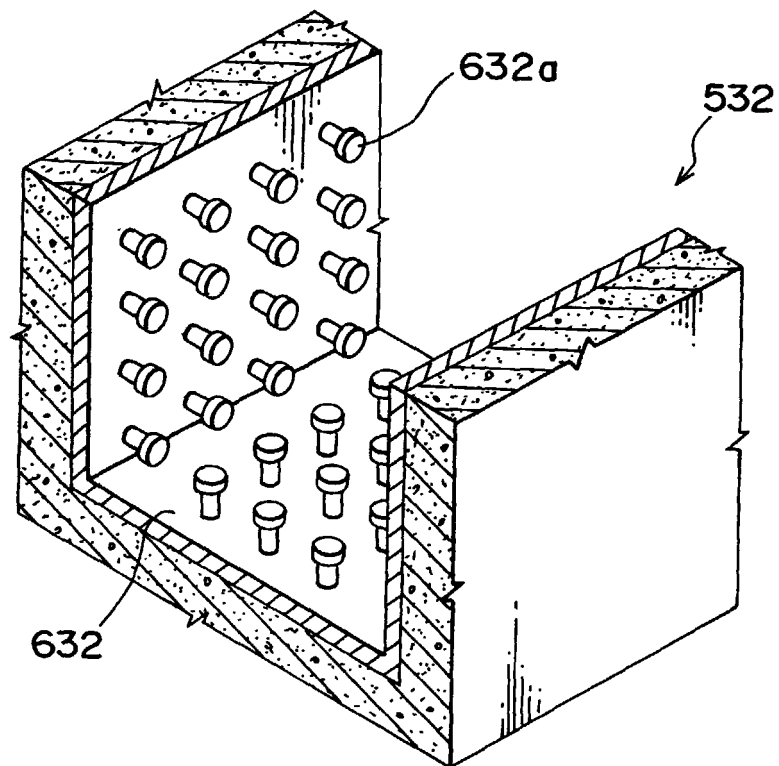


FIG. 10

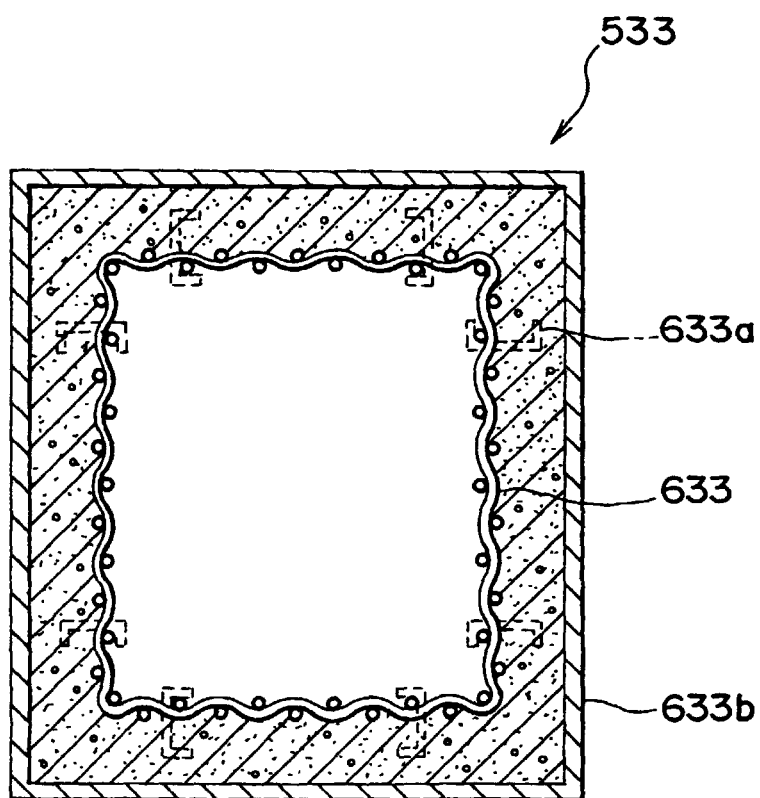


FIG. 11

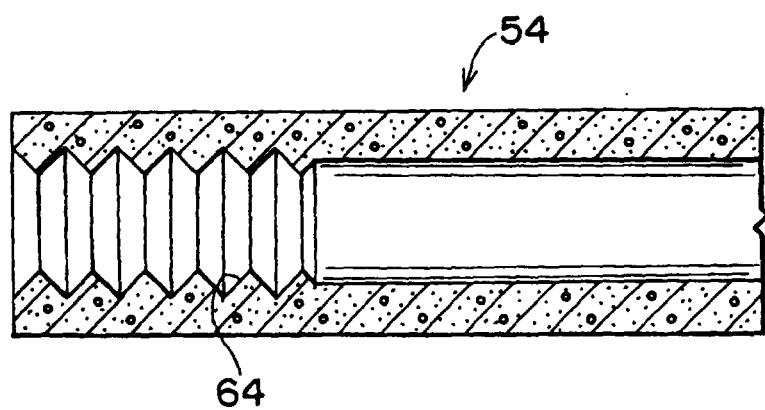


FIG. 12

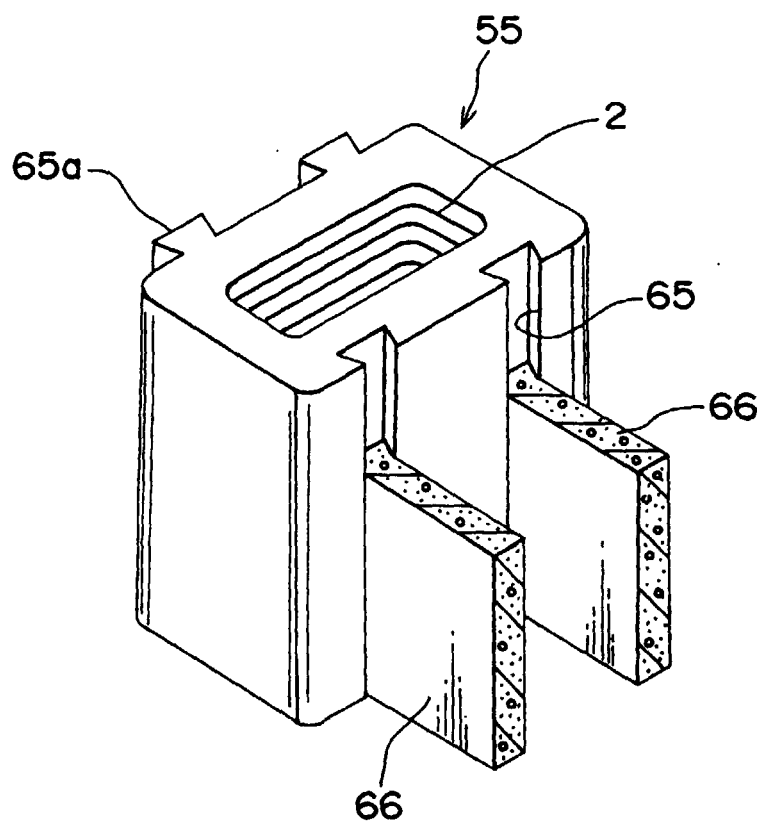


FIG. 13

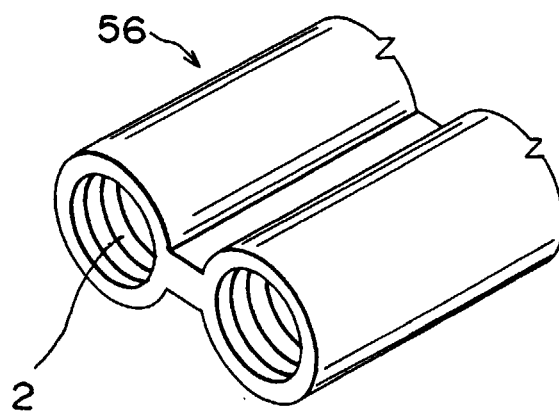


FIG. 14

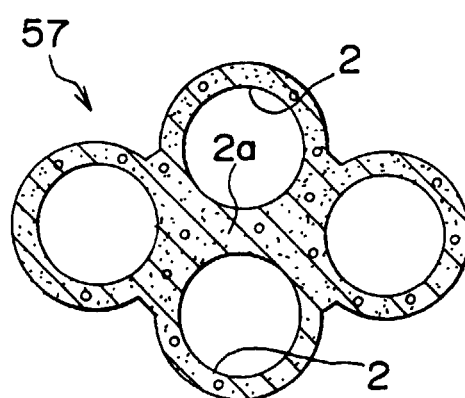


FIG. 15

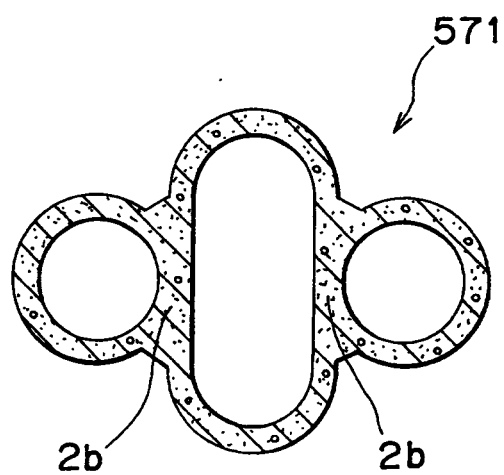


FIG. 16

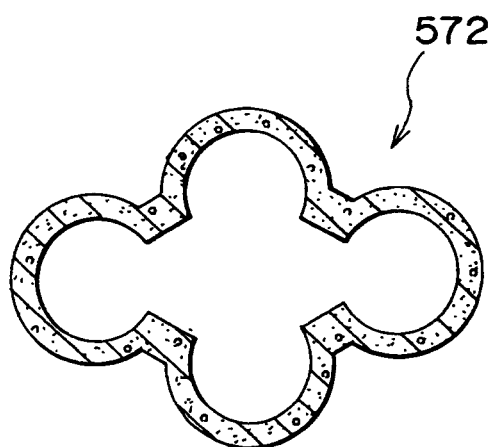


FIG. 17(A)

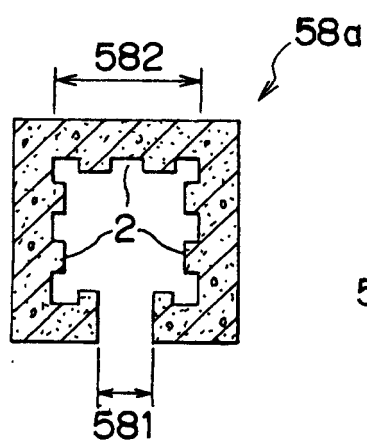


FIG. 17(C)

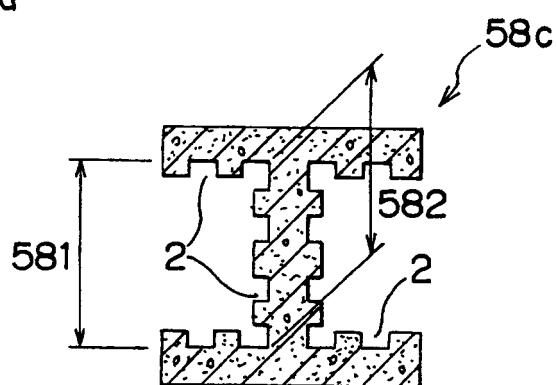


FIG. 17(B)

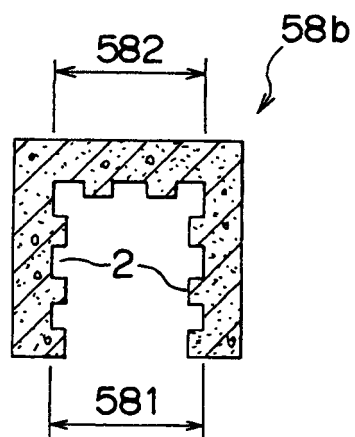


FIG. 18

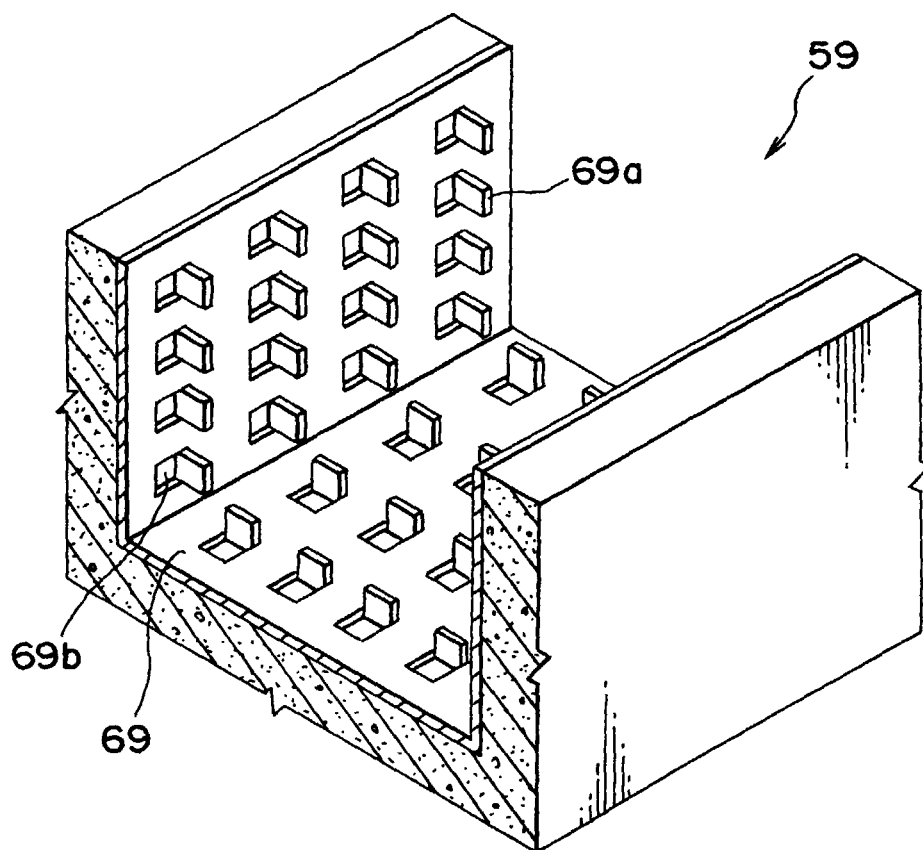


FIG. 19

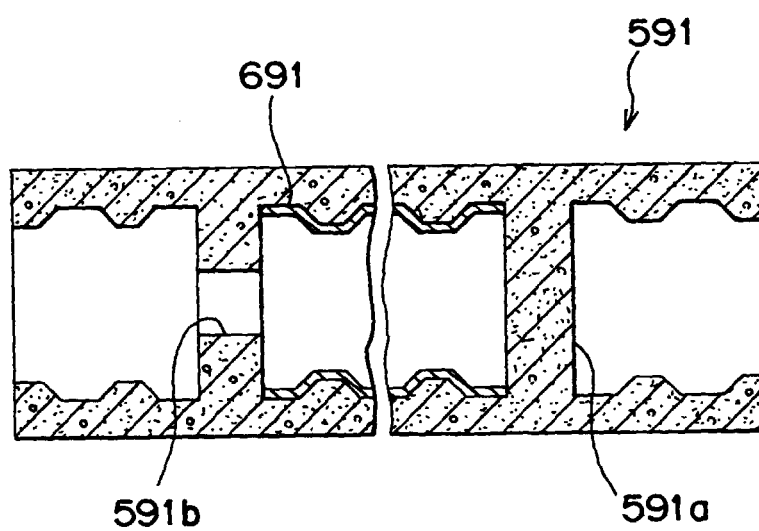


FIG. 20(A)

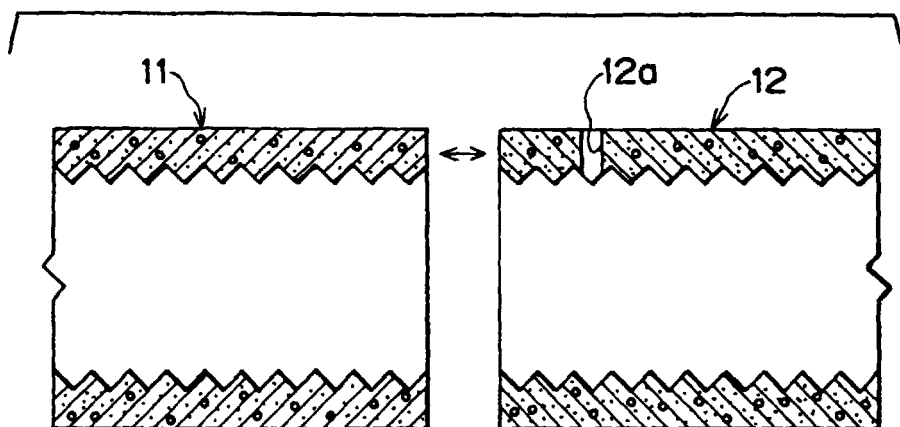


FIG. 20(B)

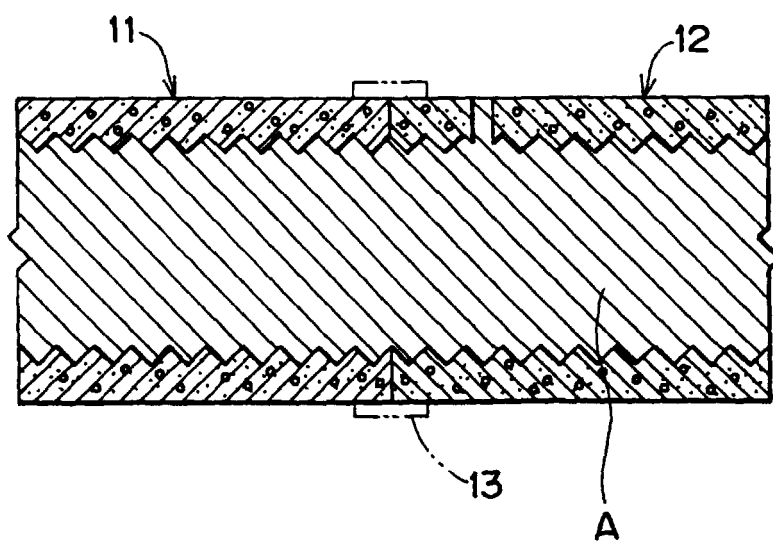


FIG. 21(A)

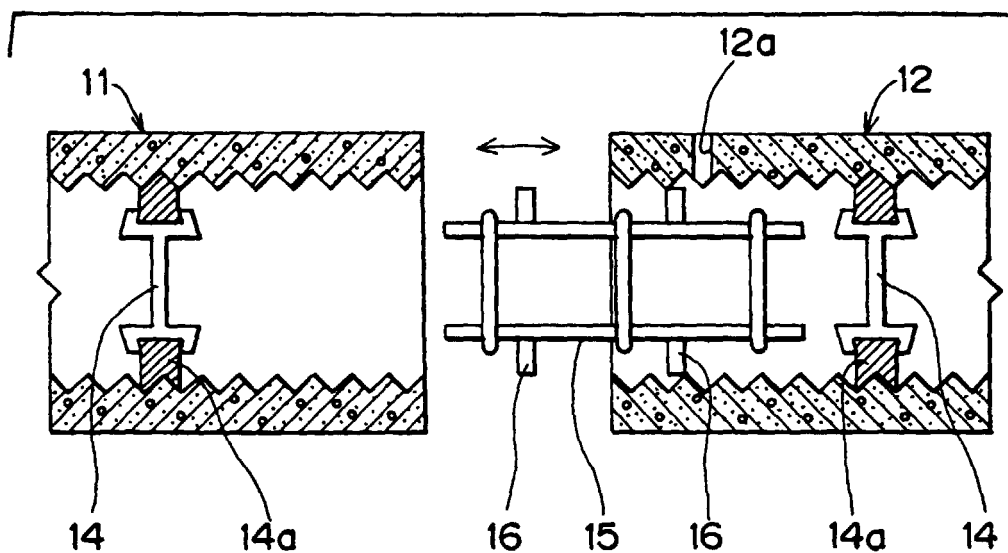


FIG. 21(B)

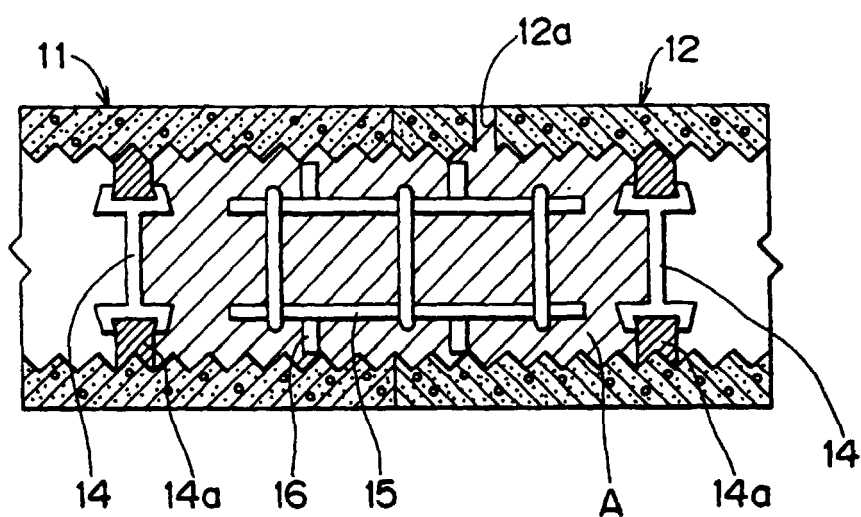


FIG. 22(A)

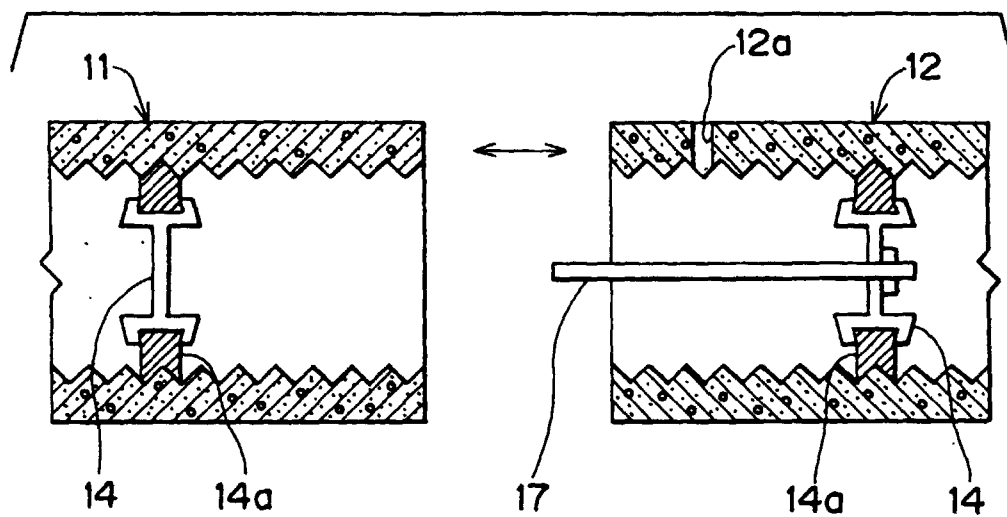


FIG. 22(B)

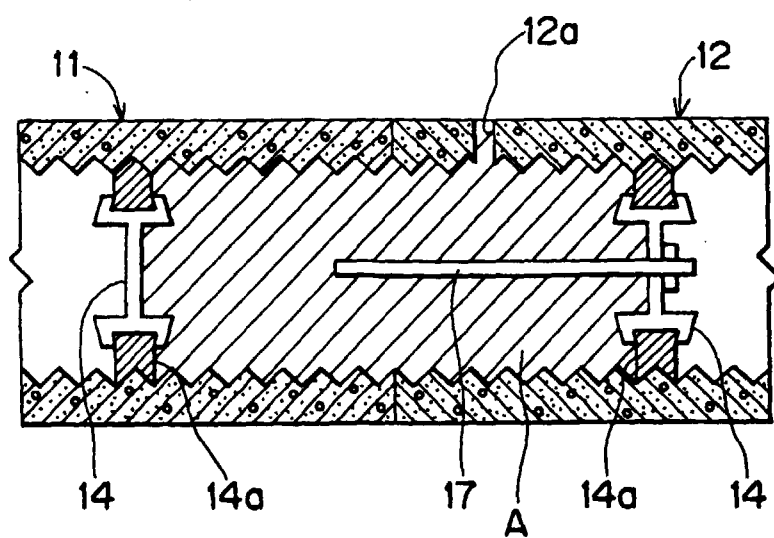


FIG. 23(A)

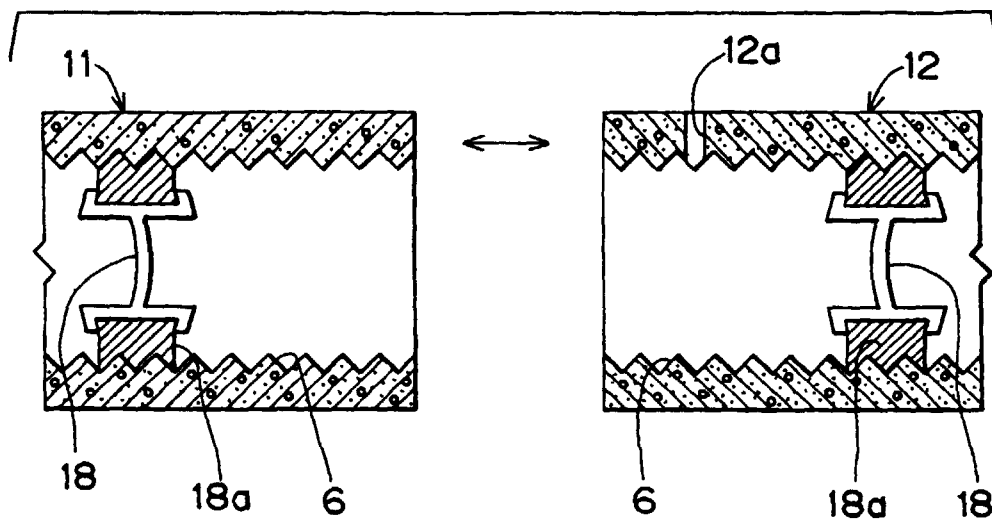


FIG. 23(B)

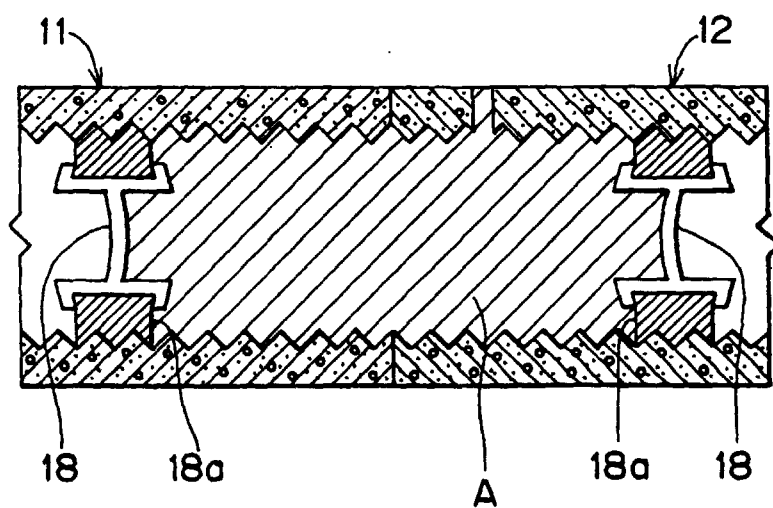


FIG. 24

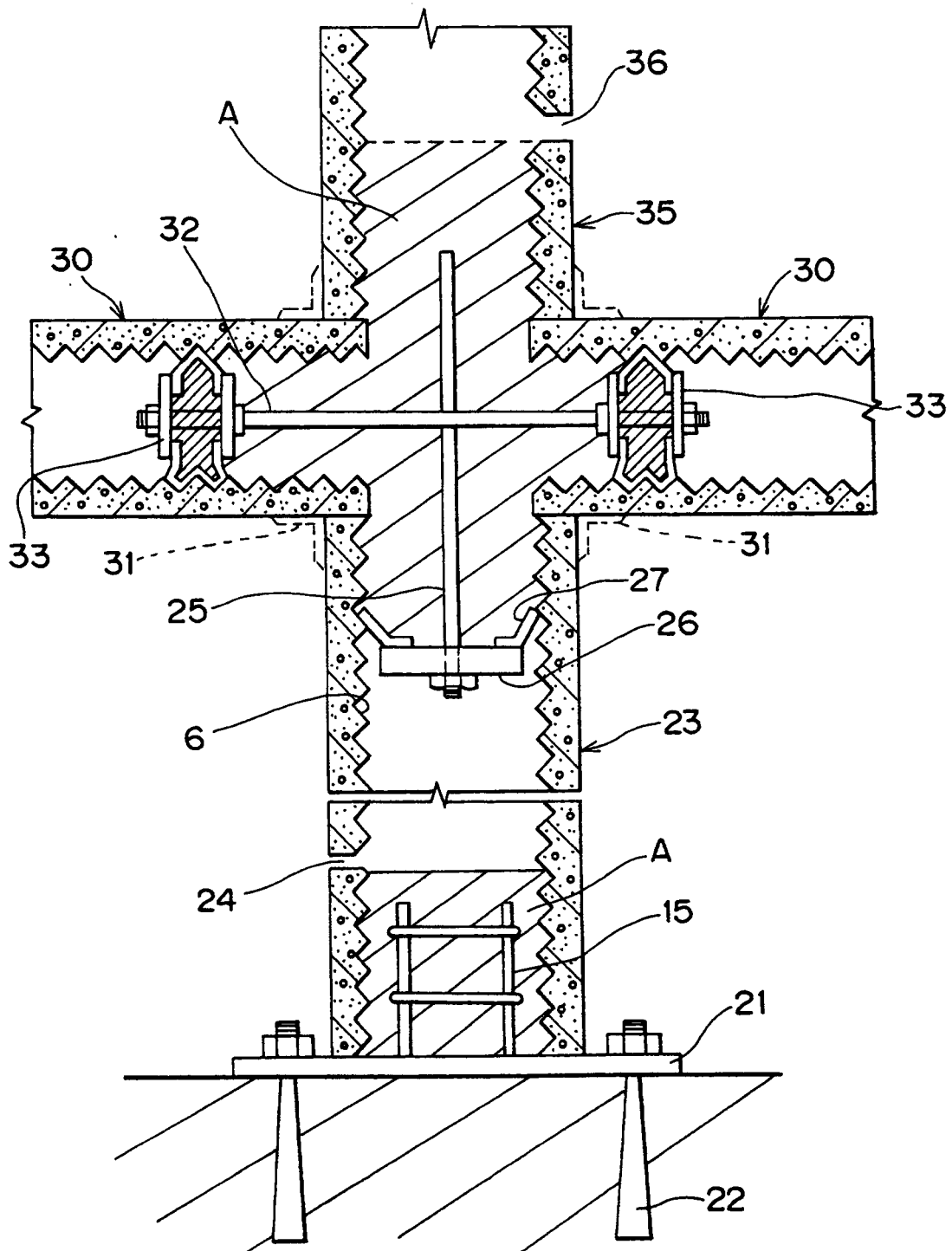


FIG. 25

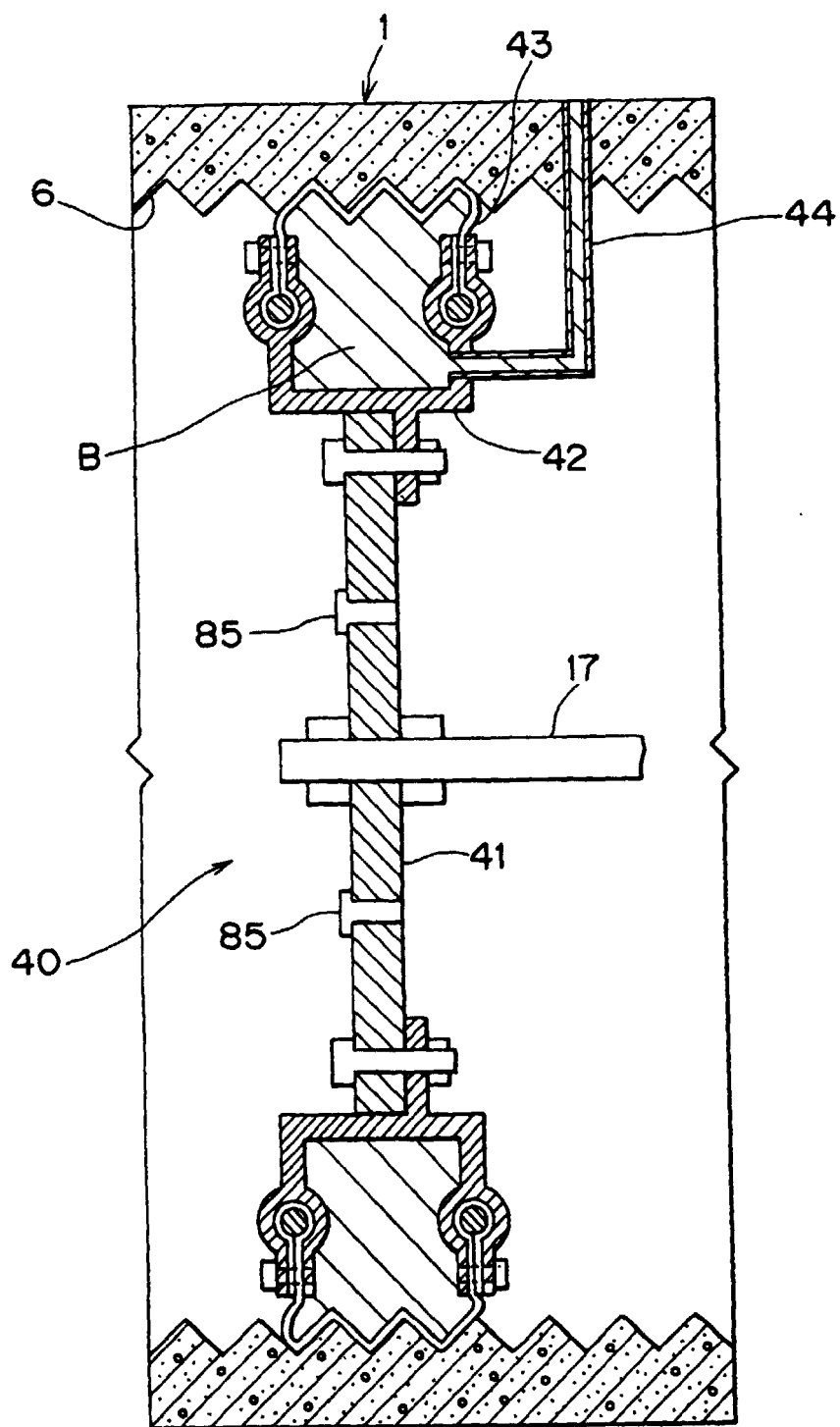


FIG. 26

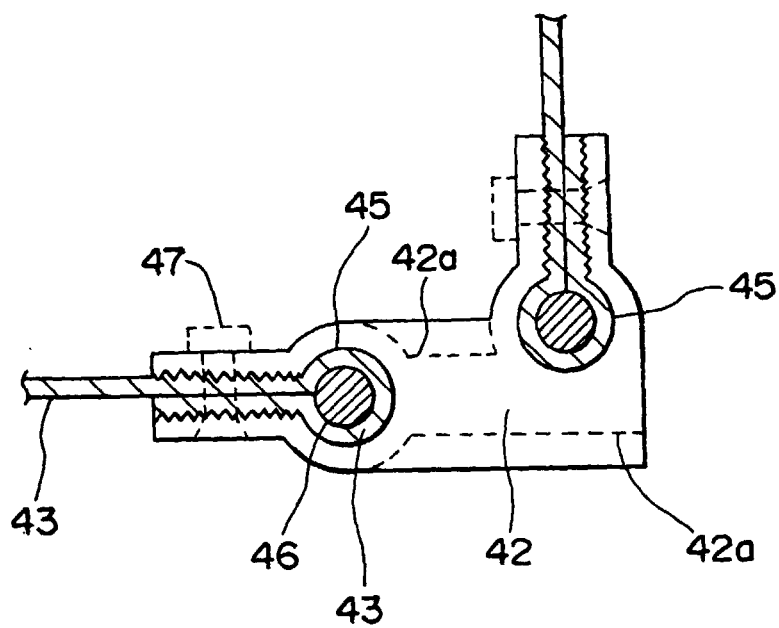


FIG. 27

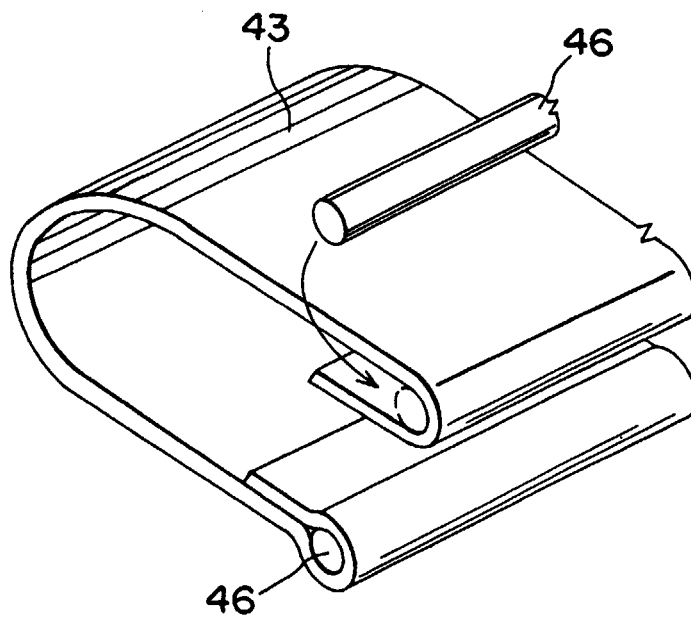


FIG. 28

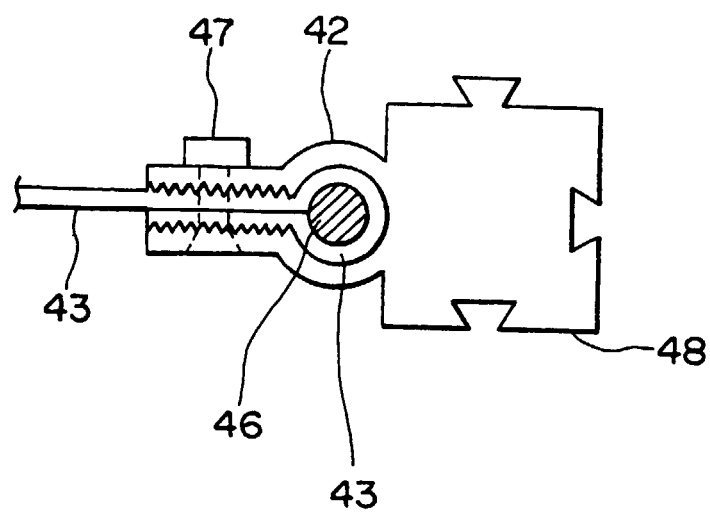
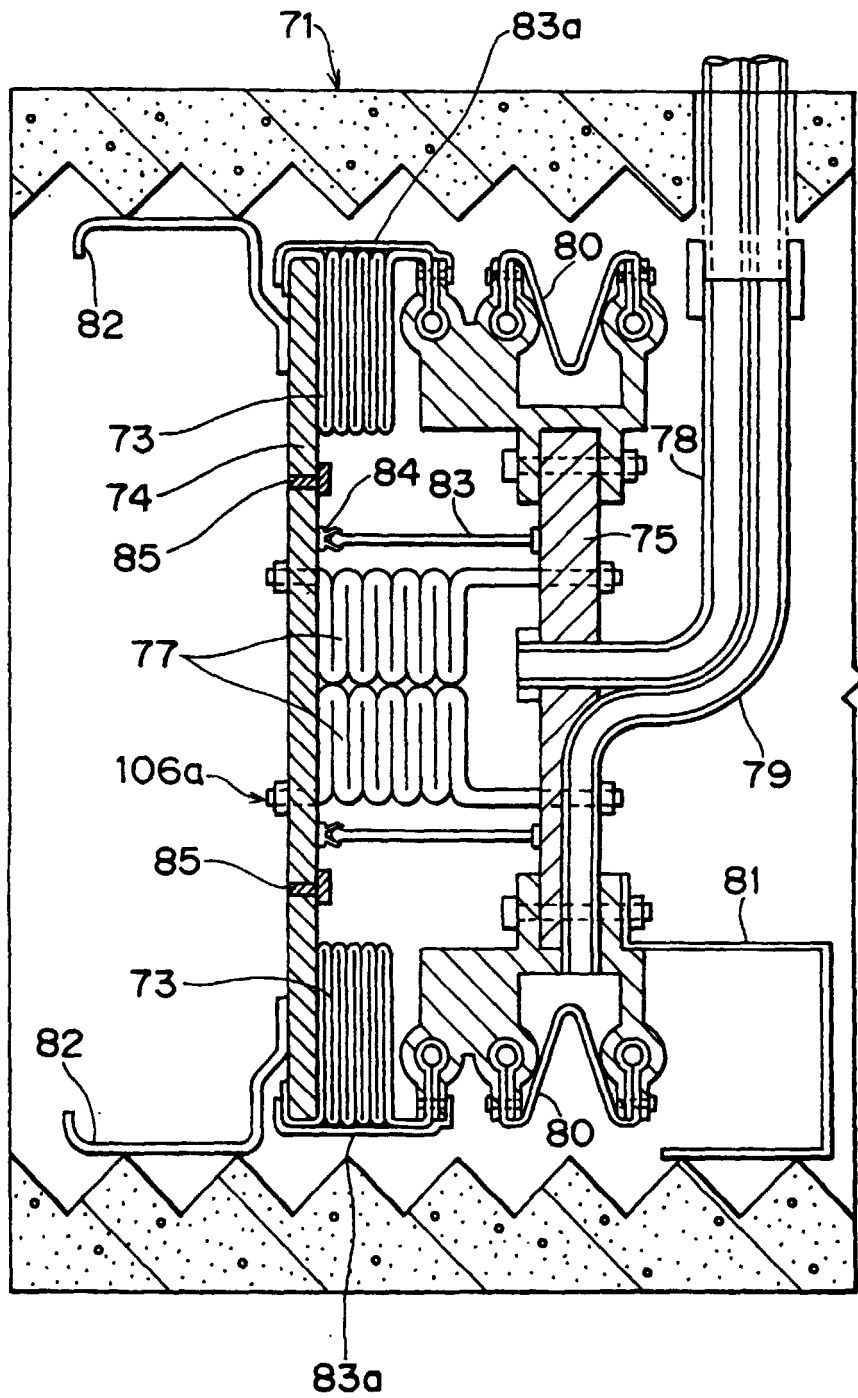


FIG. 29



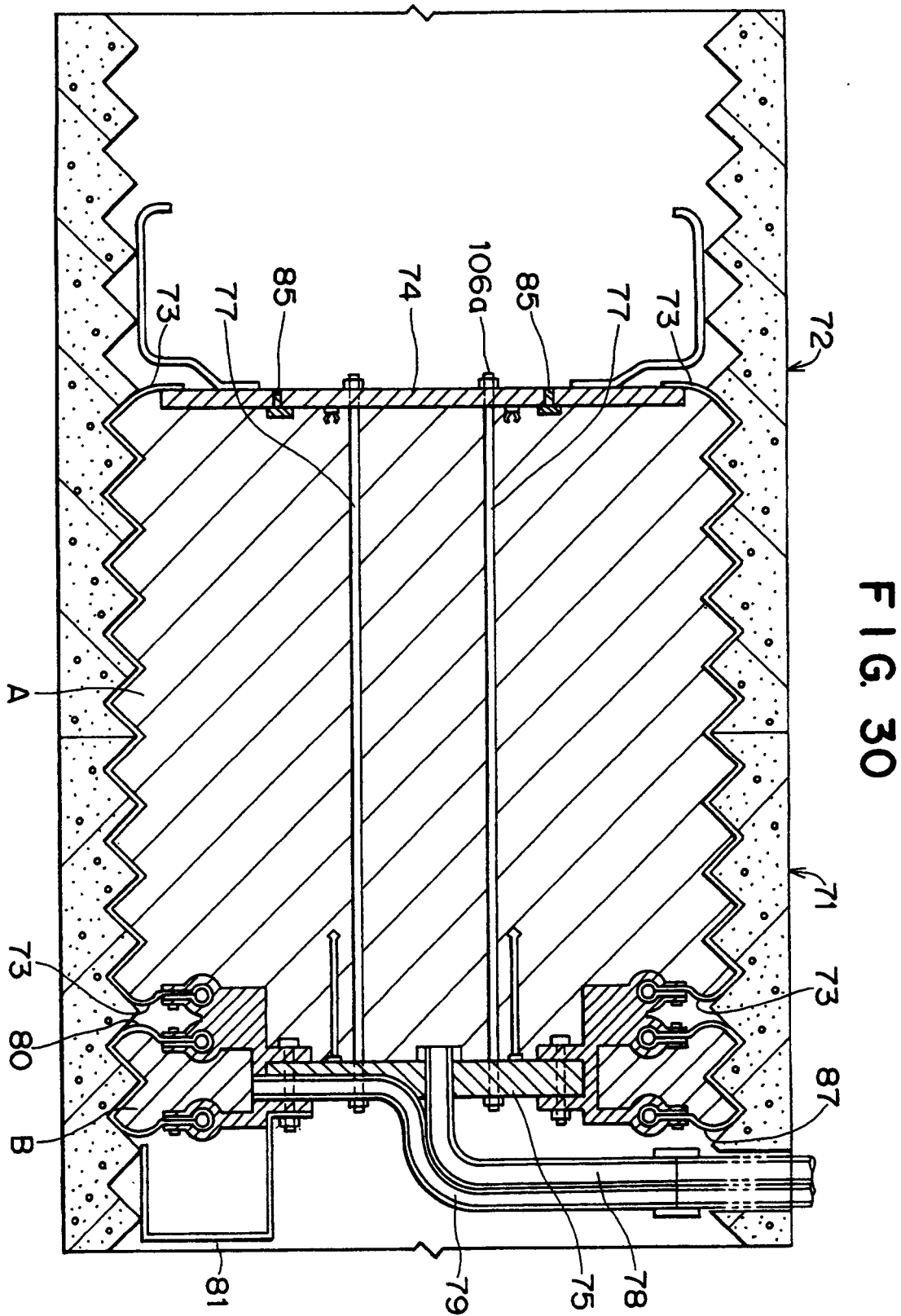


FIG. 31

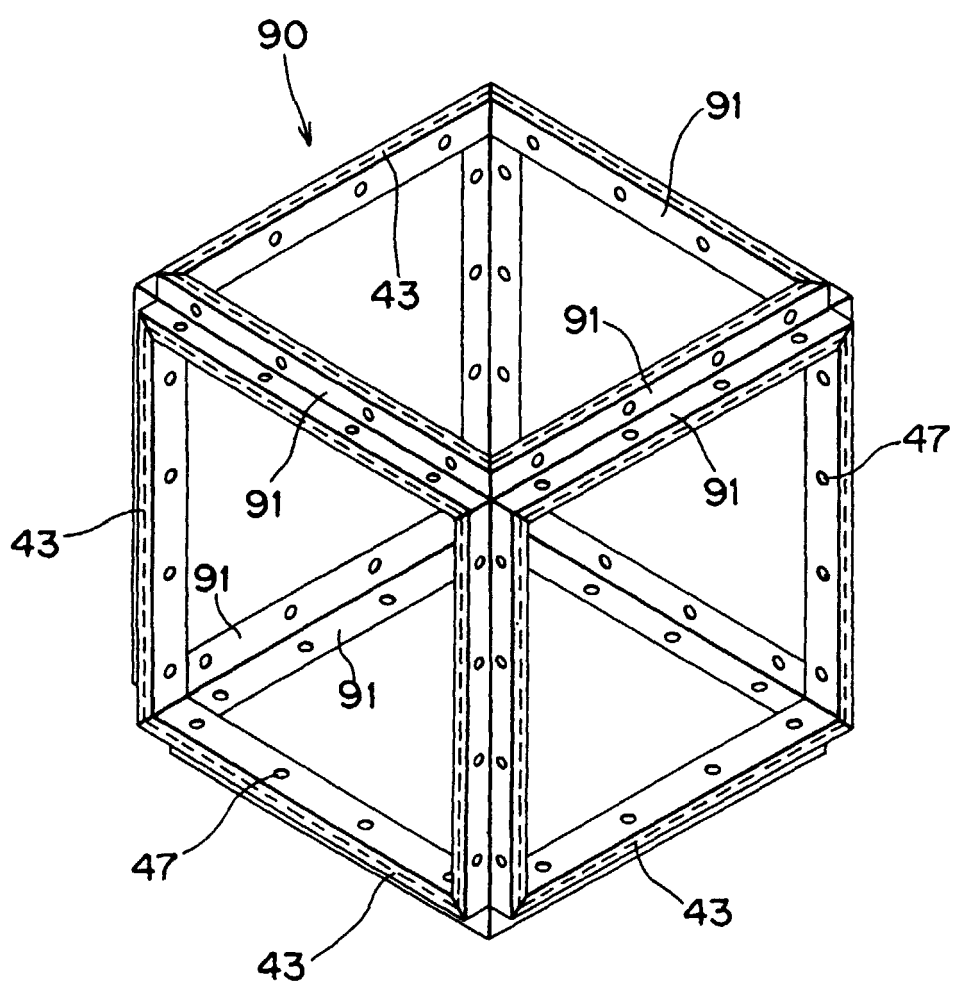


FIG. 32

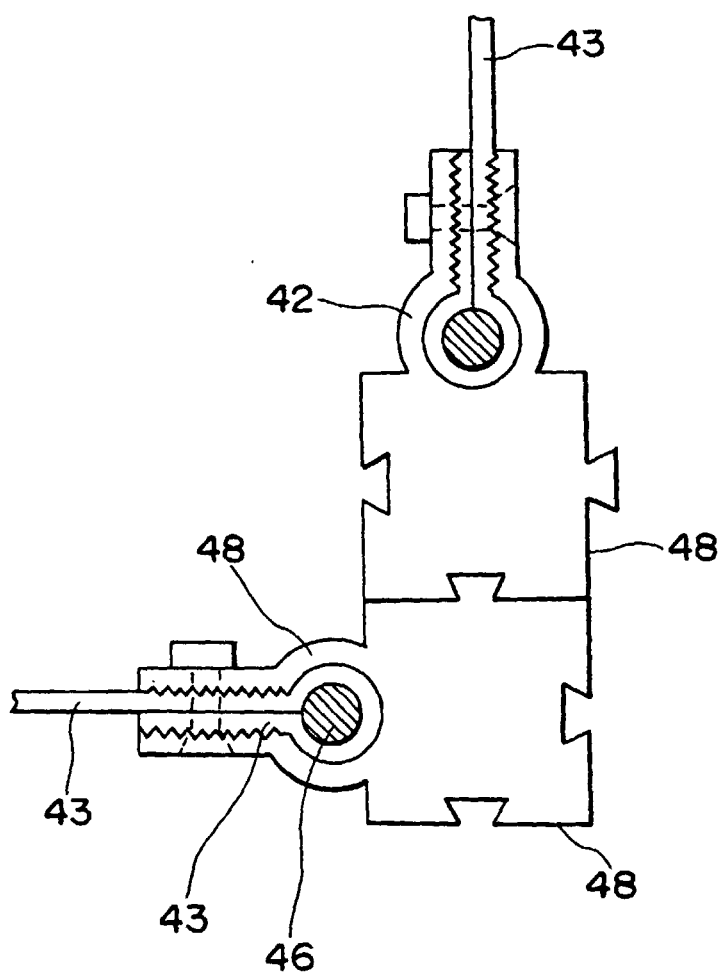


FIG. 33

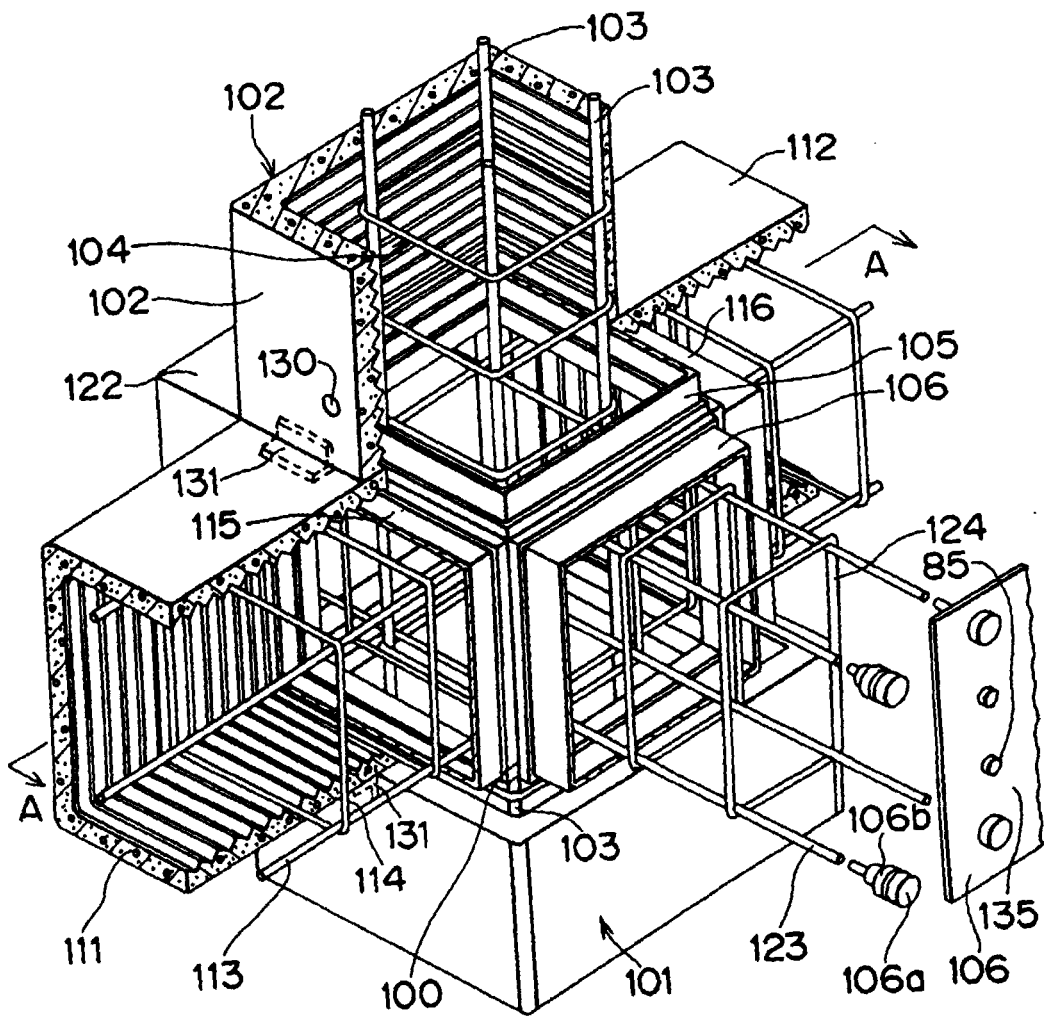


FIG. 34

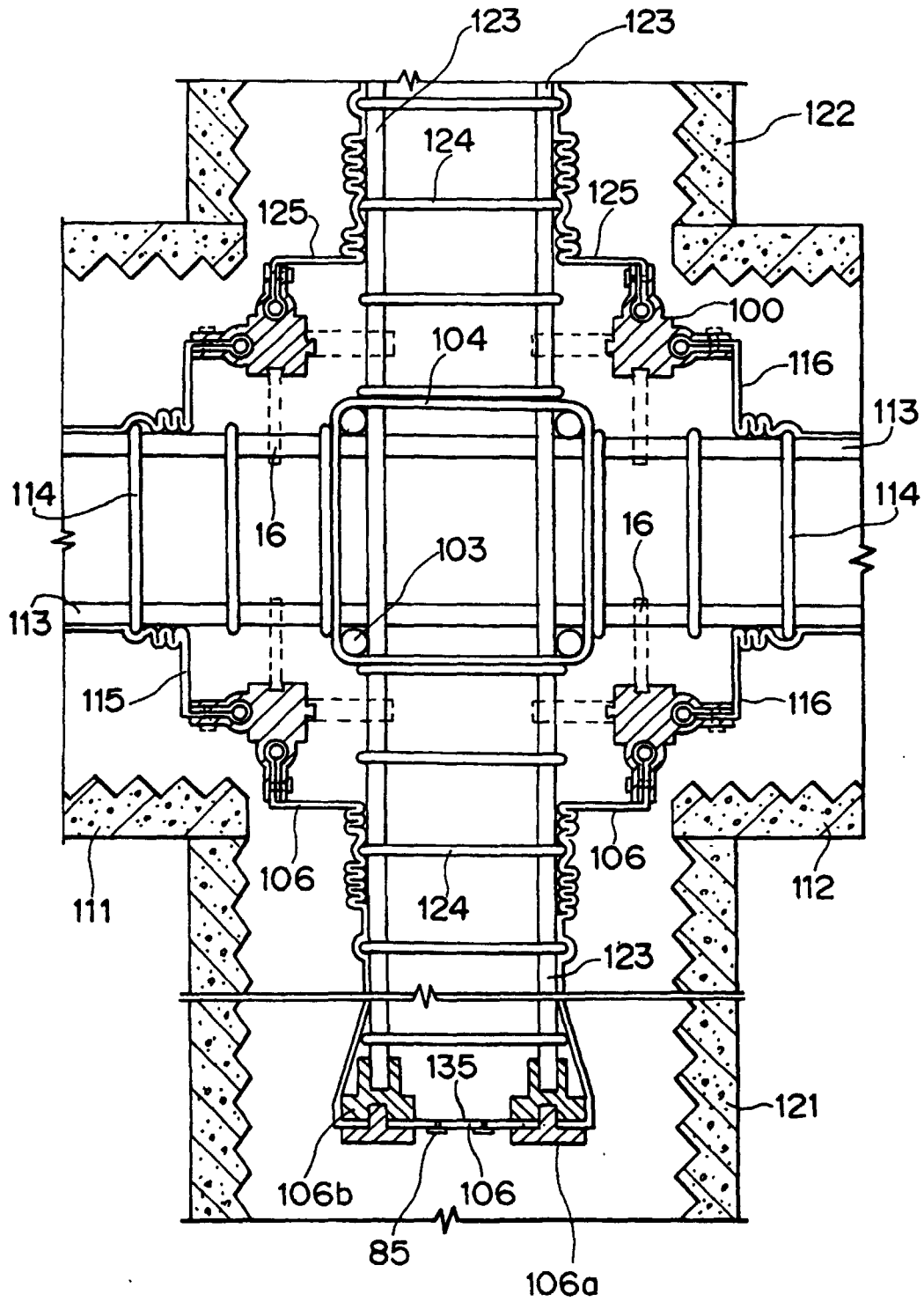


FIG. 35

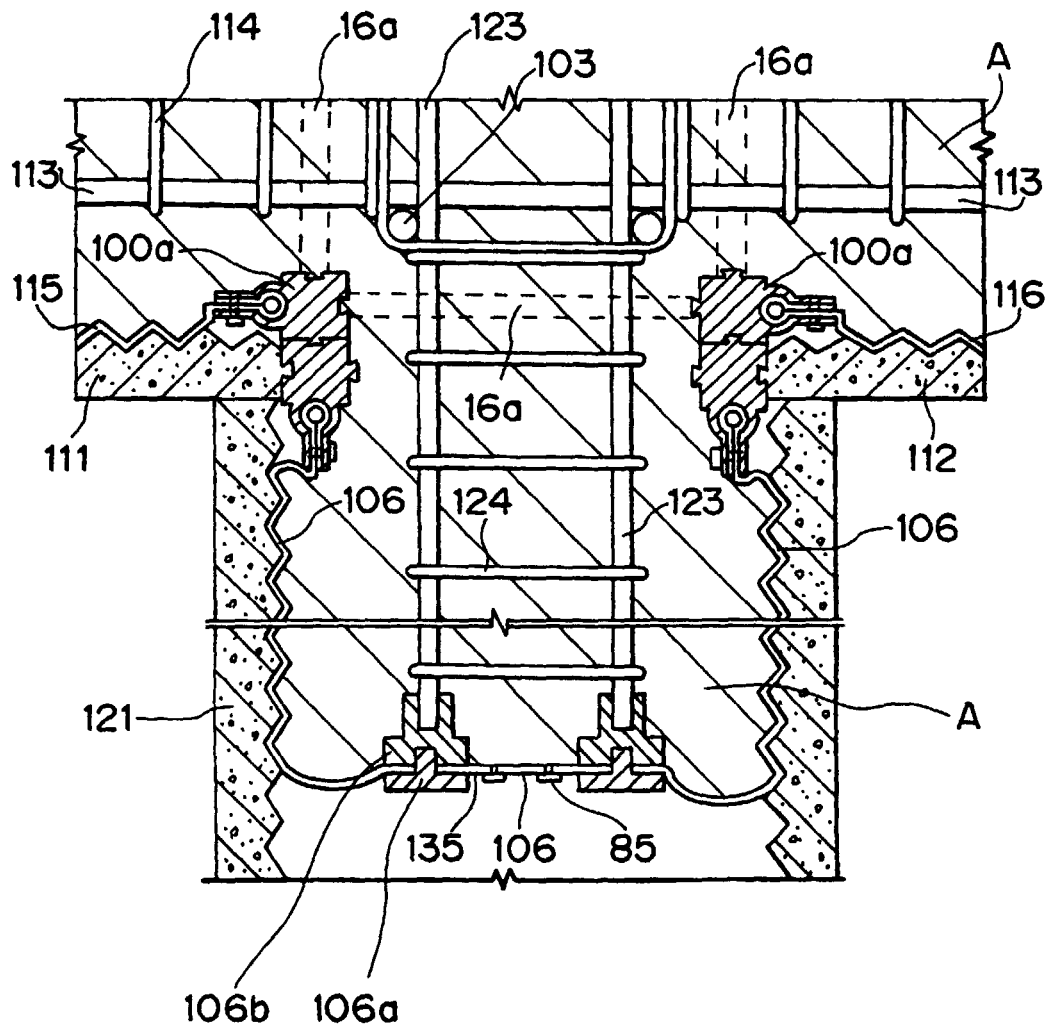
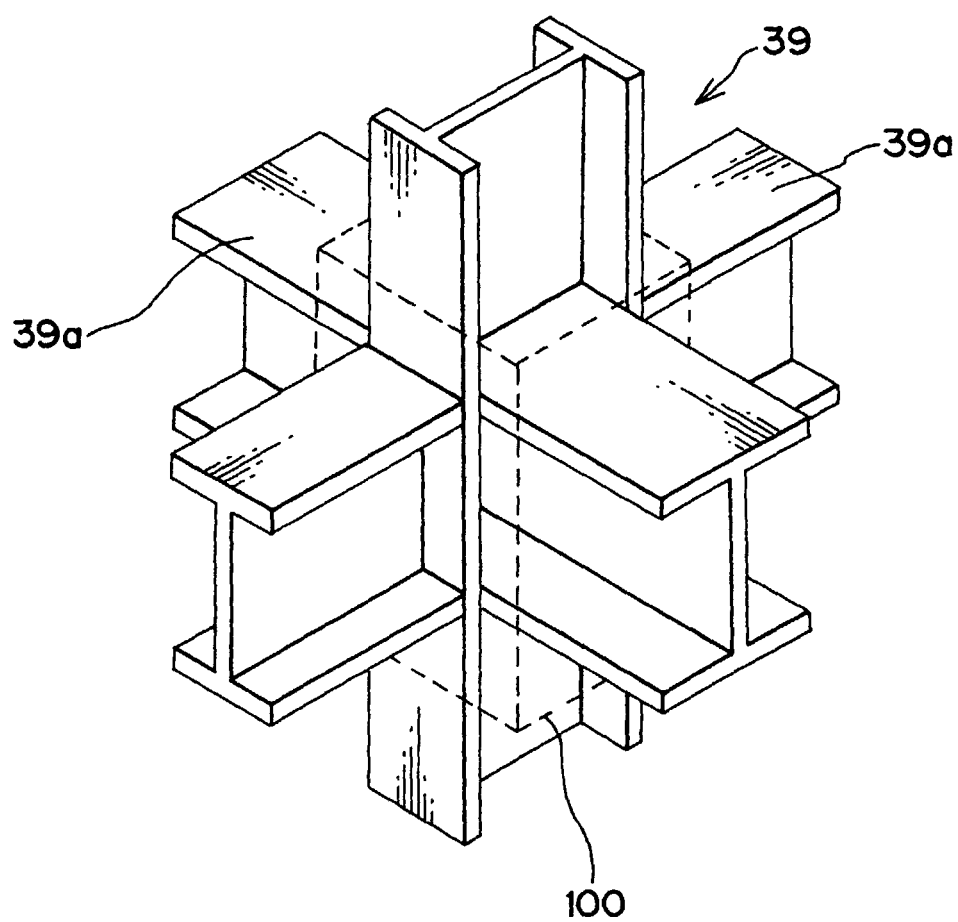
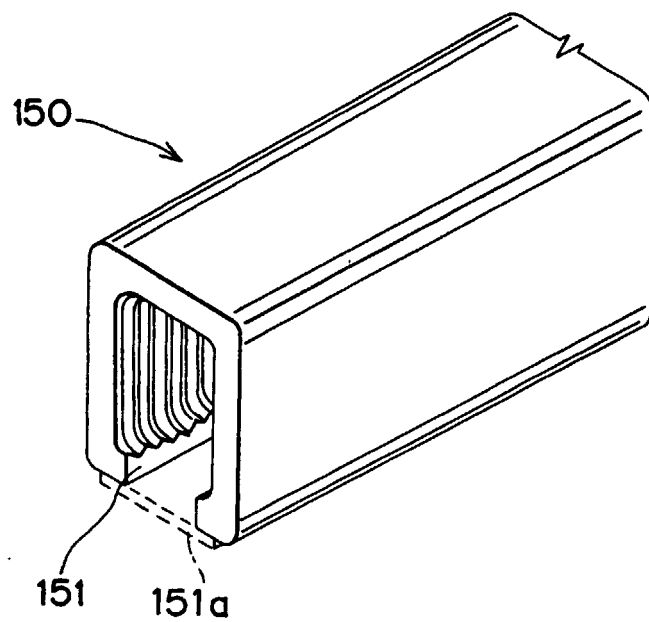


FIG. 36



**FIG. 37(A)**



**FIG. 37(B)**

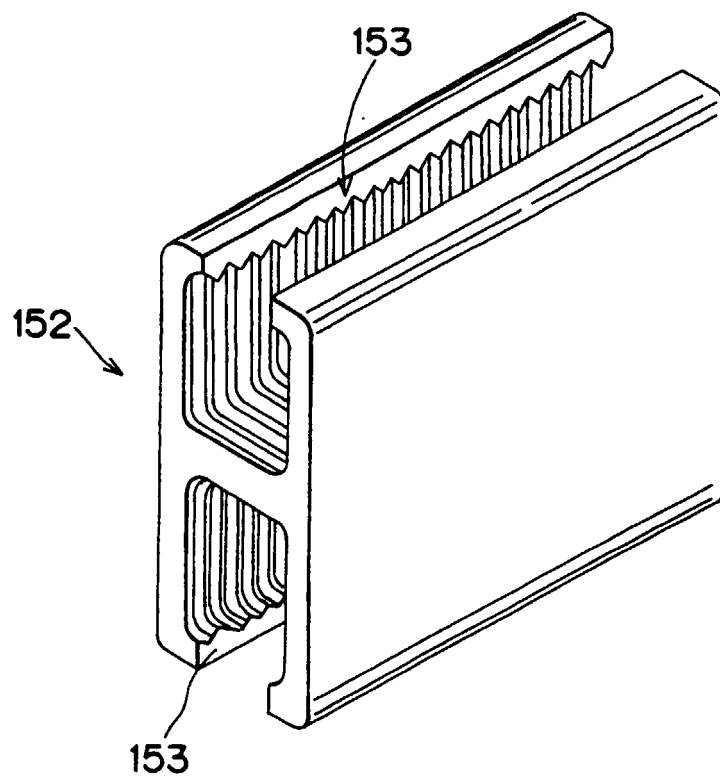


FIG. 38

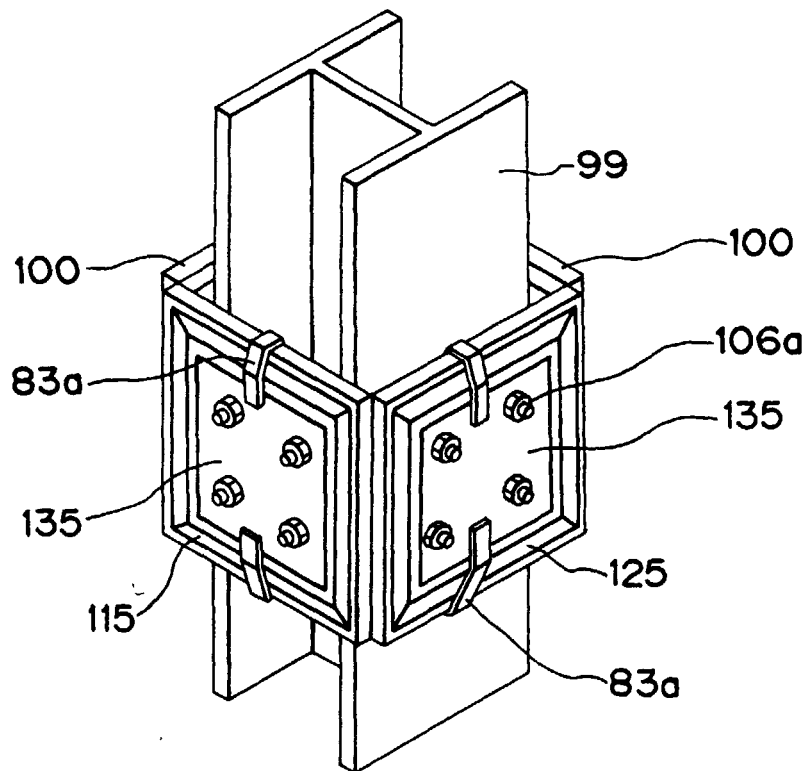
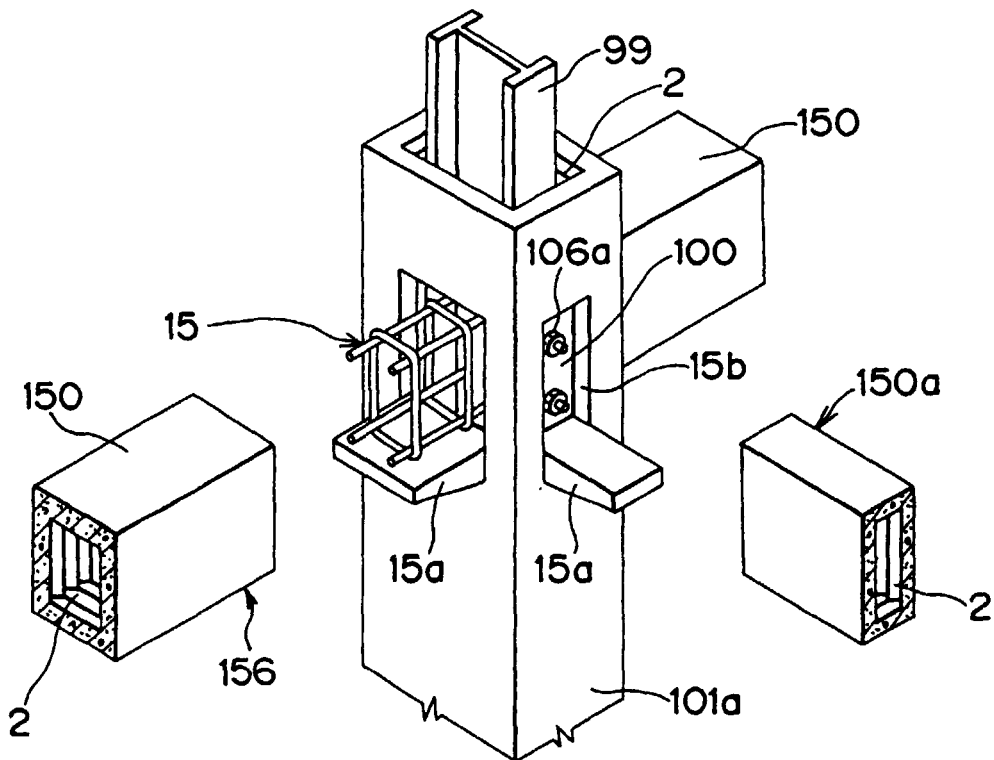
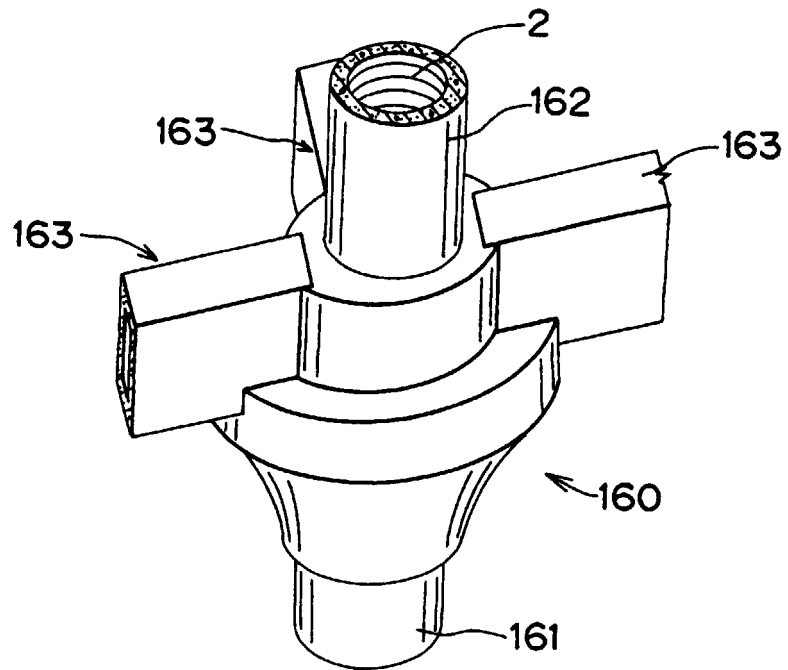


FIG. 39



**FIG. 40(A)**



**FIG. 40(B)**

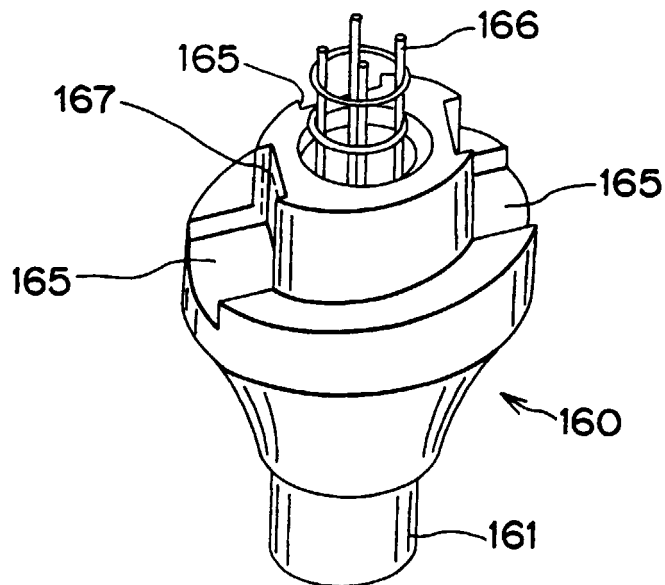


FIG. 41

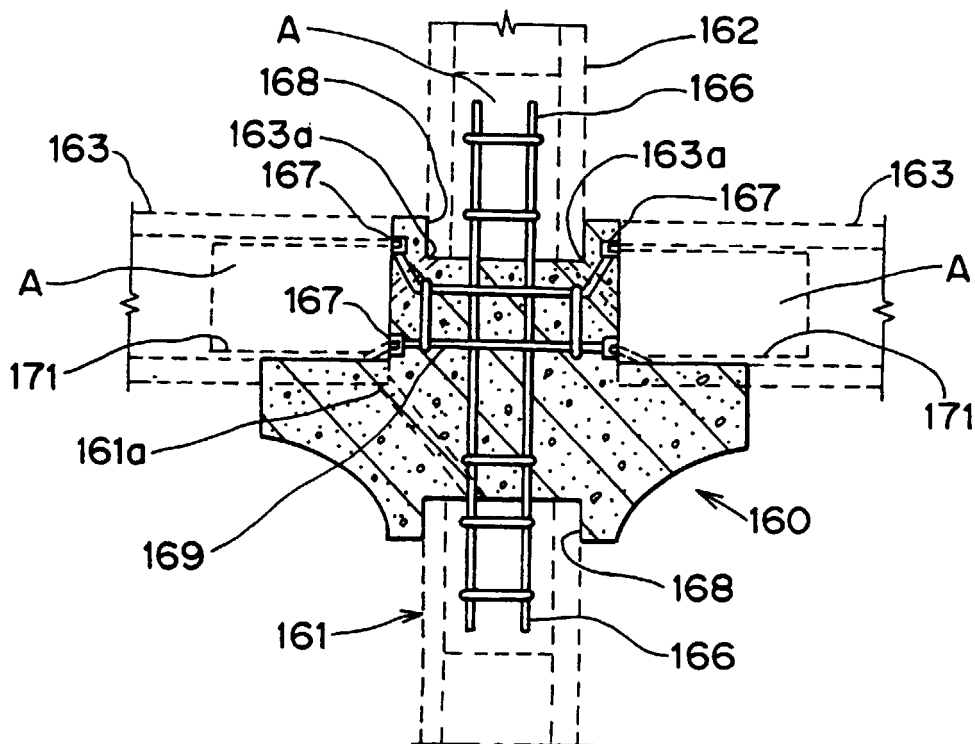


FIG. 42(A)

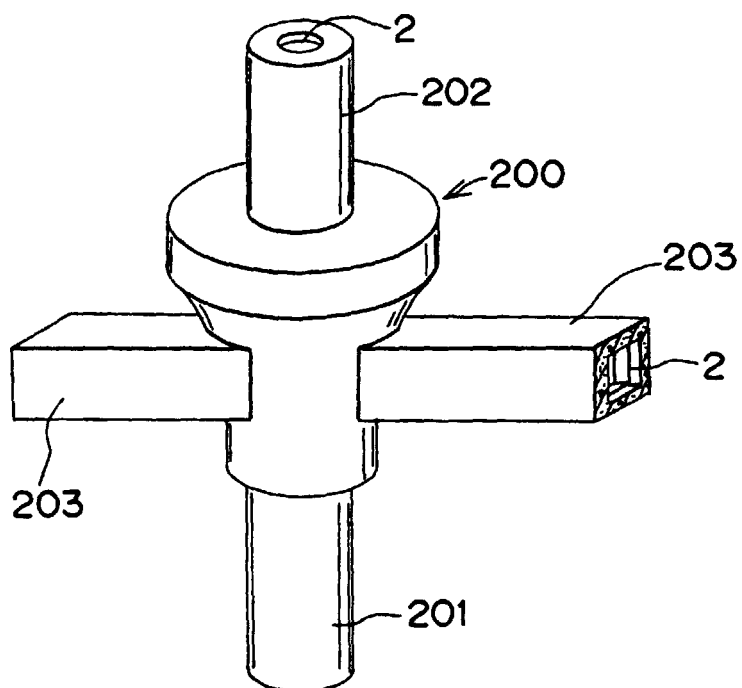


FIG. 42(B)

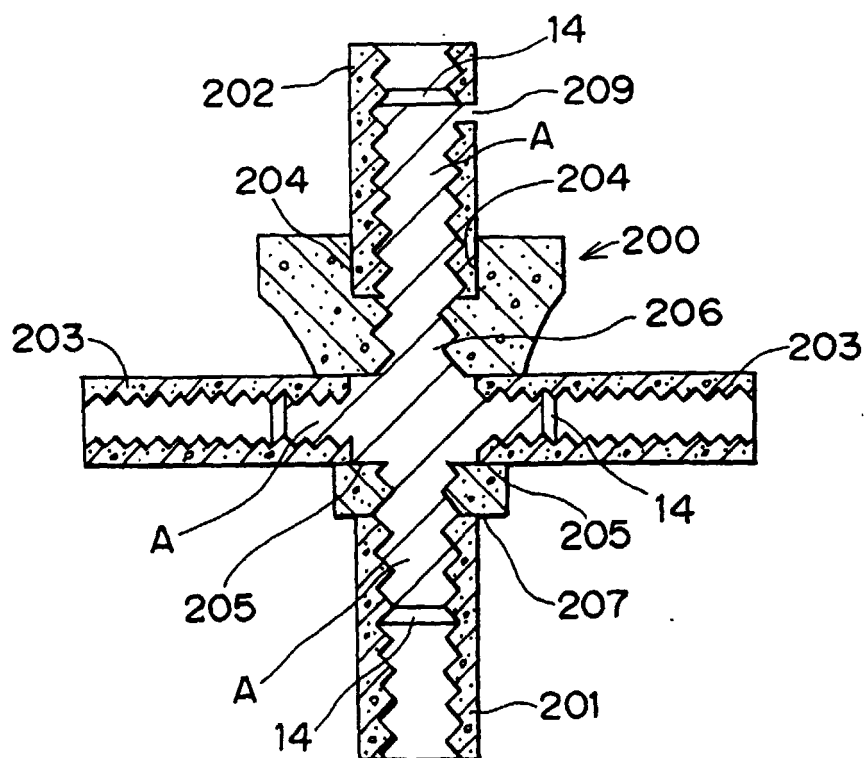


FIG. 43(A)

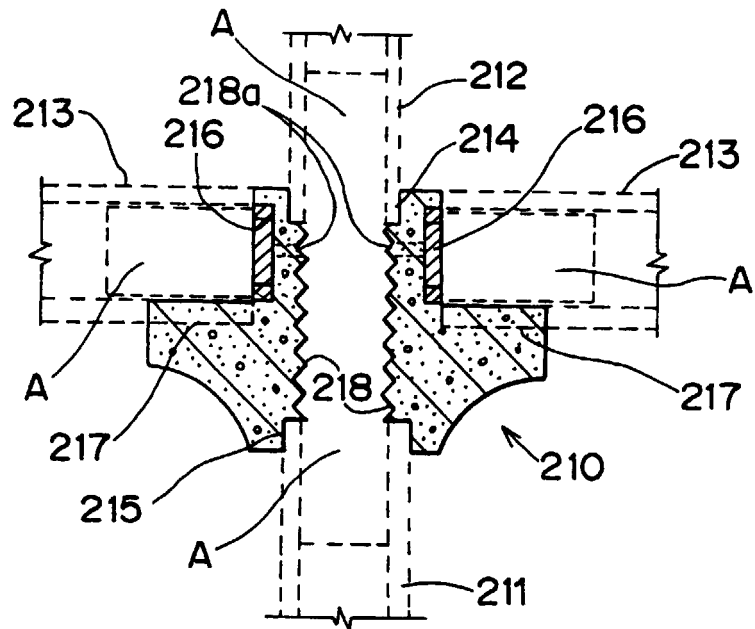


FIG. 43(B)

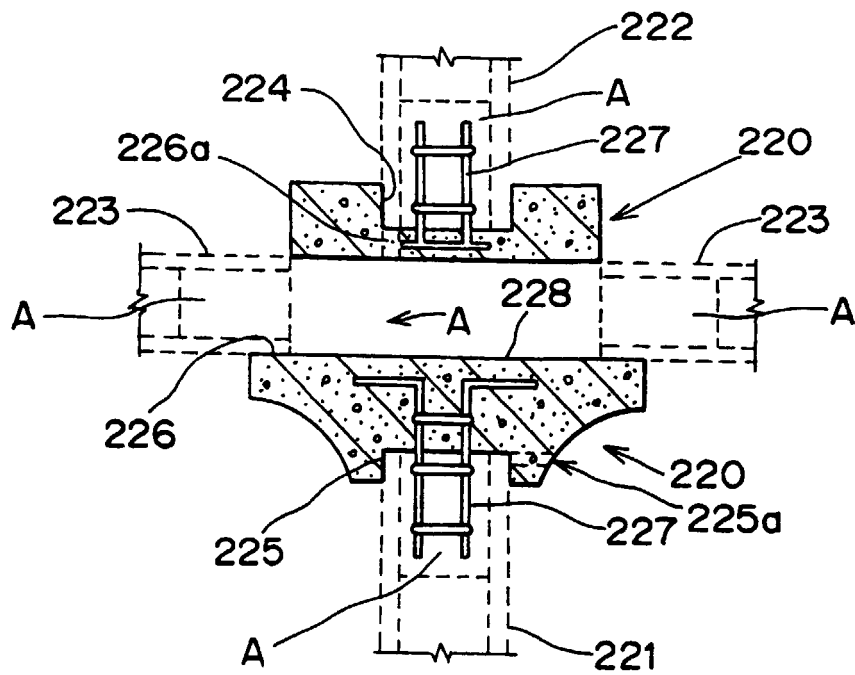


FIG. 44

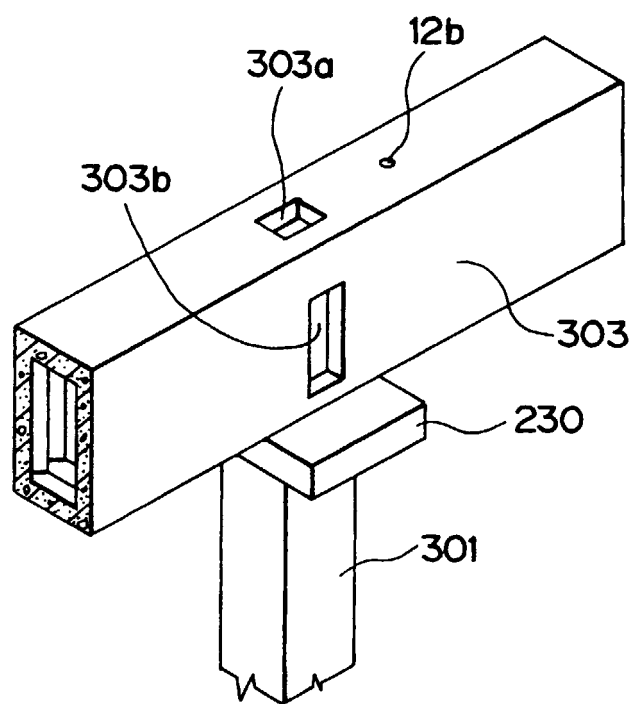


FIG. 45(A)

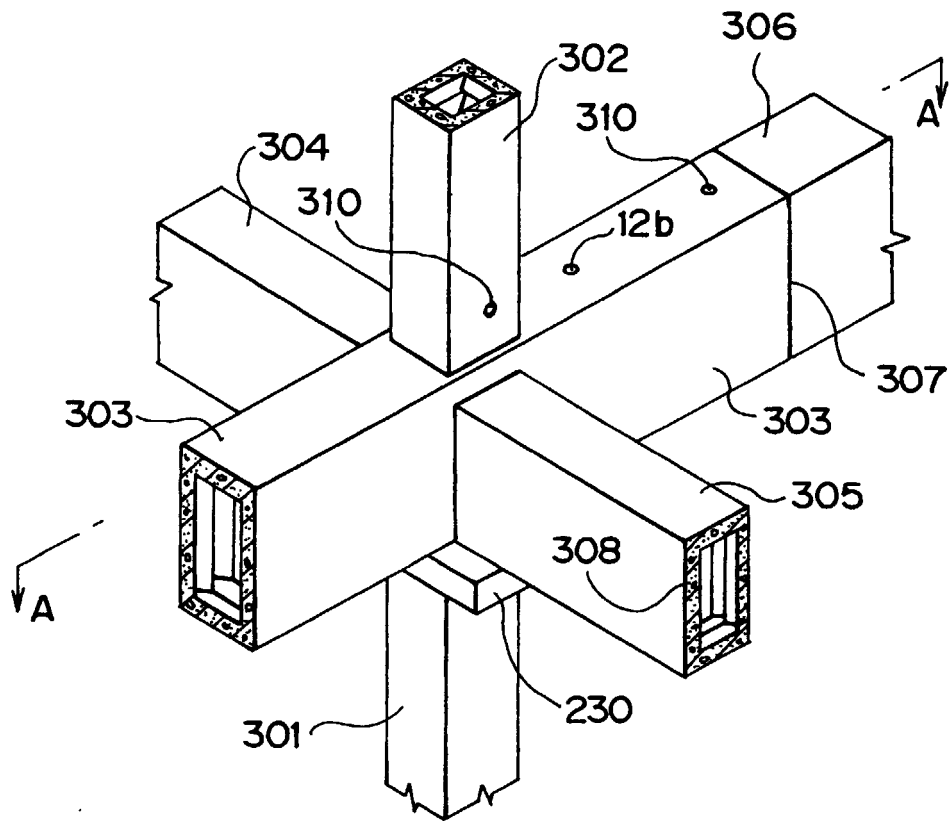


FIG. 45(B)

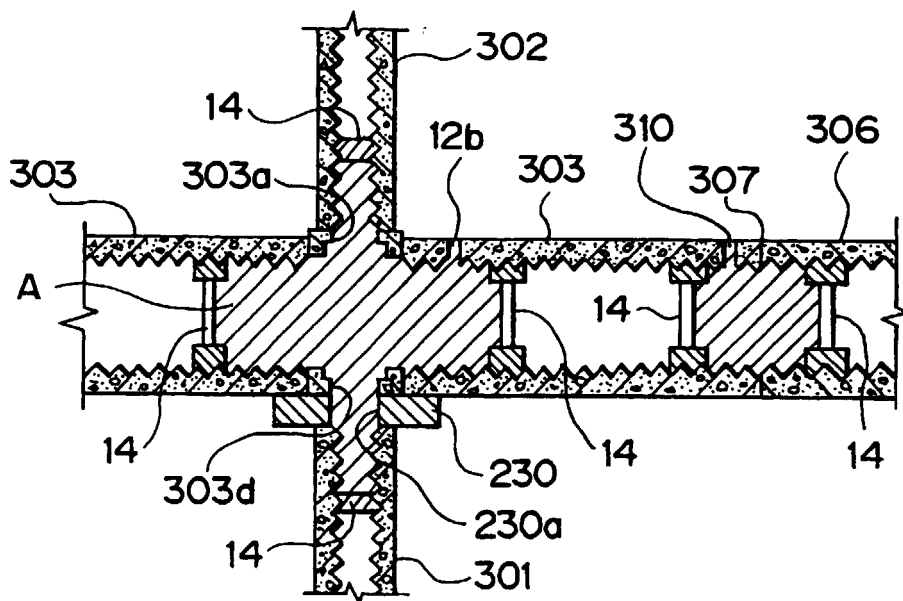


FIG. 46 (A)

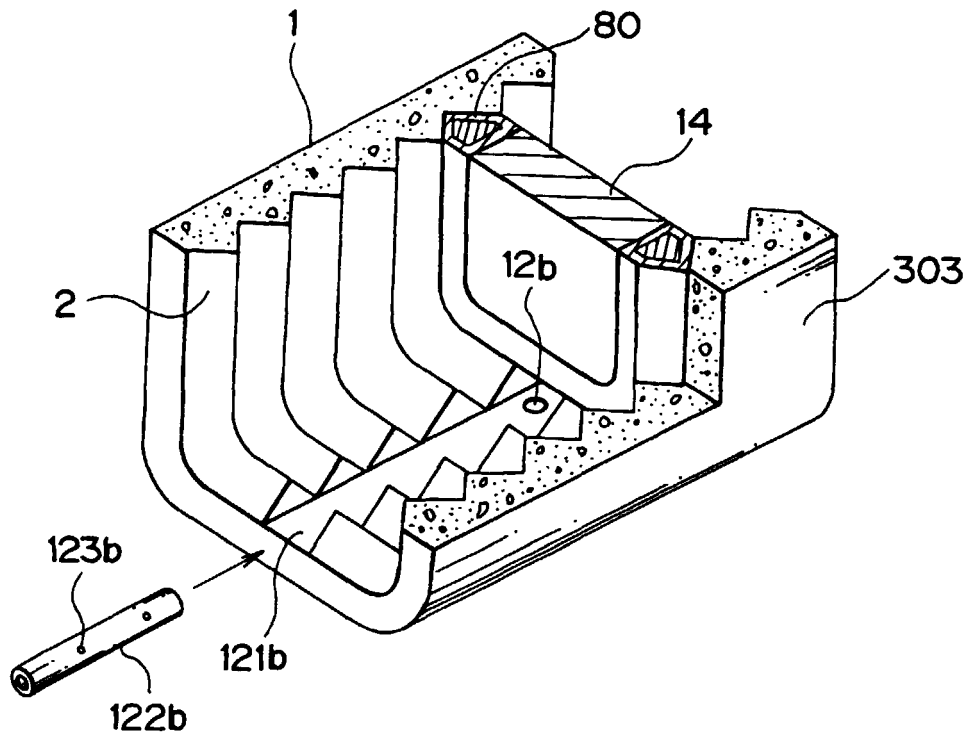


FIG. 46 (B)

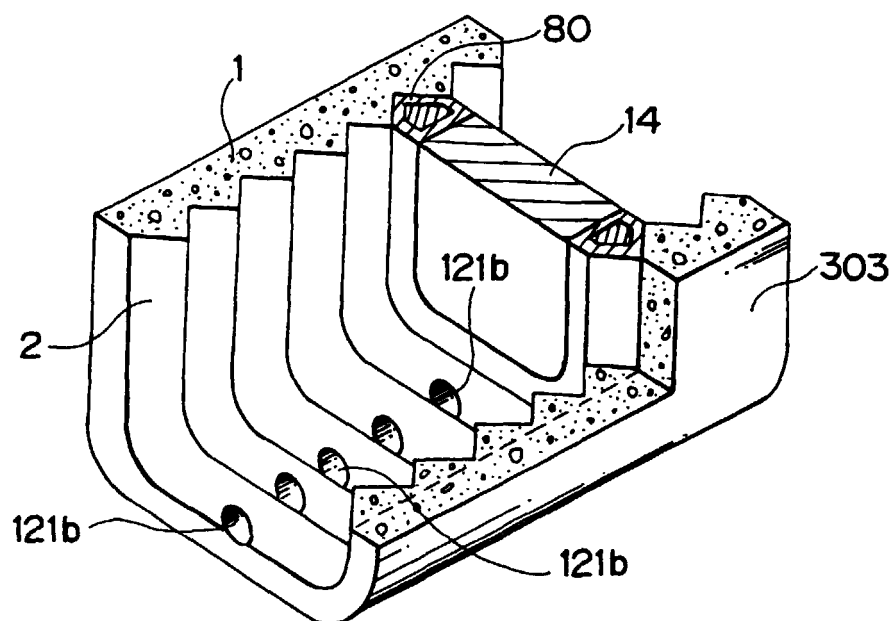
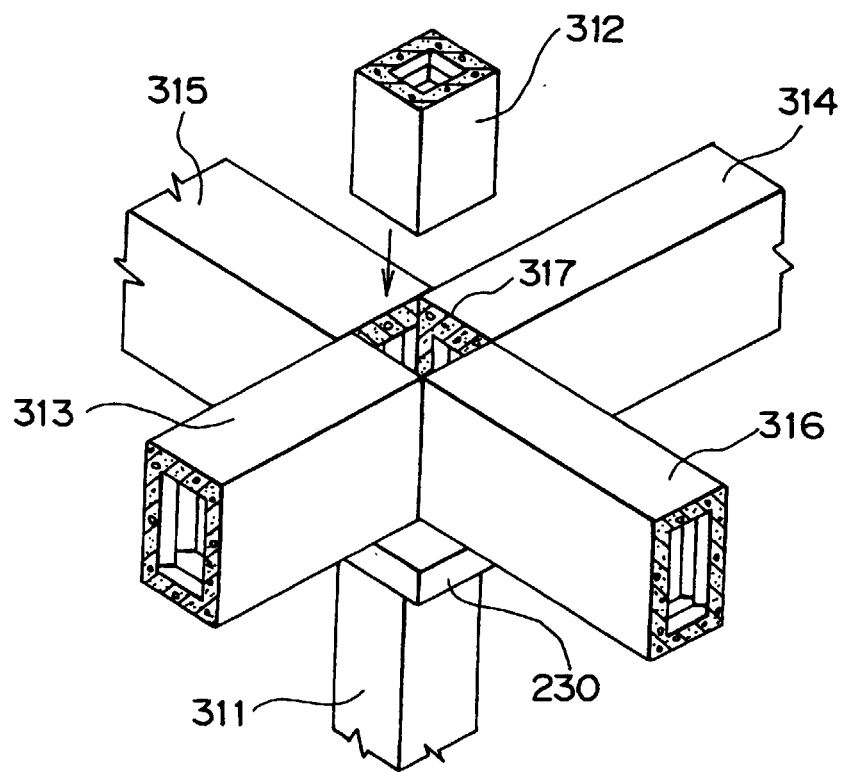


FIG. 47



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP97/01579

## A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl<sup>6</sup> E04C3/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl<sup>6</sup> E04C3/00-3/46, E04B1/00-1/36

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1997	Jitsuyo Shinan Toroku
Kokai Jitsuyo Shinan Koho	1971 - 1997	Koho
Toroku Jitsuyo Shinan Koho	1994 - 1997	1996 - 1997

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 157599/1986 (Laid-open No. 65738/1988) (Kubota, Ltd.), April 30, 1988 (30. 04. 88),	1-3, 5
Y	Full descriptions (Family: none)	4, 6-9
X	JP, 34-5439, Y1 (Yoneo Kumano), April 17, 1959 (17. 04. 59), Full descriptions (Family: none)	10 - 11 13, 17
Y		12, 14, 15, 16, 18
Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 113018/1972 (Laid-open No. 69717/1974) (Asano Pole K.K.), June 18, 1974 (18. 06. 74), Full descriptions (Family: none)	6

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

July 24, 1997 (24. 07. 97)

Date of mailing of the international search report

August 12, 1997 (12. 08. 97)

Name and mailing address of the ISA/

Japanese Patent Office

Authorized officer

Facsimile No.

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