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Description

The invention relates to a slab support system comprising a fire-resistant prefabricated steel beam and a plurality of slabs, said beam acting with concrete as a load-bearing jointing structure for said slabs, said beam comprising two web portions and horizontally projecting flange portions extending beyond the web portions.

The frame of a prefabricated building is often formed by floor and ceiling structures carried by columns and beams. As the beams act as horizontal load-bearing structures, they have to be sufficiently rigid, that is, about 500 to 800 mm high when made of steel concrete. For heat, water, ventilation and electricity installations, the beams have to be perforated or the height of the floor structure has to be increased correspondingly. In certain cases the high beam structure has been replaced with a lowered beam structure, whereby the web of the beam remains within the floor structure. The height of the lowered beam has been minimized by prestressing, for instance. Technically, a jaw beam is more difficult to manufacture than a normal beam, and the minimum thickness of the lowered portion will nevertheless be 100 to 150 mm.

Beams are also often manufactured of steel. Steel beams are easier to manufacture than prefabricated concrete beams in addition to which they are light to transport and install. Moreover, steel beams are easier to modify at the working site. As steel beams do not require grouting and are light to displace, they can be installed more rapidly than concrete beams. By adjusting the building to the frame construction timetable, the total building time can be decreased. In case of fire the strength of steel deteriorates with increasing temperature, wherefore a steel beam has to be protected from fire. The fire protection is preferably made by embedding the steel profile in a concrete floor structure whereby the lower flange only has to be protected. The protection is made either by covering the lower flange with a fire-resistant plate, insulation, paint or spray. For reasons of appearance, the piping and the fire protection are often covered with a socalled suspended ceiling.

This way of fire protection has led to the use of low hat profiles approximately of the same height as the floor unit. In the hat profile the lower flange of a rectangular basic beam is broader than the rest of the beam, thus forming projections for the floor units. Since the structure is low, the steel cannot be utilized optimally with regard to the rigidity or the structure. Despite the extra steel kilos, the hat beam (THQ beam) has been used rather widely in business buildings, for instance, so as to, utilize the building volume as efficiently as possible by means of the low floor structure. Considerable savings have also been obtained by means or the low floor structure in special cases where it would otherwise have been necessary to increase the depth of foundation and support the foundations or adjacent buildings on urban building sites.

The use of steel beams has been restricted mainly by the span length. With long span lengths the beam structure is very heavy and it has been necessary to camber the beams to eliminate deflections. With ever increasing construction costs, buildings are today built so that they can be modified later on for other uses. Such versatility is obtained by long floor units and sparse supporting structures by displacing light partition walls. In view of the manufacturing technique, long beams are difficult to handle, appropriate cambering has to be provided according to the span length despite the thermal stresses caused by welding, and the welding time increases with increasing plate thickness.

To eliminate the above drawbacks, it has more recently been suggested to use a combined structure of a steel beam and concrete. An example of such solutions would be the solution of FI Patent Application 882186. A steel beam of such a combined structure is lighter and can be used with longer span lengths than previously. The steel beam of FI Patent Application 882186 requires less welding as the beam is formed by profile parts preformed by hot rolling. However, the solution of FI Patent Application 882186 is complicated to manufacture because the inserts joining the different materials increase the amount of required welding and the great number of small pieces complicates the manufacture of the beam.

Document DE-B-2339638 discloses a shuttering panel made from sheet metal as reinforcement for a concrete floor. This wave-like unit is filled with concrete to form a concrete floor, wherein concrete flowing through openings provided in the unit is catched by an additional plate arranged below the upper flange. A slab support system with a steel beam and a plurality of slabs as mentioned above is not described.

The object of the invention is to provide a slab support system which avoids the drawbacks of prior art. This is achieved by a slab support system according to claim 1. This system is characterized in that at least each web portion with its horizontally projecting flange portion is formed by an integral material strip so that the web portion and the projecting flange portion adjoining it form a jointless entity and so that the web portion is in a slanting position with respect to the flange portion, the web portions being arranged side by side so as to slant towards each other and interconnected at edges of said web portions closer to each other by means of a horizontal upper part, and at edges of said web portions farther apart from each other by means of a lower plate welded to the web portions, and openings being formed close to the upper edges of the web portions and/or in the horizontal upper part, the space defined between the upper part of the web portions and the plate being filled with concrete (in a manner known per se). As to the advantages offered by the invention, it is to be mentioned generally that in addition to all the above-mentioned good properties, i.e. easy adaptability to the frame system of the working site, low and light structure, rapid installation, and simple installation of heat, water, ventilation and electricity, the invention offers other considerable advantages.

The slab support system of the invention is so designed that its steel parts carry the loads of the slab units during installation. The casing formed by the steel beam and the gap defined between the slabs and the steel profile are filled up in connection with the pouring of concrete into the joints of the slabs. In a finished structure, the beam carries the loads exerted on it due to the adhesion between concrete and steel. The beam is also suited for use together with a jointing slab to be cast on site. The slab and the beam can thus be concreted in one step. The beam can be fabricated on an automated line, optimizing the required welding in accordance with the required rigidity. The web portions can be simply perforated to improve adhesion. Projections possibly remaining on the edges or the holes or openings in connection with the perforation improve adhesion between the concrete and the steel. The openings are positioned, for instance, in the upper portion of the slanting web portions, so the grout passes easily inside the beam. The slanting web portions of the beam also enable the slab units to be placed quite close to the bends of the projecting flange portions without hampering the grouting. For this reason, the jaw is strained to a lesser extent than in solutions in which a separate casting space has to be left between the slab unit and the vertical web portion of the beam. The shape advantageous in case of fire and the pouring of concrete into the joints of the floor units wedge the slabs in place, leaving the projecting flanges solely for the installation of the units. The draw flange of the beam, positioned within the profile can be protected from fire in advance in connection with the manufacture of the beam unit without increasing the height of the floor structure. The projecting flanges protect the fire protection layer during transport and installation. The fire protection layer may also be protected from mechanical wear and damages by means of a thin plate attached to the projecting flanges.

In the following the invention will be described by means of preferred embodiments shown in the attached drawing, in which

Figure 1 is a cross-sectional view of a slab support system of the invention;

Figure 2 is a side view of the beam used in the invention;

Figure 3 illustrates the attachment of the beam to a vertical structure;

Figure 4 is a side view of another embodiment of the attachment of the beam to a vertical structure;

Figure 5 is a cross-sectional view of another embodiment of the beam used in the invention;

Figure 6 is a block diagram of an automated production line of the beam used in the invention; and

Figure 7 is a cross-sectional view of still another embodiment of the beam used in the invention.

Figure 1 is a cross-sectional view of the slab support system of the invention in a situation where slabs rest on the beam and concrete has been poured inside the beam and into the gaps between the beam and the slabs. In the beam of Figure 1, each web portion 2 with an adjoining horizontally projecting flange portion 1 is made of an integral material strip. The web portions 2 are in a slanted position with respect to the projecting flanges 1. The web portion 2 and the projecting flange portion 1 adjoining it may be formed e.g., by bending from a suitable strip of steel.

The two web portions 2 with the projecting flanges 1 are Positioned side by side so that the web portions slant towards each other and are interconnected at the edges closer to each other by means of a horizontal upper part 3. The horizontal upper Part 3 may be formed by a separate material strip, such as a steel strip, which is welded to the upper edges of the web portions.

In the embodiment of Figure 1, the two entities formed by the web portion 2 and the Projecting flange 1 are completely jointless.

A horizontal steel plate 4 is welded between the edges of the web portions 2 farther apart from each other in such a manner that the plate acts both as a lower mould wall for the concrete 8 to be poured inside the basic profile and as a lower flange bearing the loads of the beam. In the example of the figure, the plate 4 is Positioned higher than the level of the lower surfaces of the Projecting flanges 1. This arrangement enables the beam to be protected 10 from fire without increasing its structural thickness.

Shoulders 12 may be attached to the web portions 2 slanting towards each other. The plate 4 forming the lower flange rests on the shoulders during welding.

To fill the beam with concrete, the slanting web portions are provided with holes or openings 14. To ensure adhesion between the steel and the concrete, the edges of the openings 14 are provided with prodlike or platelike projections 5 at the fabrication stage, for instance.

Suspension rods 6 made of steel pass from the upper edge of the beam to the lower edge of the slabs to be supported. The suspension rods increase the ability of the beams to support the slabs together with a wedgelike concrete part 7 formed outside the beam when the beam is being concreted. In addition to the suspension rods 6 it is also possible to use gripping hooks 18 which efficiently anchor the wedgelike concrete part 7 in position. To increase the rigidity of the beam during installation, the steel area of the upper surface can be increased by means of a steel plate 9 or concrete steels welded under or above the upper part of the basic profile. The use of concrete steels improves the adhesive properties.

At the installation stage the beam is supported in the middle on structures beneath it before the slabs are placed in position. The middle support is removed after the grouting has gained sufficient strength. The use of support during grouting ensures efficient adhesion, which decreases deflection during and after construction so that the need of cambering is reduced. The support decreases substantially the need of steel on the compression side caused by stresses occurring during installation.

Figure 2 shows the beam shown in Figure 1 from the side. The openings in the web portions 2 of the beam are so positioned that no cast cavities are formed under the horizontal upper part 3 of the beam in connection with concreting. The openings 14 are positioned in the web Portions close to the upper edges. The openings 14 may also be used for laying reinforcements for slab fields and pipings for heat, water, ventilation and electricity installations.

Figure 3 shows the attachment of the beam shown in Figures 1 and 2 to a vertical supporting structure or column. The end of the beam is so shaped that a beam bracket 11 can be wholly fitted within the beam. The horizontal upper part of the beam forming the upper flange rests on the bracket, and the beam is tightened to the bracket by means of bolts 13 from the side of the beam against the side of the bracket. The tightening can also be carried out by means of installing wedges. This ensures that the beam has sufficient torsional rigidity during installation. Support torque is produced in the jointing beam by providing the bracket with a concrete reinforcement 15 extending through it before the grouting of the joint. The support torque decreases the deformations of the beam and increases the load carrying capacity. An alternative way of producing support torque is shown in Figure 4. Draw-bars 16 are arranged to go through the column. They are fixed to the end of the beam by means of pinching nuts 17. The nuts are tightened through the opening 14 of the web of the beam.

Figure 5 shows another embodiment of the beam used in the invention. In this embodiment, the grouting of the beam has been carried out at the fabrication stage. The bending capacity of the beam can be increased by a prestressing technique conventionally applied to concrete beams The degree of prestress can be higher than conventionally as the steel profile around the concrete efficiently limits the cleaving of concrete, functioning as a kind of web reinforcement. In the embodiment of Figure 5, the horizontal upper part 3 of the beam can be provided with openings or holes 20 through which concrete 21 is poured into the inner space of the beam. The edges of the openings or holes 20 can be provided with projections 22 similar to the projections 5 of the openings 14 described above. The embodiment of Figure 5 is otherwise structurally similar to the embodiment of Figure 1.

In the embodiment of Figure 5, no additional steels have to be provided on the upper surface of the beam because the beam itself forms a jointing structure at the installation stage. When the beam is bent, the plate 4 receives the tensile stress while the upper portion of the concrete filling of the beam receives the compression stress.

Due to the shape of the beam it can be produced efficiently on an automated production line. Figure 6 is a block diagram of the beam production line. The desired shape of the beam is achieved, e.g., by bending thin steel plate. Holes are made by any suitable means in the web portions, for instance. The projections improving the adhesion are also formed at the perforation stage. The parts are sawed into determined dimensions and the beam is cambered according to its span length if desired. The upper part, the possible additional steel of the upper part, and the plate forming the lower flange, which are flame-cut into dimensions, are cambered so as to correspond to the profile in shape. The welding of the additional steels can be carried out easily by means of an automatic welder by submerged arc welding through welding grooves formed in the corners of the steel plates. Beam head details are welded by robot welding. Finally, the beam is coated and protected from fire if required.

Figure 7 shows still another embodiment to be used in the invention. The embodiment of Figure 7 differs from that of Figures 1 and 2 in that projecting flange portions 31, web portions 32 and an upper part 33 are formed by an integral basic profile in Figure 7. The basic profile may be formed by a cold-moulded profile, for instance. In this embodiment, the projecting flange portions 31, the web portions 32 and the upper part 33 form an integral entity without any joints. The plate forming the lower flange is indicated with the reference numeral 34, the holes with the reference numeral 40, the projections with the reference numeral 42 and the shoulders with the reference numeral 32. Concrete is indicated with the reference numeral 41.

The embodiments described above are not intended to restrict the invention, but the invention can be modified as desired within the scope of the claims. Accordingly, it is obvious that the slab support system of the invention and the beam used in the invention or their details need not be exactly similar to those shown in the figures but other alternatives are possible as well.

Claims

1. A slab support system comprising a fire-resistant prefabricated steel beam and a plurality of slabs, said beam acting with concrete as a load-bearing jointing structure for said slabs, said beam comprising two web portions and horizontally projecting flange portions extending beyond the web portions, **characterized** in that at least each web portion (2, 32) with its horizontally projecting flange portion (1, 31) is formed by an integral material strip so that the web portion (2) and the projecting flange portion adjoining it form a jointless entity and so that the web portion (2, 32) is in a slanting position with respect to the flange portion, the web portions (2) being arranged side by side so as to slant towards each other and interconnected at the edges of said web portions (2) closer to each other by means of a horizontal upper part (3, 33), and at the edges of said web portions (2) farther apart from each other by means of a lower plate (4, 34) welded to the web portions, and openings (14, 20, 40) being formed close to the upper edges of the web portions (2, 32) and/or in the horizontal upper part (3, 33), the space defined between the upper part (3, 33) of the web portions (2, 32) and the plate (4, 34) being filled with concrete.

2. A slab support system according to claim 1, **characterized** in that the upper part (3) interconnecting the web portions (2) at the edges closer to each other is formed by a separate material strip.

3. A slab support system according to claim 1, **characterized** in that the web portions (32), the projecting flange portions (31) and the horizontal upper part (33) are formed by an integral basic profile.

4. A slab support system according to claim 1, 2 or 3, characterized in that projections (5, 22, 42) protruding from the plane of the web portion (2, 32) or the upper part (3, 33) are formed in the edges of the openings (14, 20, 40) to ensure adhesion between the concrete and steel.

5. A slab support system according to any of the preceding claims, **characterized** in that the lower plate (4, 34) connecting the lower edges of the web portions (2, 32) is positioned above the plane of the lower surfaces of the projecting flange portions (1, 31).

6. A slab support system according to any of the preceding claims, **characterized** in that at least one additional steel plate (9) and/or concrete steel is attached to the horizontal upper part (3, 33).

Patentansprüche

1. Ein Plattenträgersystem mit einem feuerbeständigen, vorgefertigten Stahlträger und einer Vielzahl von Platten, wobei der Träger zusammen mit Beton als lasttragende Verbindungsstruktur für die Platten wirkt, wobei der Träger zwei Steg-Abschnitte und sich über die Steg-Abschnitte hinaus erstreckende horizontal vorstehende Gurt-Abschnitte aufweist, dadurch gekennzeichnet, daß mindestens jeder Steg-Abschnitt (2, 32) mit seinem horizontal vorstehenden Gurt-Abschnitt (1, 31) aus einem zusammenhängenden Materialstreifen derart gebildet ist, daß der Steg-Abschnitt (2) und der an ihn angrenzende vorstehende Gurt-Abschnitt eine verbindungsstellenfreie Einheit bilden und daß der Steg-Abschnitt (2, 32) in Bezug auf den Gurt-Abschnitt in einer schrägen Position ist, wobei die Steg-Abschnitte (2) so nebeneinander angeordnet sind, daß sie sich einander zuneigen und an den näher beieinander liegenden Kanten der Steg-Abschnitte (2) durch ein horizontales oberes Teil (3, 33) und an den weiter voneinander entfernt liegenden Kanten der Steg-Abschnitte (2) durch eine an die Steg-Abschnitte angeschweißte untere Platte (4, 34) miteinander verbunden sind und wobei Öffnungen (14, 20, 40) nahe bei den oberen Kanten der Steg-Abschnitte (2, 32) und/oder in dem horizontalen oberen Teil (3, 33) ausgebildet sind, wobei der zwischen dem oberen Teil (3, 33) der Steg-Abschnitte (2, 32) und der Platte (4, 34) definierte Raum mit

Beton gefüllt ist.

2. Plattenträgersystem nach Anspruch 1, dadurch gekennzeichnet, daß der die Steg-Abschnitte (2) an den näher beieinander liegenden Kanten verbindende obere Teil (3) durch einen separaten Materialstreifen gebildet ist.

3. Plattenträgersystem nach Anspruch 1, dadurch gekennzeichnet, daß die Steg-Abschnitte (32), die vorstehenden Gurt-Abschnitte (31) und der horizontale obere Teil (33) durch ein einheitliches Grundprofil gebildet sind.

4. Plattenträgersystem nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß von der Ebene der Steg-Abschnitte (2, 32) oder von dem oberen Teil (3, 33) vorspringende Vorsprünge (5, 22, 42) in den Kanten der Öffnungen (14, 20, 40) ausgebildet sind, um Haftung zwischen dem Beton und dem Stahl zu gewährleisten.

5. Plattenträgersystem nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die die unteren Kanten der Steg-Abschnitte (2, 32) verbindende untere Platte (4, 34) oberhalb der Ebene der unteren Oberflächen der vorstehenden Gurt-Abschnitte (1, 31) angeordnet ist.

6. Plattenträgersystem nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß mindestens eine zusätzliche Stahlplatte (9) und/oder Betonstahl an dem horizontalen oberen Teil (3, 33) angebracht ist.

Revendications

1. Système de soutien de dalles qui comprend une poutre préfabriquée en acier, résistante au feu, et une pluralité de dalles, ladite poutre agissant avec du béton comme une structure de liaison supportant la charge pour lesdites dalles, ladite poutre comprenant deux parties âmes et des parties ailes qui dépassent horizontalement et s'étendent au-delà des parties âmes, caractérisé en ce qu'au moins chaque partie âme (2, 32) avec sa partie aile (1, 31) qui dépasse horizontalement est formée par une bande monobloc de matériau de sorte que la partie âme (2) et la partie aile en saillie qui lui est contiguë forment une entité sans raccord et que la partie âme (2, 32) est dans une position inclinée par rapport à la partie aile, les parties âmes (2) étant disposées côte à côte de façon à pencher l'une vers l'autre et étant reliées au niveau des bords des parties âmes (2) les plus proches les uns des autres au moyen d'une pièce supérieure (3, 33) horizontale et reliées au niveau des bords desdites parties âmes (2) les plus éloignés les uns des autres au moyen d'une plaque inférieure (4, 34) soudée auxdites parties âmes, et des orifices (14, 20, 40) étant formés près des bords supérieurs desdites parties âmes (2, 32) et/ou dans la pièce supérieure horizontale (3, 33), l'espace défini entre la pièce supérieure (3, 33) des parties âmes (2, 32) et la plaque (4, 34) étant rempli de béton.

2. Système de soutien de dalles selon la revendication 1, caractérisé en ce que la pièce supérieure (3) qui relie les parties âmes (2) au niveau des bords les plus proches les uns des autres est formée par une bande séparée de matériau.

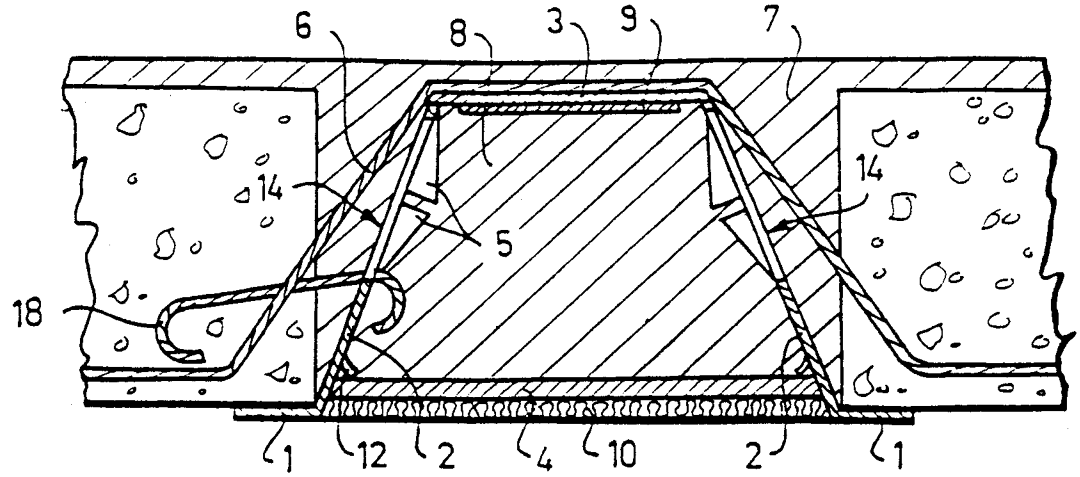
3. Système de soutien de dalles selon la revendication 1, caractérisé en ce que les parties âmes (32), les parties ailes (31) en saillie et la pièce supérieure horizontale (33) sont formées par un profilé de base monobloc.

4. Système de soutien de dalles selon la revendication 1, 2 ou 3, caractérisé en ce que des saillies (5, 22, 42) qui dépassent du plan de la partie âme (2, 32) ou de la pièce supérieure (3, 33) sont formées dans les bords des orifices (14, 20, 40) pour garantir l'adhésion entre le béton et l'acier.

5. Système de soutien de dalles selon l'une quelconque des précédentes revendications, caractérisé en ce que la plaque inférieure (4, 34) qui relie les bords inférieurs des parties âmes (2, 32) est placée au-dessus du plan des surfaces inférieures des parties ailes (1, 31) qui dépassent.

6. Système de soutien de dalles selon l'une quelconque des précédentes revendications, caractérisé en ce qu'au moins une plaque supplémentaire (9) en acier et/ou en acier-béton est fixée à la pièce supérieure (3, 33) horizontale.

FIG. 1



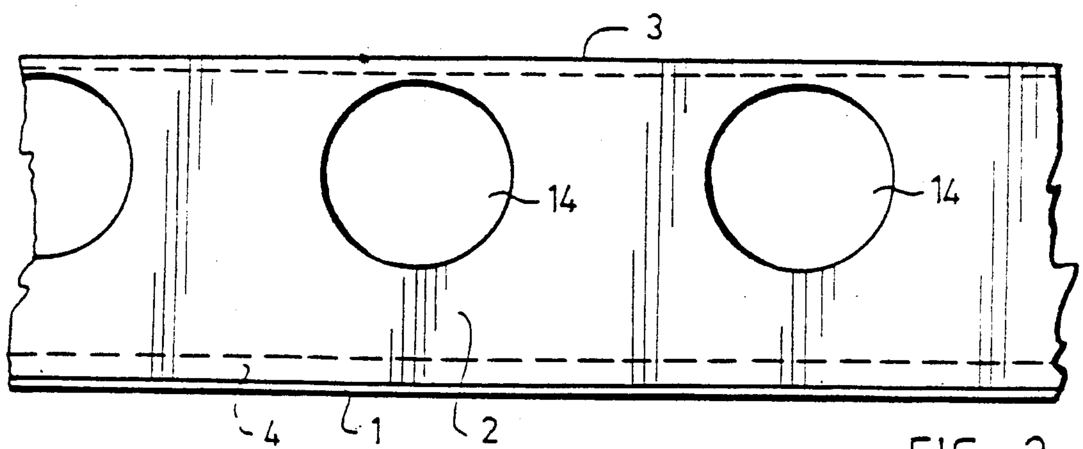


FIG. 2

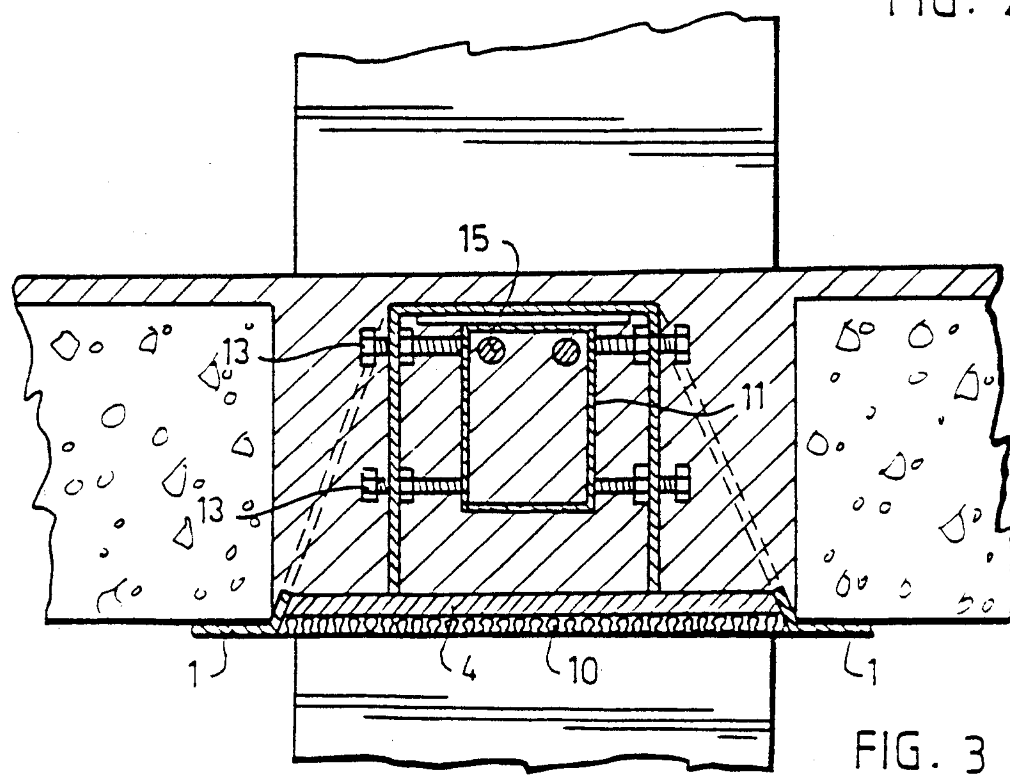


FIG. 3

FIG. 4

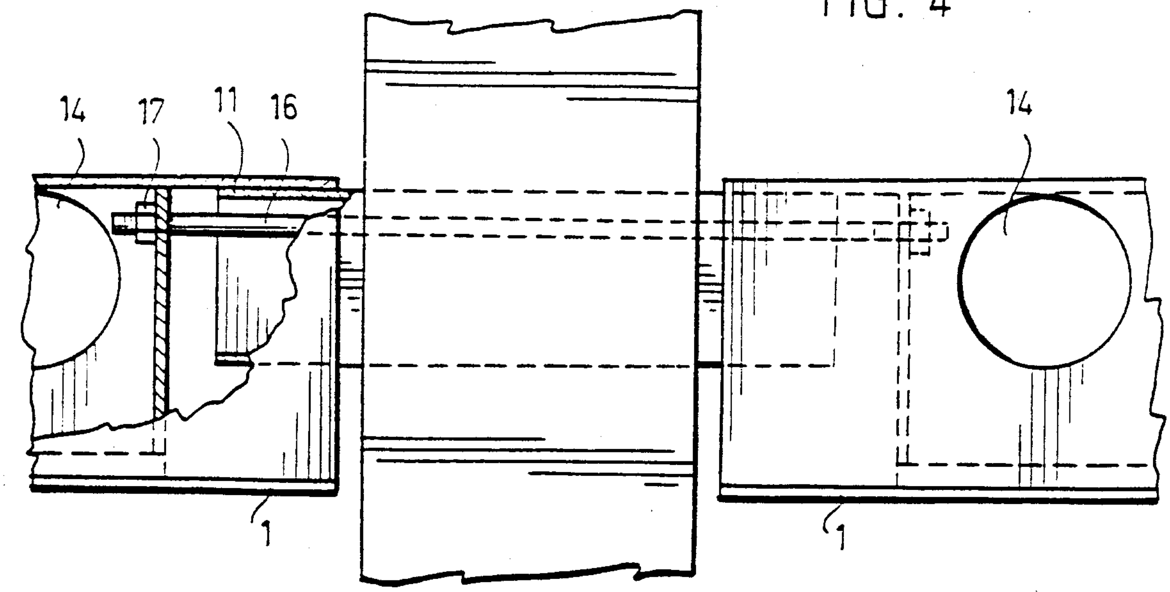
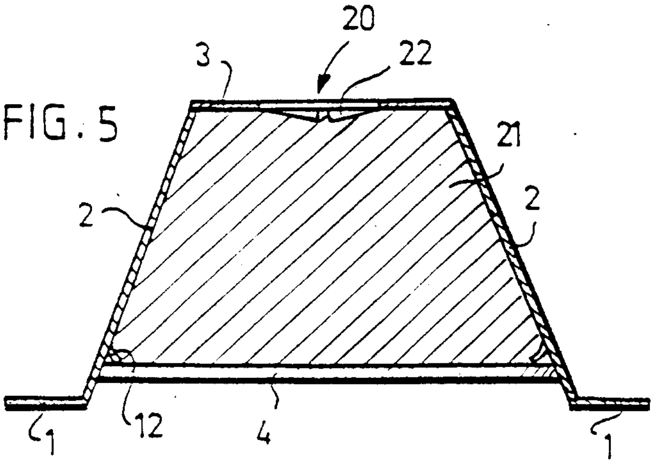


FIG. 5



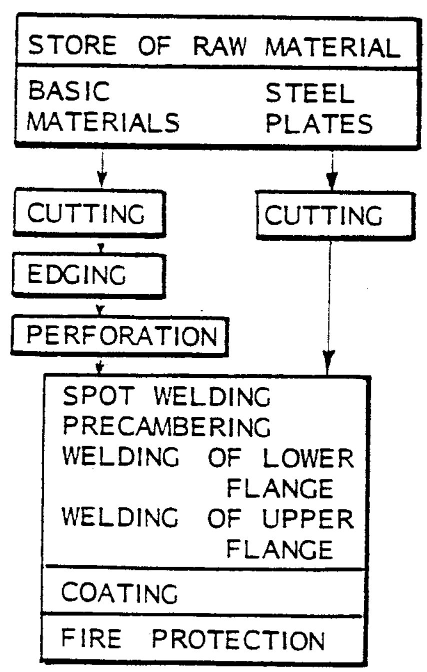


FIG. 6

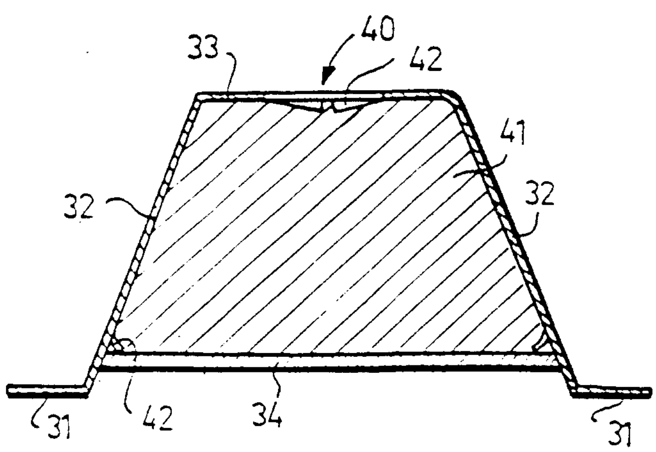


FIG. 7