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(54) **Method and device for mounting horizontal beams to steel columns.**

(57) In order to accurately and reproducably mount horizontal beams (4) to a steel column a supporting means (14) is connected -initially preferably provisionally - to a steel column (2), said supporting means extending along a free length of the column (2) from a lower support (4,23) to the level of a superposed horizontal beam, whereafter a horizontal beam (4) is arranged on and connected to the supporting means (14) The supporting means (14), which is prefabricated, is rigidly connectable to the column for stiffening co-action therewith and is supported with its lower end (19) against a bedding which may be an underlying beam (4), and supports with its upper end (18) the horizontal beam (4). In case of multi-storey buildings, supporting means (4) and horizontal beams (4) are alternatingly stacked on each other.

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METHOD AND DEVICE FOR CONNECTING HORIZONTAL BEAMS TO STEEL COLUMNS

The present invention concerns a method and a device for mounting floor-carrying horizontal beams between multi-storey steel columns.

The invention deals with erection of multi-storey buildings and particularly the design of columns of preferably orthogonal structural frameworks of such buildings, said frameworks including multi-storey columns of steel and joining beams of concrete or steel. Normally, such frameworks are made with steel columns which, prior to mounting, are provided with weld-connected shoulders, steel plates or brackets for supporting and holes for bolt-connecting the beams, respectively. Often the beams, whether they are made of steel or concrete, are pivotably supported on the column supports, combined with a certain torsional restraint however in relation to the columns. In other cases there is a need to make the orthogonal framework stiff, e.g., in a façade having capacity to transmit horizontal forces in the plane of the framework. The beam ends are then fixed to the columns, involving that beam and column must be rigidly connected in regard of momentum.

Examples of the above mentioned art appears from SE-B-8700147-5 in which are described and shown frameworks comprising multi-storey steel columns, horizontal concrete spandrel beams and precast concrete floor elements. To the columns, which normally have H- or I-sections, supporting steel plates are attached in advance between the column flanges. Apart from the strict requirement of accurate location of such plates, since they define the floor level their mere existence between the column flanges leads to difficulties when a façade spandrel beam shall be lowered between the column flanges, particularly when the façade beam has such dimensions that it cannot simply be inclined suffiently to pass support plates at a higher level.

The object of the present invention is to avoid said disadvantages as well as to further develop the state of art. This is achieved in that the invention has been given the characteristic features stated in the claims below.

According to one aspect of the invention, the previously utilized supporting steel plates, which were attached at defined levels along a column, have been replaced by supporting means having a fixed length, said supporting means obtaining a direct bottom support at an already defined level and providing an upward support for a horizontal beam at a supporting level which, thus, is likewise pre-defined. By prefabrication of supporting means, as well as horizontal beams, and the dimensional accuracy resulting therefrom, each floor level will be most accurately defined by addition of the respective heights of supporting means and beams.

As a variation, supporting means can be used having lengths shorter than but close to the one defined as above, said supporting means by means of height adjusting means obtaining an indirect support at the level already defined and providing an upward support for a horizontal beam at a level which is adjustable by means of said height adjusting means to be the correct support level for a horizontal beam. In this way a simple possibility of adjustment is achieved under maintenance of the other advantages of the invention.

According to another aspect of the invention, each steel column is composed from a multi-storey high column having a constant cross-section (here denoted core-column) and supporting means connected thereto, said supporting sections extending from the bottom surface of a beam at one floor level to the corresponding top surface of a beam at the underlying floor level, or, in case of a foundation to that foundation, so that, when mounting a framework, after the core-columns have been erected, supporting means and beams can be stacked on top of each other in pace with the supporting means being connected to the core-columns.

Whichever aspect of the invention is considered, a number of important advantages are being achieved, such as an essentially simplified art of assembly resulting in great possibilities to obtain high dimensional accuracy in the vertical direction. Additionally, the steel columns will be imparted an essentially increased stiffness and load bearing capacity along their free zone between the connected beams due to the supporting means connected thereto along these zones. Also, new possibilities are created to provide rigid connection of horizontal beams to the column composed of core-column and supporting means at the top edge of the beam as well as at its bottom edge. Further, possibilities to achieve composite co-action with concrete are provided when the supporting means are connected such that laterally closed channel-like spaces are created between the supporting means and the core-columns, and into said spaces is injected a hardening casting composition.

When erecting multi-storey columns it is an advantage if these can be brought directly to the building site in pre-cut lengths without first needing to be prepared at a welding workshop for accurate attachment of support devices. Since the supporting means according to the present invention sets aside the need of such preparation of columns, the preparation at the welding workshop is limited to

the supporting means which are substantially more easy to handle, but require high dimensional accuracy. The sum of the heights of the supporting means and the beam ends define the storey hight at so called "drop in" assembly, if such is utilized without particular level adjustments being done storey-wise. After the core-columns have been located and connected to the foundation the supporting means are placed against the support, which, after the first floor, is constituted by the top surfaces of the beams.

Before mounting of the beams the supporting means are provisionally connected to the column by means of clamps, bolts or spot welds. Connection by strength weld at this stage normally takes place only at those locations of attachment that are not accessible after mounting of the beams, this in order to make the main welding work independent of the mounting. After mounting of the beams of the first floor level follows the mounting of at least the floor slabs closest to the columns and thereafter the final (weld) connection of the underlying supporting means to the core-column. Using the floor as a platform the erection procedure is then repeated floor by floor.

An essential technical effect arises when the supporting means by welding along their entire lengths or parts thereof are connected to the core-columns, whereby the cross-section, bending stiffness and capacity to withstand normal forces of the free cross-sections of the composite parts of the columns are considerably increased as compared to the corresponding capacities of the core-column. If buckling is a critical design criteria the cross-sectional area of the core-column therefore may be reduced correspondingly. If, on the other hand, the compressive stress in the steel cross-section is decisive, the cross-section of the core-column can be reduced only to the extent a part of the normal force is channeled through the beam ends connected to the core-column between the supporting means. Thus, if the beam ends and their connections to the composite parts of the columns are made such that the beam is rigidly connected to the columns, i.e., rigidly connected at its upper edge as well as at its bottom edge, the function of the beam ends as parts of the columns is ensured. The fixation of the beam ends to the columns in turn leads to an orthogonal framework having a considerable in plane diaphragm capacity as regards the transfer of horizontal forces. In certain cases it may be difficult to perform sufficient weld connections at the interface between the beam top surface and the supporting means so as to be in parity with the moment capacity of the rest of the composite column. In such cases, the supporting means may be completed with a reinforcement bar or a bolt connected thereto which is anchored by injected grout fill or a screw, respectively, in the underlying beam.

To the extent the supporting means are connected to the core-column in such a way that they, together with core-column, define a laterally closed, vertically extended space along parts of the column, the invention offers another technical effect of importance, viz., in that this space may be injected with a concrete grout which after its hardening will act composite with the column, the load capacity and stiffness thereof being further essentially increased. In case the façade beams are of concrete a space is advantageously left between the beam ends and the web of the columns such that also at that location is formed a vertical, laterally closed space which may be injected with a concrete grout. Also in cases where a façade beam is of steel the beam ends may be designed such (e.g. by transverse web stiffening plates) that corresponding spaces are formed between the beam ends and the core-column. In both cases it is possible to perform the grouting operation in one sequence after the whole or a part of the building has been mounted, especially if it is monitored that the spaces between supporting means and core-columns have connection to adjacent spaces between the beams and core-columns. In addition to the load carrying advantages of grouting said spaces, also considerable heat and noise insulation is achieved.

The invention will be discribed in the following, reference being made to the accompanying drawings, wherein:

- Fig. 1 is a prespective view of a part of a framework of a multi-storey building seen from inside,
- Fig. 2 is a view showing at an enlarged scale a detail of a framework similar to the one according to Fig. 1,
- Fig. 2a is a view showing a detail similar to the one according to Fig. 2 but concerning an alternative method of mounting a supporting means,
- Figs 3 and 4 are views showing at a further enlarged scale a vertical and a horizontal section, respectively, through the column of Fig. 2 in the area of a beam support, and
- Figs. 5 and 6 are views showing a vertical and a horizontal section, respectively, through a portion located at a higher level of the column of Fig. 2 in the area of the upper side of a façade beem.

Fig 1 shows composite frameworks comprising vertical, multi-storey high steel columns 1, 2 and 3 and horizontal façade beams 4 and 5 of concrete on one hand in a frontal façade of a multi-storey building (to the left of the figure) and on the other hand in a gable façade (to the right of the figure) of

the same building. The horizontal beams 4 of the frontal façade have supporting surfaces 6 for floors 7, comprising prefabricated floor elements 8, and the façade elements 5 of the gable façade of the building have a longitudinally extending recess 9 at floor level adapted for jointing of a floor element 8 for transmittal of shear forces. The façade beams 4 and 5 are each integral and extend vertically between a window opening 10 of a storey under and over the floor 7, respectively, carried of the façade beams. Longitudinally the façade beams extend between two columns. In the example shown the frontal façade includes two H-section columns 1 and 2 and one corner column 3, comprising two inter-connected U-sections. In any case each column has two opposed flanges 11 and 12, between which is introduced the end of a façade beam, and a web portion 13.

According to the state of art the ends of the beams 4 and 5 were supported by supporting means attached between the flanges 11 and 12 of the columns. According to the present invention the beam ends are instead supported by supporting means (not shown in Fig. 1) which successively are introduced into the structure and themselves are supported against a rigid bedding in the shape of a foundation or the like when a lower façade beam is concerned and in the shape of an already mounted underlying façade beam when storeys at a higher level are concerned.

The principle of the invention appears more closely from Fig. 2 showing a portion of a core-column 2 of Fig 1 partly cut off, portions of two façade beams 4 connected thereto and some floor slabs 8 supported on one of the façade beams 4. The façade beam 4 to the right of Fig 2 is connected at its right-hand end to the corner column 3 of Fig. 1 while the left façade beam 4 is connected with its left-hand end to column 1 of Fig 1. In Fig 2 are shown two supporting means 14 of which the lower one 14a with its non-shown bottom end supports against a fixed bedding, e.g., in the shape of the upper surface of an underlying façade beam 4. In the example shown, the supporting means 14 have the shape of U-sections, the flanges 15 and 16 of which are accomodated between the flanges 11 and 12 of the core-column 2 and the web portions 17 of which are turned away from the web portion 13 of the core-column. Preferably, the supporting means 14 are provided at both ends with supporting plates 18 and 19 connected by welding. On the upper supporting plate 18 of the lower supporting means 14a is resting the lower edge of a façade beam 4 on which in turn rests the upper supporting means 14b with its supporting plate 19.

In practice, mounting is performed such that one supporting means 14 is erected on the bedding in question and is provisionally connected to the core-column. This, e.g., can be achieved by means of spot welds 20 against the flanges 11, 12 of the core-column, as is shown at the supporting means 14b on which a façade beam has not yet been placed. Subsequently, a façade beam 4 is lowered onto the supporting means 14 and the entire or parts 8 of a floor are placed on the supporting surface 6 of the façade beam. Final connection of a supporting means 14 to a core-column takes place by means of strength weld 21, as is shown at the supporting means 14a which is loaded by a façade beam 4 and at least parts 8 of a floor 7.

As previously mentioned, the supporting means 14 are suitably prefabricated to obtain accurate dimensions. When the façade beams, as in the example shown, comprise concrete beams, also these beams at manufacture are provided with accurately located lower supporting plates 22 (Figs. 3 and 4) and upper supporting plates 23 (Figs 5 and 6). In addition, a U-section 24 against which the supporting plates 22 and 23 are welded, preferably extends along the entire height of the beam.

If, for manufacturing reasons, it should be impossible to make all supporting means 14 of an exactly equal length, it is preferred to make all supporting means shorter than the fixed length. One reason for this, of course, is that a too great length would make the supporting means unusable without cutting. For certain mounting reasons it may also be suitable to make the supporting means shorter than the fixed length. In Fig. 2a is shown how the mounting of a supporting means 14′ is performed in such cases. On the upper surface of a facade beam 4 is placed a wedge 40 on which a supporting means 14′ is erected. By means of the wedge 40 the level of the upper side of the supporting means 14′ is adjusted such that said upper surface is located at the correct level to serve as a support for a horizontal beam 4 placed thereon. When the supporting means 14′ has been adjusted at the correct level it is welded to the flanges 11 and 12 of the core-column 2 in a similar way as described above, thereafter the wedge 40 is removed.

For connection between a façade beam 4 and an underlying supporting means 14a a hole 25 may be provided in the supporting plate 18 of the supporting means, said hole being adapted to cooperate with a stud 26 (Figs. 3 and 4) projecting from the underside of the façade beam, said stud being threaded into a threaded hole in the support plate 22 at mounting. At its top the façade beam 4 is connected by welding of its supporting plate 23 and by intermedience of a round iron 27 to the web portion 13 of the core-column before an upper supporting means 14b is arranged on the supporting plate 23 of the façade beam (Figs 5 and 6). In

order to obtain satisfactory connection between the supporting means 14 and the façade beam 4 also in this area if accessibility for welding is bad a hole and a stud (not shown), or, a bolt joint may be provided between them in a similar way as at the upper side of the supporting means.

As shown in Fig 2, between a supporting means 14 and the web portion 13 of a core-column a laterally closed space is formed having the shape of a vertical channel 28 between the supporting means and the column. This channel may suitably be injected with a hardening grout, such as concrete, in order to obtain composite action with the supporting means and the core-column. In such case it is of course advantageous if the stud or studs 26 projecting into the channel 28 are of the finned reinforcement bar kind for improved co-action with the injected grout.

In order to keep the supporting means levelled with the flanges 11 and 12 of the core-column and/or in order to achieve connection between the vertical channel 28 and the end areas of over and/or underlying façade beams some kind of spacing means may be arranged between the supporting beams and the core-column. One example of such a spacing means 29 is shown in Figs. 3 and 4 to be arranged between the supporting plate 18 of the supporting means and the web portion 13 of the core-column.

As appears from at least Figs. 3-6 there is also a vertical space 13 between the ends of the façade beams and the web portion 13 of the core-column. According to the present invention this space 30 is in communication with the over and/or underlying vertical channel 28, such that a plurality of channels and spaces can be injected simultaneously.

At its ends the façade beam 4 is thinner than the distance between the flanges 11, 12 of the core-column. Therefore, it is suitable to force it against one of the flanges of the core-column by means of wedges 31 (Fig. 2), in this case against the flange 11. In such case, the U-section 24 can be welded (at 32) to the flange 11 so that also the beam end is effectively incorporated in the composite column including also the core-column and the supporting means 14. For the sake of continuity in the composite column also the upper supporting plates 18 are welded (at 33) to the lower supporting plate 22 (Fig. 3) of the superposed façade beam 4 and the lower supporting plates 19 of the supporting means 14 are welded to the upper supporting plate 23 of the underlying façade beam 4 (Fig. 5).

The space formed between the beam end and the flange 12 of the column can easily be sealed so that no injection grout leaks out.

In order to obtain the desirable channel forming space between a supporting means and a core column the supporting means may, of course, have other cross-sections than U-shaped ones, particularly if the core-column itself has flanges as in the example described. As the most simple case, thus, a plane plate can be contempled, said plate being welded to the flanges of the core-column.

Even if the invention has been described in connection with columns having H- or I-section, it may as well as be applied to columns having a closed cross-section, for instance □-section.

Claims

1. method of mounting horizontal floor carrying beams between multi-storey steel columns, **characterized in**
- that a supporting means (14) extending along a substantial free length of the columns (2) from a lower support (4;23;40) to the level of a superposed horizontal beam is at least provisionally connected to each steel column (2), and
- that a horizontal beam (4) is arranged on and connected to the supporting means (14).

2. A method according to claim 1, the lower support being a lower horizontal beam, **characterized in** that the supporting means (14) are connected to the lower horizontal beam (4).

3. A method according to claim 1 or 2, **characterized in**
- that the supporting means (14) are connected to the steel columns (2) such that vertical channels (28) are formed between the supporting means and the columns, and
- that a hardening composition is injected into the vertical channels, said composition after hardening co-acting composite with the columns (2) and the supporting means (14).

4. A method according to claim 3, **characterized in**
- that the horizontal beam (4) is arranged on the supporting means (14) such that a space (30) is formed between the beam and the columns, said space being in communication with the vertical channels (28), and
- that the injected composition is allowed to fill also said spaces (30) for co-action with the beam (4) and the columns (2).

5. A method according to claims 2 and 4, **characterized in**
- that the lower horizontal beam (4) is arranged at the columns (2) such that between said beam and the columns are formed spaces (30) being in communication with the vertical channels, and
- that the injected compositon is allowed to fill these spaces for co-action with the lower beam and the columns.

6. A device for mounting a horizontal floor carrying beam between multi-storey steel columns,

characterized by a supporting means (14;14′) extending along each column (2) and being rigidly connectable to the columns for stiffening co-action therewith, said supporting means with its lower end (19) being supported against a bedding (4;23;40) and supporting with its upper end (18) the horizontal beam (4).

7. A device according to claim 6, **characterized in** that the supporting means (14) is directly supported against the bedding (4;23) and has a length corresponding to the supporting level of the horizontal beam above the bedding.

8. A device according to claim 6, **characterized in** that the supporting means (14′) is supported against the bedding (4;23) by the intermedience of a level adjusting means (40) and has a length which is less than the supporting level of the horizontal beam (4) above the bedding, the upper end of said supporting means (14) being vertically adjustable to the supporting level of the horizontal beam above the bedding.

9. A device according to claim 7 or 8, said columns carrying at least two horizontal beams, **characterized in** that the bedding is an underlying horizontal beam.

10. A device according to claim 6, 7 or 8, **characterized in** that the supporting means are plates welded to the columns.

11. A device according to claim 6, 7 or 8, **characterized in** that the supporting means are sections welded to the columns.

12. A device according to claim 10 or 11, **characterized in** that the supporting means (14,14′) together with the respective column (2) define vertical channels (28) in which may be injected a hardening composition for possible composite co-action with the supporting means and the columns.

13. A device according to claim 12, said columns (2) having a section including a web portion (13) and at least two flanges (11,12), **characterized in** that the supporting means (14) are at least partly introduced between the flanges (11,12) of the columns.

14. A device according to claim 13, **characterized in** that the supporting means are U-sections (14;14′) the flanges (15,16) of which are introduced between the flanges (11,12) of the steel columns and welded thereto.

15. A device according to anyone of claims 6-14, **characterized in** that between each supporting means (14) and a horizontal beam (4) is arranged at least one supporting plate (18/22).

16. A device according to claim 15, **characterized in** that the supporting means (14) at both ends thereof are provided with pre-welded supporting plates (18,19).

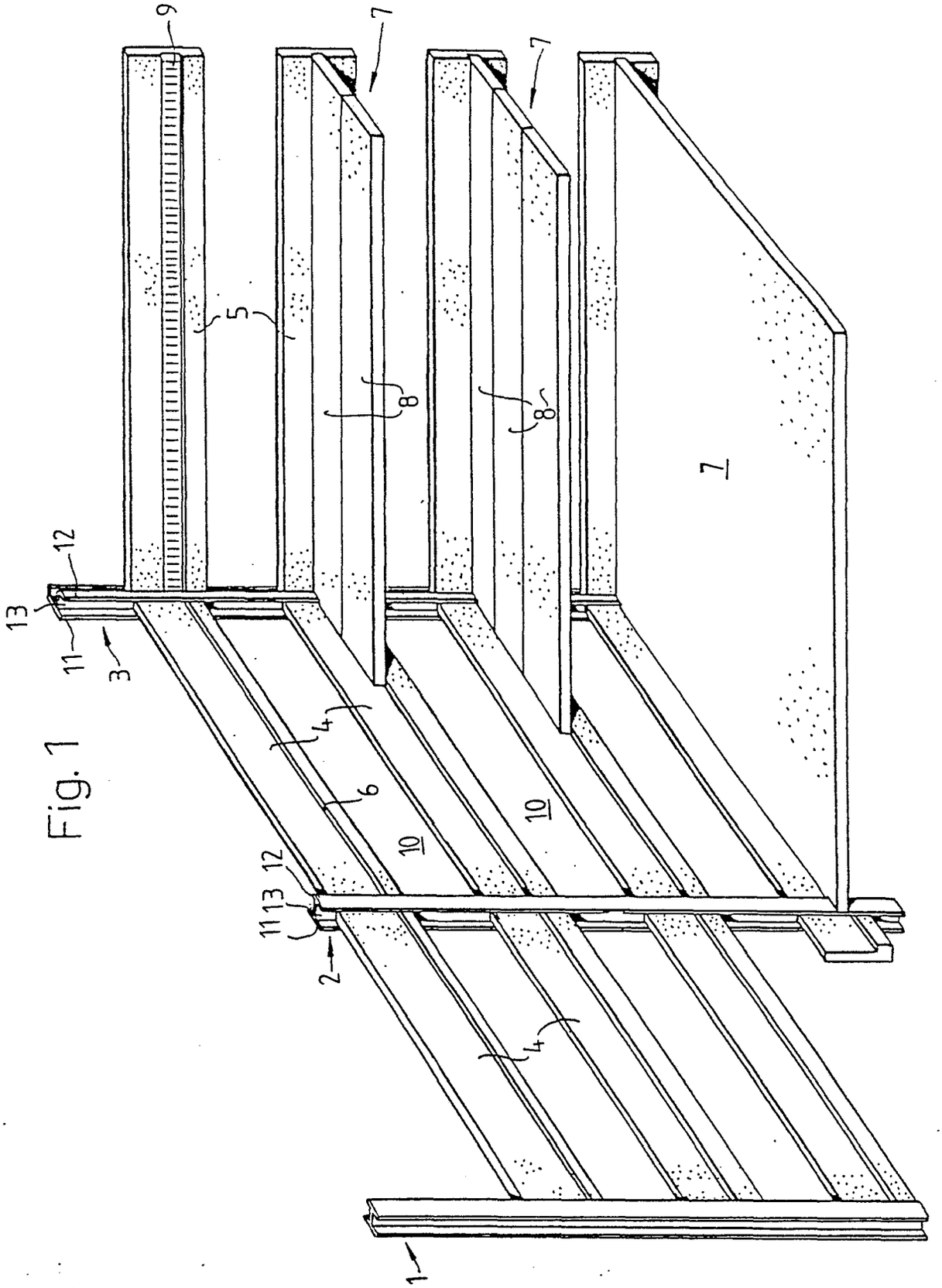

Fig. 1

Fig. 2

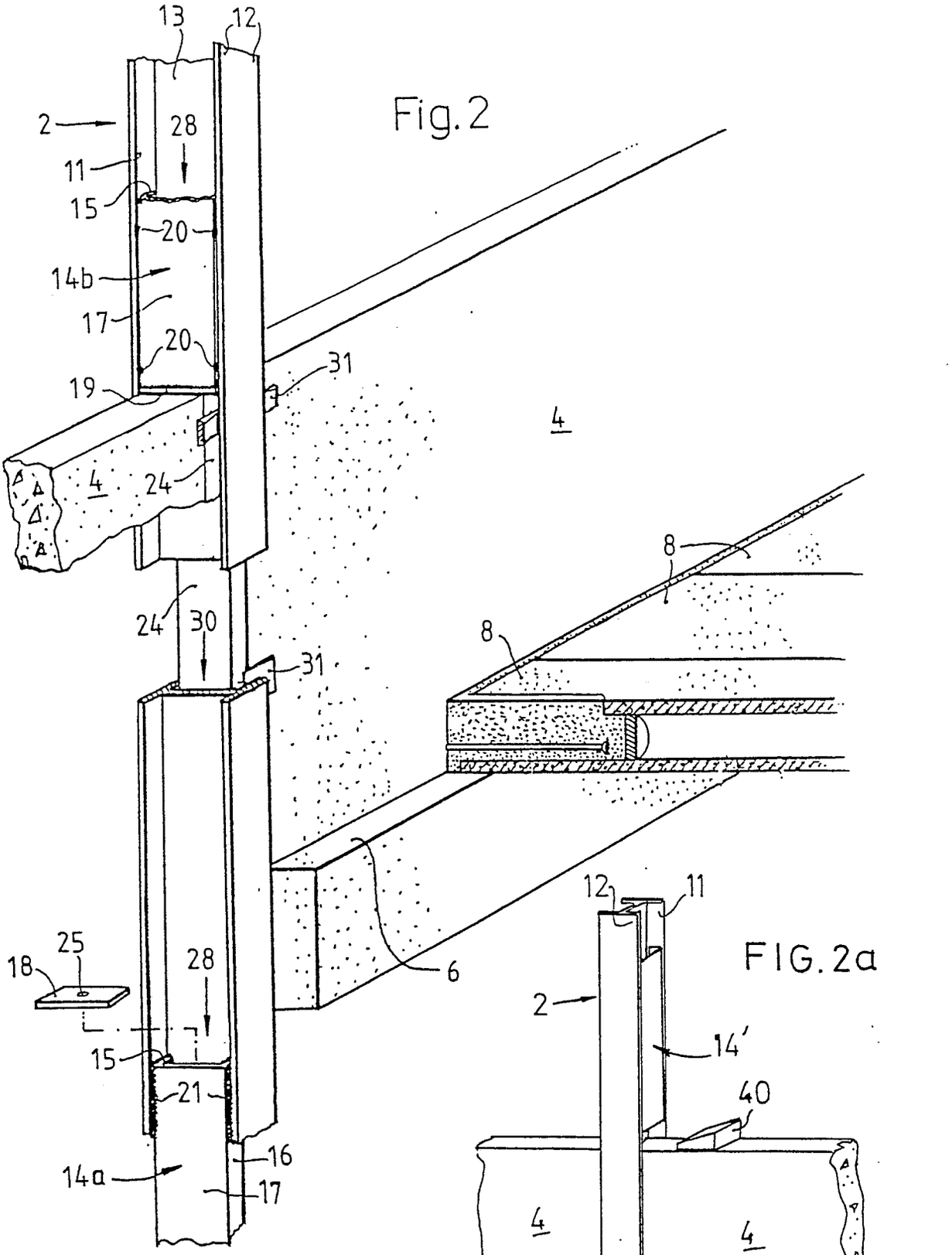
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FIG. 2a

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FIG. 3

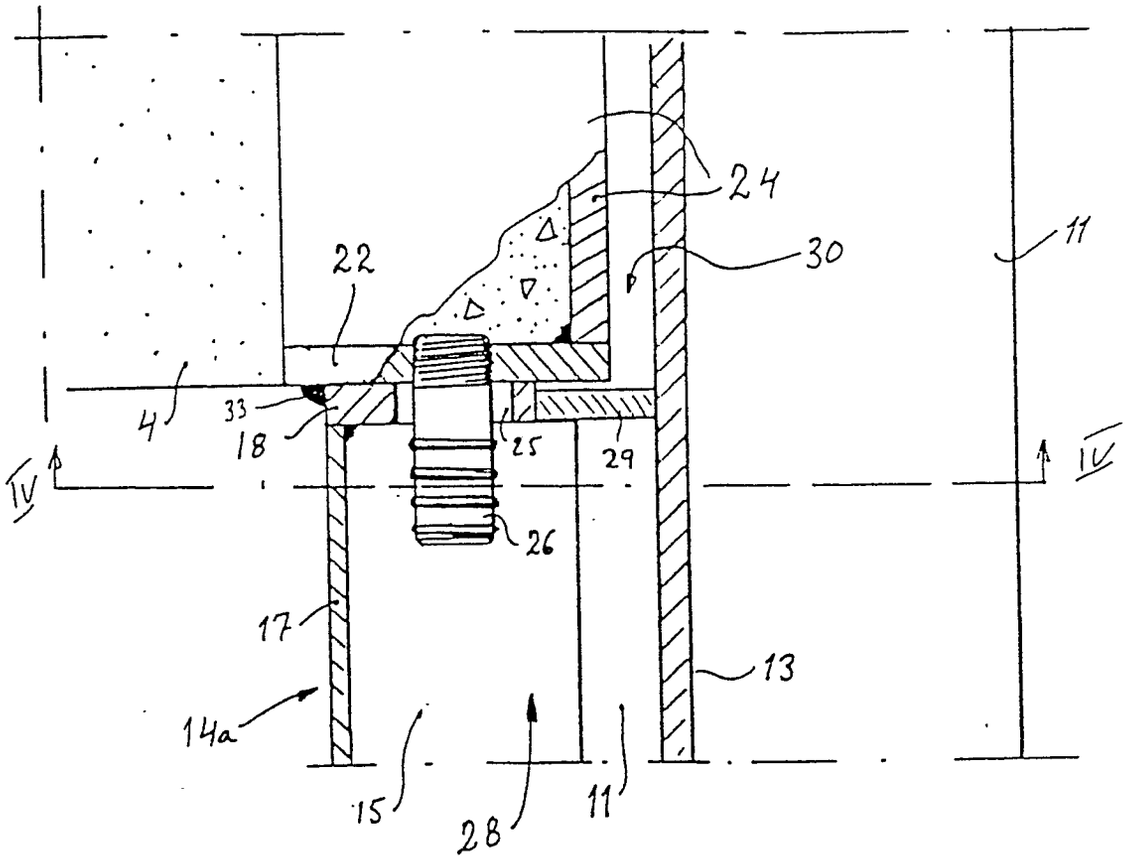
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FIG. 4

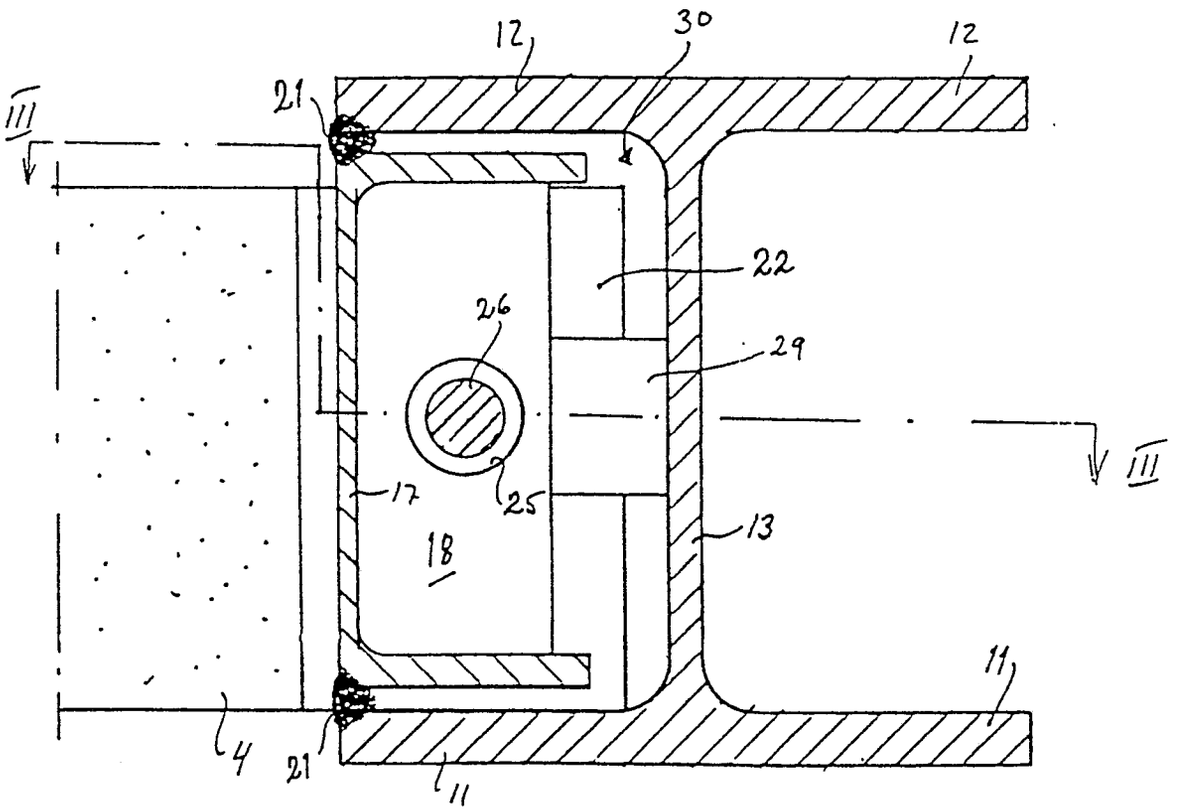
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FIG. 5

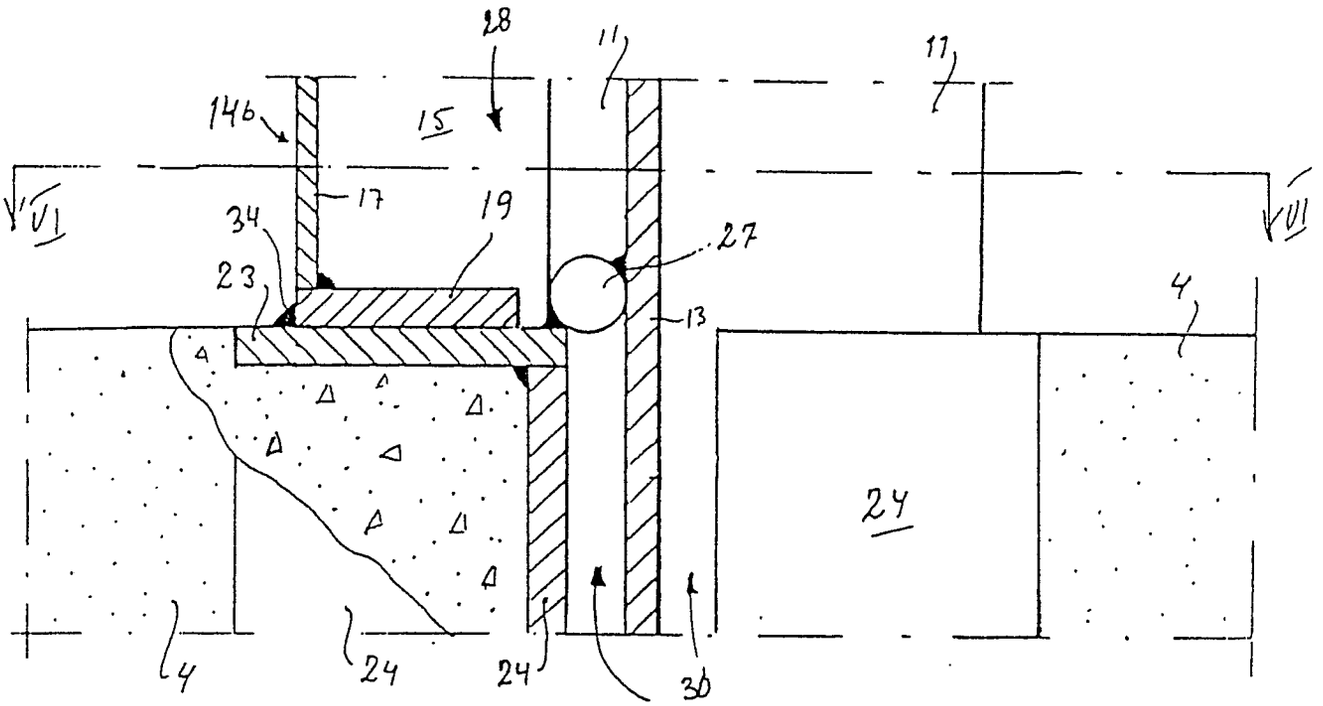
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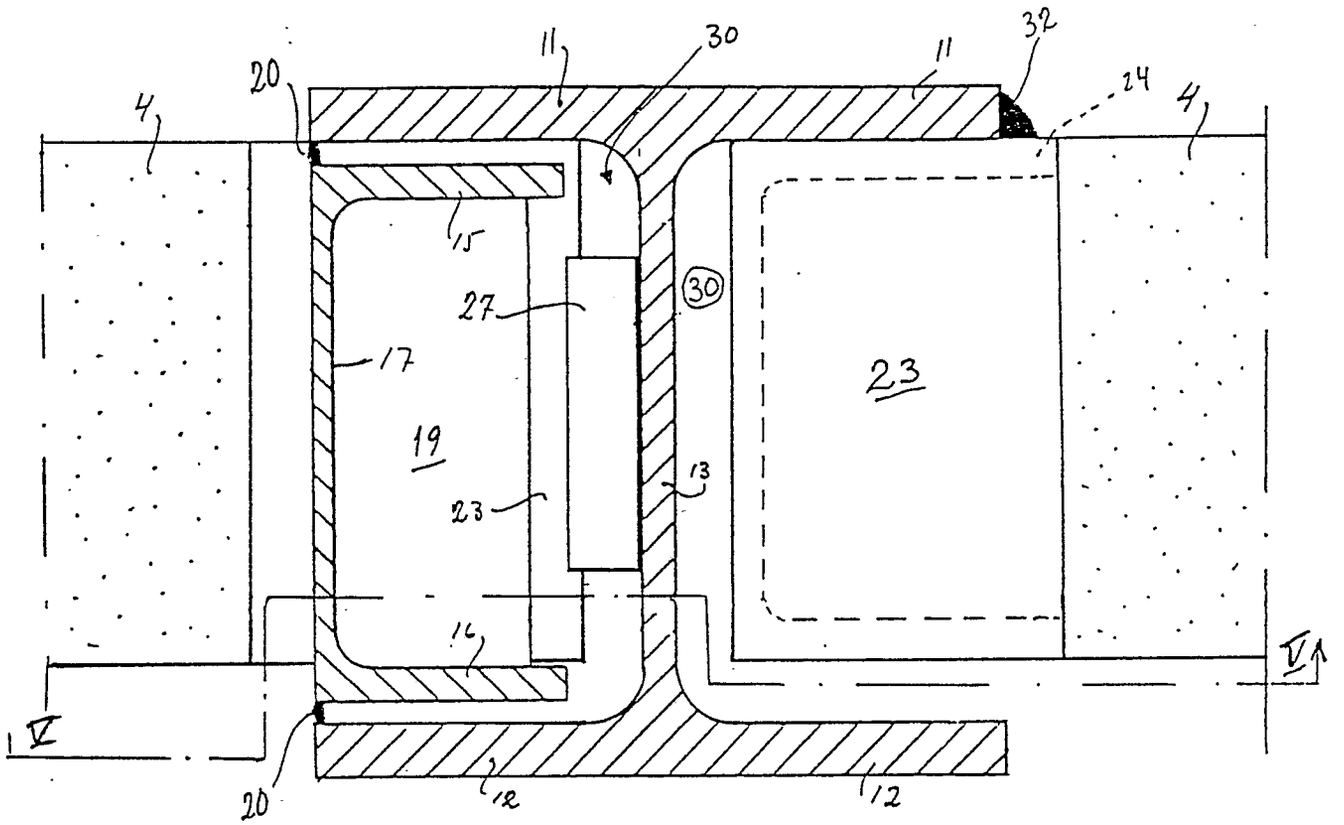
FIG. 6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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 85 0027

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	WO-A-8 805 484 (AB STRÄNGBETONG) * The whole document *	1,4-6, 10,13, 15	E 04 B 2/62 E 04 B 1/24
A	SOVIET INVENTIONS ILLUSTRATED, Section P/Q week 8152, 28th March 1981, Derwent Publications Ltd., London, GB; & SU-A-726 431 (KIEVPROEKT HOUSING) 16-02-1979	1,6	
A	US-A-3 690 079 (J.W. HEMMINGER) * Colonne 2, lignes 19-38; figures 1-3 *	1,6,13, 14	
A	US-A-4 107 893 (E.G. RENSCH) * Colonne 3, lignes 29-53; figures 2-4,11 *	1,6	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 04 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25-04-1990	KAPPOS A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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