



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.03.2009 Bulletin 2009/13

(51) Int Cl.:
E04B 1/00 (2006.01)

(21) Application number: **08275057.1**

(22) Date of filing: **23.09.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **24.09.2007 GB 0718770**

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(54) **Thermal break arrangements for construction elements**

(57) A thermal break, wall-penetrating connector comprising a load transferring, heat insulating gasket having a first face adapted to be secured against a first

heat conductive structural element and a second face adapted to be secured against a second such element with no heat conductive path between the first and second said elements.

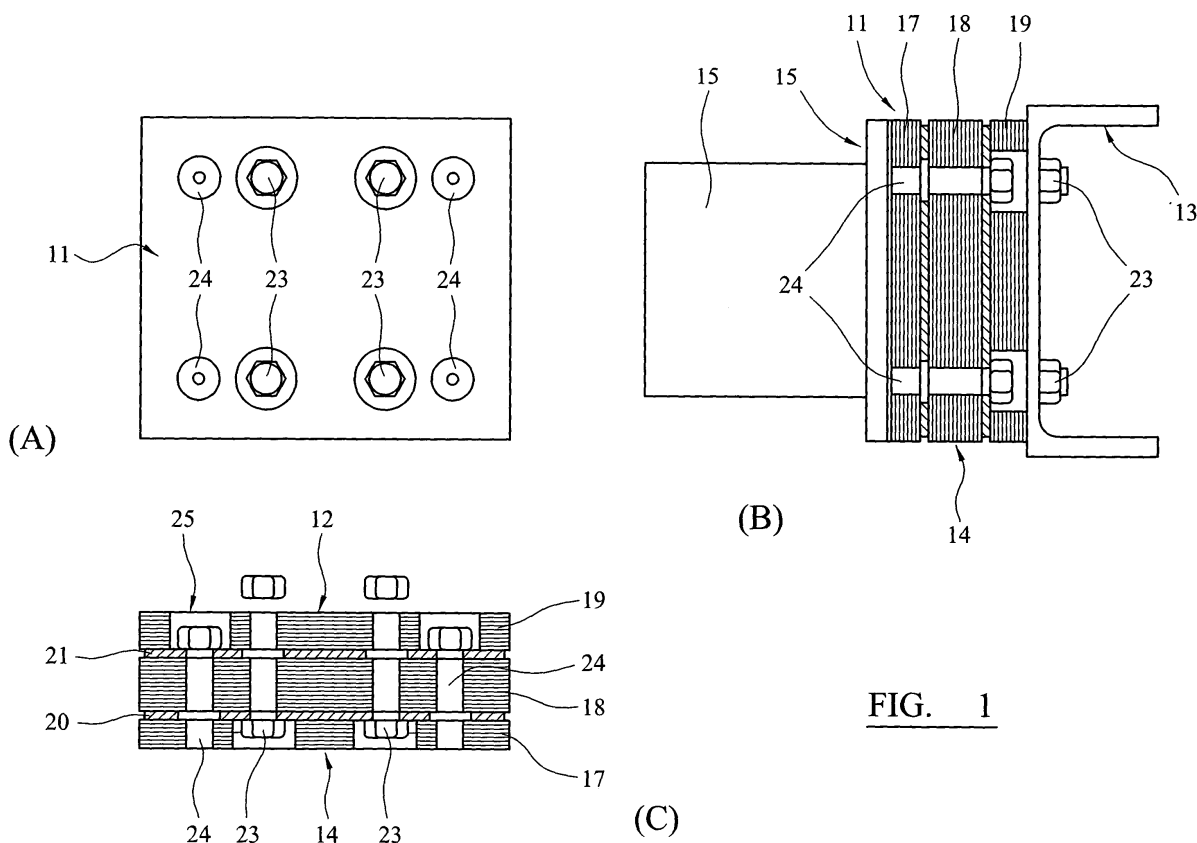


FIG. 1

Description

[0001] This invention relates to insulation arrangements for construction members, particularly for thermal insulation. In particular, but not exclusively, the present invention relates to connection arrangements for construction members, such as for thermal insulation, where an external element requires structural attachment to internal structure.

[0002] Building regulations may require - and it is in any event clearly desirable - that thermal conductivity of elements that penetrate the insulation layers of buildings should be designed to avoid a cold bridge. Such elements may comprise, for example, simply supported or cantilever beams that support balconies or other steel appendages or structures.

[0003] Conventional constructional methods, however, do not generally involve a true thermal break in such a constructional element. In one suggestion, M16 stainless steel bolts pass through an insulated cloak containing a stainless steel compression block. The average conductivity taken over the whole cross section is said to be low enough to meet some building regulations, but locally the bolts still provide a heat conductive path, or cold bridge, through which heat is lost/cold is transferred. This can potentially cause condensation and mould growth, which is deleterious to inner building materials and surfaces.

[0004] The present invention provides improved insulation arrangements, which can be realised for steel and/or reinforced concrete structures.

[0005] According to a first aspect of the present invention, there is provided an insulating, wall-penetrating connector comprising a load transferring, insulating gasket having a first face adapted to be secured against a first conductive structural element and a second face adapted to be secured against a second such element with no conductive path between the first and second said elements.

[0006] It is recognised, of course, that strictly speaking, any material is heat conductive to a greater or lesser degree. By 'conductive' herein is meant heat conducting to a similar extent as steel or like load-transferring constructional material, and by 'insulating' is meant conducting to at least an order of magnitude less than that (and which differences in conductivity may be sufficient to eliminate a cold bridge from occurring between internal and external environments). At least one of the first and second conductive structural elements may be formed of or may comprise a concrete material. Whilst concrete is less heat conductive than steel, it will be understood that structural concrete elements of typical dimensions would provide a cold bridge in the absence of the connector of the present invention. This may be exacerbated where, as is typically the case, steel reinforcing members are provided in the concrete, thereby raising the heat conductivity of the structural member when compared to a similar member constructed purely from concrete.

[0007] The first face may be adapted to be secured against a first conductive structural element and the second face against a second such element with no heat conductive path and/or no electrical conductive path between the first and second said elements.

[0008] The gasket may be adapted to be secured against the first and/or the second conductive structural element by structural fixings such as bolts, and may comprise oversize holes (which may be bolt holes), leaving an air gap between the fixings and material they pass through. It will be understood that the air gap may act to insulate the fixings and thus the air gap may be an insulating air gap. The gasket may comprise internal structural layers, which may be of steel with captive bolts welded or otherwise secured thereto and projecting from the gasket to serve as means to secure the gasket to structural elements.

[0009] A suitable heat insulating material is a resin-impregnated wood/wood material/wood-based material. The wood material may be a laminate, and may be a densified timber laminate. The wood material may be impregnated with, for example, phenolic resin, and impregnation may be carried out in a vacuum tank. A gasket made using this material has suitable material properties in use under compression, bending, torsion and shear loading for supporting balconies and significant structural loads for other types of wall penetrating structural connections.

[0010] Another suitable insulation material is a non-compressible glass foam, which may be used in conjunction with the resin-impregnated wood. Such a gasket will carry moderate loads, with good insulation. Other suitable plastics and/or composite materials may be employed. For example, a polycarbonate plastics material may be employed. A suitable manufacturing technique for a plastics-based gasket may be pultrusion.

[0011] The gasket may comprise captive bolts or nuts for engaging said first and/or second element (using corresponding nuts or bolts). Such bolts/nuts may be embedded in the gasket and may be welded or otherwise secured, for example, to an inner steel plate. Separate steel plates may be provided for each of the first and second elements. The or each steel plate may serve as both a spreader plate and a reinforcing plate to assist in the transfer of significant loads through the connector in the form of a composite structural element. Whilst the inherent strength of the gasket (in particular of the densified timber laminate) may be sufficient to resist applied loading in use of the connector, the or each steel plate may serve (optionally primarily) as a washer to prevent the bolt head embedding in the insulating material. Individual washers may be used instead of a washer plate. The steel plates may be omitted, for example, should the load requirements permit.

[0012] The connector may be adapted to be secured directly to a steelwork member of a steel frame building. The connector may be primarily suitable for a steel to steel connection and thus may be suitable for use with

first and second conductive structural steel elements. The connector may also or alternatively be suitable for use in concrete, particularly reinforced concrete, structures. The connector may therefore be suitable for a steel to concrete connection or indeed a concrete to concrete connection. The connector may be adapted to make use of secondary internal or external connections as a means of connecting to steel reinforcement embedded in a concrete structure, where the projection may be of suitable anchorage to comply with relevant design codes.

[0013] For use in reinforced concrete structures, the connector may be bolted to a steel member having reinforcing bar projections adapted to be cast and embedded into a structural concrete slab. The projection may be of suitable anchorage to comply with relevant design codes. A means of connecting the bolts to such reinforcement may involve the use of rod coupling nuts, which may themselves be embedded in the concrete.

[0014] A typical size for the connector is 250 x200 x 80mm.

[0015] The connector may be a tensile connector, that is a connector adapted to be placed under tension, in use. The connector may be a compressive connector, that is a connector adapted to be placed under compression, in use. The connector may comprise connector halves or sections, one of which may be an upper tension half or section and the other of which may be a lower compression half or section. The halves may be adapted to be separated to suit the connection required, and a non structural insulating material may be used to fill the gap between the two halves, to provide improved heat insulation.

[0016] According to a second aspect of the present invention, there is provided a connector assembly comprising:

at least one tensile connector adapted to be placed under tension, in use;

at least one compressive connector adapted to be placed under compression, in use; wherein the at least one tensile and at least one compressive connector each comprise a load transferring, insulating gasket having a first face adapted to be secured against a first conductive structural element and a second face adapted to be secured against a second such element with no conductive path between the first and second said elements.

[0017] Further features of the at least one tensile and the at least one compressive connector are defined above in relation to the connector of the first aspect of the present invention.

[0018] Embodiments of the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows front elevation (A), side elevation (B) and plan (C) views, of one embodiment of connector

in accordance with the present invention;

Figure 2 shows a perspective view of the connector of Figure 1 set between typical structural elements to be connected thereby;

Figure 3 shows a perspective view of the connector of Figure 1 in a typical wall-penetrating situation;

Figure 4 shows a side elevation view of the connector of Figure 1 set between alternative, typical structural elements to be connected thereby;

Figure 5 shows partial cross-sectional side elevation (A) and plan (B) views of the connector of Figure 1 set between further alternative typical structural elements to be connected thereby; and

Figure 6 shows front elevation (A), side elevation (B) and plan (C) views of connectors, and a connector assembly, in accordance with a further embodiment of the present invention.

[0019] Figure 1 illustrates an insulating, wall-penetrating connector 11 comprising a load transferring, insulating gasket 12 adapted to be secured against a first conductive structural element 13 and against a second such element 15 (Figure 1B), with no conductive path (or only a broken, insulated conductive path) between the first and second said elements 13, 15.

[0020] The gasket 12 is a laminate of outer and inner insulating layers 17, 18, 19 and stainless steel layers 20, 21 squeezed tightly together on assembly. The steel layers 20 and 21 are typically of a stainless steel, which has a lower heat conductivity/heat transfer coefficient than other, mild steels. However, it will be understood that other types of steels including mild steels may be employed. The stainless steel layer 20 has bolts 23 welded to it passing through the inner insulating layers 18, 19 and through oversize bolt holes in the stainless steel layer 21. The bolts 23 are countersunk in the gasket 12. Bolts 24 are welded to the stainless steel layer 21, pass through the inner insulating layers 17, 18 and through oversize bolt holes in the stainless steel layer 20. The bolts 24 are also countersunk as shown at 25 in the Figure.

[0021] The inherent strength of the gasket 12, in particular of the material used to form the insulating layers 17, 18 and 19 (and which will be discussed in more detail below) may be sufficient to resist applied loading in use of the connector 11. However, the or each stainless steel layer 20, 21 may act primarily as washers, assisting in preventing bolt heads or nuts from penetrating the insulating layer 18. Regular circular washers may be used in place of the layers 20, 21, provided they do not make contact with a passing bolt. It will be understood that the steel layers 20, 21 may serve as both a spreader plate and a reinforcing plate to assist in the transfer of significant loads through the connector in the form of an internal

composite structural element in conjunction with the central insulating layer 18, and through the insulating compression layers, 17, 19. The steel layers 20, 21, may be omitted should the load requirements permit.

[0022] The gasket 12 is adapted to be secured against the first conductive structural element 13 by the bolts 23, and against the second conductive structural element 15 by the bolts 24. Passing through oversize bolt holes in the gasket, the bolts 23 do not make contact with the steel layer 21, and the bolts 24 do not contact the steel layer 20, so there is no direct thermal conductive path, and thus no cold bridge, through the gasket 12. The oversize bolt holes in the gasket may also ensure that there is no electrical conductive path.

[0023] The upper sets of bolts 23, 24 (Figure 1A) essentially bear the load of the loaded attachment, which may be a cantilevered appendage such as a balcony. The lower sets of bolts 23, 24 (also Figure 1A) primarily serve to hold the connector's layers together, and need not be of the same size as the upper bolts in that they may serve to deal with reverse (compressive) loads. The lower bolts may thus be smaller than the upper bolts. The upper bolts may be standard M 16 bolts, as used widely in construction.

[0024] The layers may be adhesively secured together to improve the load capabilities and/or to aid assembly. However, the layers need not necessarily be adhered. It may well be better to rely mainly if not necessarily exclusively on the bolts, suitable tightened, for the integrity of the connector.

[0025] Figures 1 and 2 illustrate a thermal break connector 11 constructed as above described, which has a thermal resistance of about $0.3\text{m}^2\text{K/W}$, optionally about $0.4\text{m}^2\text{K/W}$, and which may be adapted to support balconies from a reinforced concrete structure. The composition may be varied to improve the load capabilities, and/or to improve the thermal resistance of the connector to suit various thermal requirement regulations, but will make use of the insulating layers 17, 18, 19 as structural members.

[0026] The first structural element 13 of Figures 1A-C comprises a steel beam 27 with reinforcing bar loops 28 and a lap plate 29 that can be welded to structural steelwork and in use cast into the concrete of an outer wall of a building, as shown in the perspective view of Figure 2. The second structural element 15 comprises a bracket 31, shown as attaching to a beam of a balcony.

[0027] Clearly, the nature of the first and second elements 13, 15 will depend on the application of the thermal break connector.

[0028] The insulating layers 17, 18, 19 need, of course, to have physical and mechanical properties appropriate to the loads they will be required to bear and the conditions under which they will be deployed. A suitable heat insulating material for general building purposes is resin-impregnated wood/wood material, which can be formulated to have minimal or no shrinkage, will not crack or warp under a wide range of loadings, is impervious to

water and resistant to salt water, oils and chemicals and can tolerate wide temperature variation. Suitable resins include phenolic resins, and impregnation may take place under vacuum conditions. In the illustrated embodiment, the heat insulating material is a densified timber laminate.

[0029] A particular advantage to forming the insulating layers 17, 18 and 19 of densified resin-impregnated timber laminate is that this provides the layers with significant strength and resistance to applied loading in use of the connector 11. In particular, each of the layers 17, 18 and 19 are made up of a number of individual sub-layers sandwiched together. The wood grain in adjacent timbers are oriented generally at 90 degrees to one another, in a similar fashion to plywood. This, combined with use of the resin, provides the layers with their significant strength and indeed may provide sufficient strength such that the stainless steel layers 20, 21 could be dispensed with. In particular, the layer 18 may experience large shear forces in the region between the adjacent bolts 23 and 24, due to the bolts applying loading on the layer in opposite axial directions.

[0030] The connector may have inherent fire safety features. The resin used to impregnate the wood (and/or the resin impregnated, densified timber laminate) may have, for example, self-extinguishing properties. The resin impregnated, densified timber laminate itself may char on its outer faces, but such charring forms an insulating layer, which can protect the internal wood against degrading for a period, for example, an hour or more, to meet designated design requirements, and thus the connector will remain viable.

[0031] Figure 3 shows the connector 11 attached to a steel beam 13 and supporting a balcony 30 secured on a steel beam 31 with the structural element 15 penetrating the outer brick cladding 32 of a building.

[0032] Turning now to Figure 4, there is shown a side elevation view of the connector 11 of Figure 1 set between alternative typical structural elements to be connected thereby. The first structural element 13 in this instance is typically a steel frame. The second structural element 15 may comprise of an external structural element through which a cold bridge may occur without the use of a means of preventing this such as the connector 11 disclosed herein. A wall penetrating attachment may be used between the external element and the thermal connector to assist a construction programme.

[0033] Figure 5 shows partial cross-sectional side elevation (A) and plan (B) views of the connector 11 of Figure 1 set between further alternative, typical structural elements to be connected thereby. In this instance, the first structural element 13 is an L-shaped steel beam that is cast into a reinforced concrete slab 34 on site. Reinforcing bars 36, similar to the bar 29 shown in the embodiment of Figure 2, are provided in the slab 34. In this instance, however, the slab 34 is provided with built-in means of attachment to the connector 11, in the form of internally threaded rod coupling nuts 38, 40. Typically, the connector 11 (and any further such required connec-

tors) is secured to the steel beam 13 off-site using the rod coupling nuts 38 and 40. The assembled connector 11 and beam 13 is then transported on site, and the reinforcing bars 36 secured to the rod coupling nuts 38, 40. Using appropriate formwork (not shown), the concrete slab 34 is then cast and envelops the reinforcing bar loops 36 and rod coupling nuts 38, 40 as shown in the Figure. Once again, the second structural element 15 may comprise of an external structural element through which a cold bridge may occur without the use of a means of preventing this such as the connector 11 disclosed herein. A wall penetrating attachment may be used between the external element and the thermal connector to assist a construction programme.

[0034] Figure 6 shows front elevation (A), side elevation (B) and plan (C) views of connectors, and a connector assembly, in accordance with a further embodiment of the present invention. Illustrated are upper tensile and lower compressive connector halves or sections 11a and 11b, each of similar construction to the connector 11 of Figure 1. Like components of the connector sections 11 a and 11 b with the connector 11 of Figure 1 share the same reference numerals with the addition of the suffixes 'a' and 'b', respectively. The connector sections 11 a, 11b are of similar construction to the connector 11, save that the connector sections include only single pairs of bolts 23a, 24a and 23b, 24b respectively.

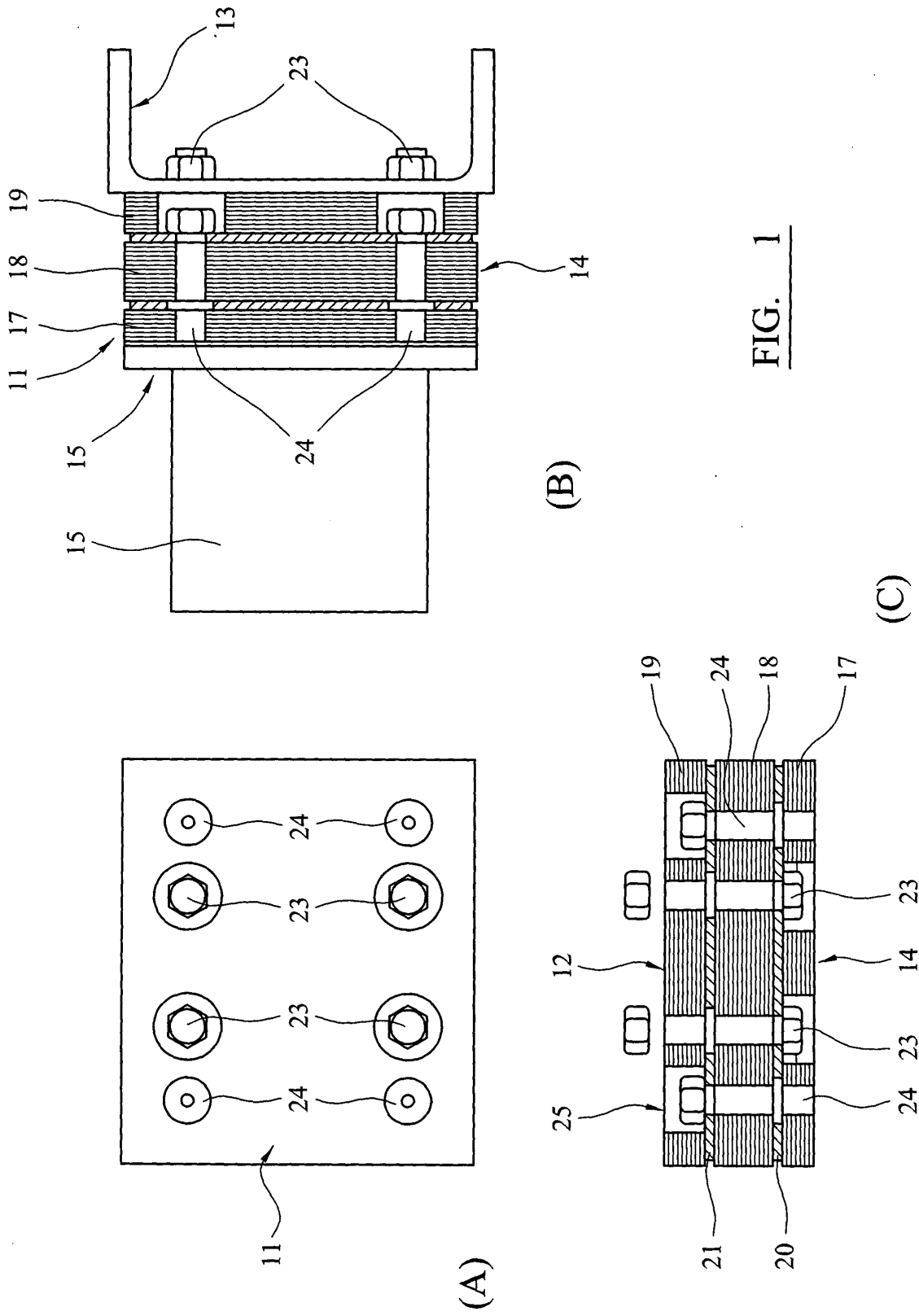
[0035] The connector sections 11 a, 11b are separated to suit the connection required and in this case to better support the cantilever loading of a structural element 15. A non structural insulating material 42 can be used to fill a gap 44 between the two sections 11a, 11 b to provide improved heat insulation. The connector sections 11a and 11b can together be considered to form part of a connector assembly.

Claims

1. A thermal break, wall-penetrating connector comprising a load transferring, heat insulating gasket having a first face adapted to be secured against a first heat conductive structural element and a second face adapted to be secured against a second such element with no heat conductive path between the first and second said elements.
2. A connector according to claim 1, in which the gasket comprises inner and outer insulating layers and structural layers intermediate the outer and inner insulating layers.
3. A connector according to claim 2, wherein the structural layers are made of steel.
4. A connector according to claim 1, 2 or 3, adapted to be secured against the first and/or the second heat conductive structural element by structural fixings.

5. A connector according to claim 4, in which the structural fixings are bolts.
6. A connector according to claim 4 or 5, in which the gasket comprises internal structural layers with captive structural fixings secured thereto to serve as means to secure the gasket to structural elements.
7. A connector according to claim 6, wherein the internal structural layers are made of steel.
8. A connector according to claim 6 or 7, in which the gasket comprises oversize holes for the structural fixings, leaving a gap between the fixings and any thermally conductive element they pass through, to thermally isolate the fixings.
9. A connector according to any one of claims 1 to 8, in which the gasket comprises insulating material comprising a resin-impregnated wood material.
10. A connector according to claim 9, in which the wood material is impregnated with phenolic resin.
11. A connector according to claim 9 or claim 10, in which the wood material is impregnated under vacuum conditions.
12. A connector according to any one of claims 9 to 11, in which the gasket comprises a load transferring insulating material comprising a resin-impregnated densified timber laminate.
13. A connector according to any one of claims 1 to 12, having a reinforcing bar projection adapted to be embedded in concrete.
14. A connector according to claim 13, in which the projection comprises at least one rod coupling nut for coupling the rod to the connector.
15. A connector assembly comprising:

at least one tensile connector adapted to be placed under tension, in use;
at least one compressive connector adapted to be placed under compression, in use; wherein the at least one tensile and at least one compressive connector each comprise a load transferring, insulating gasket having a first face adapted to be secured against a first conductive structural element and a second face adapted to be secured against a second such element with no conductive path between the first and second said elements.



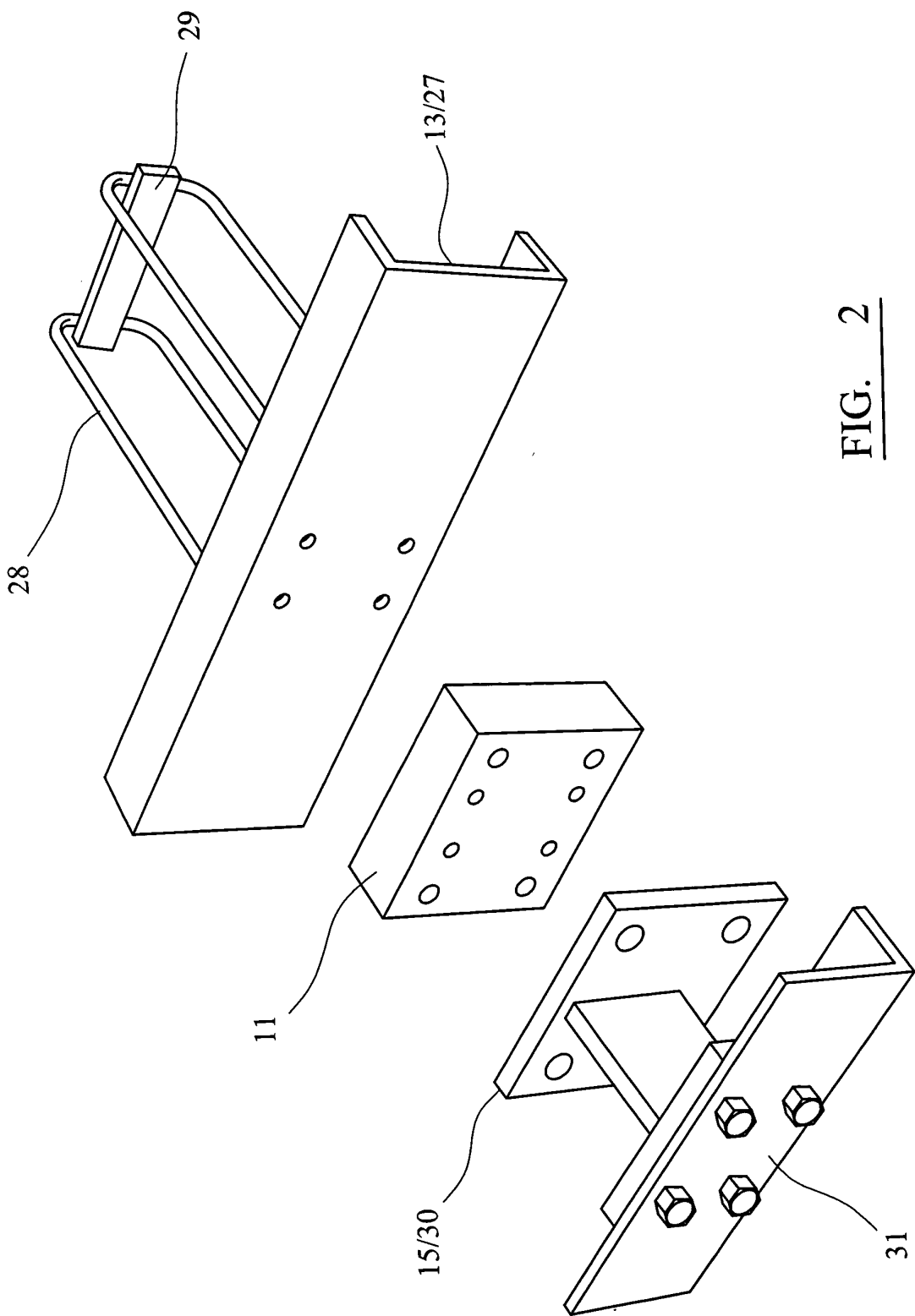


FIG. 2

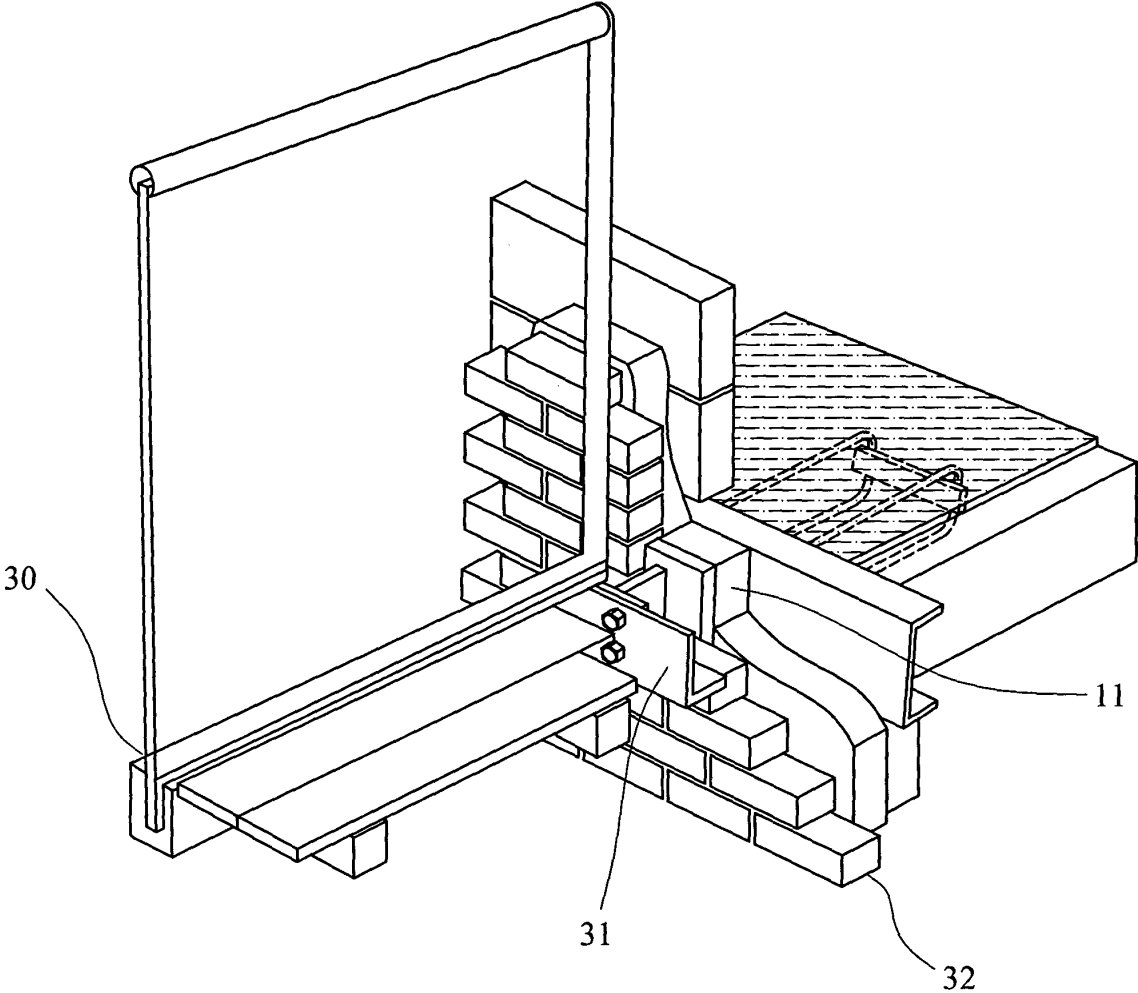


FIG. 3

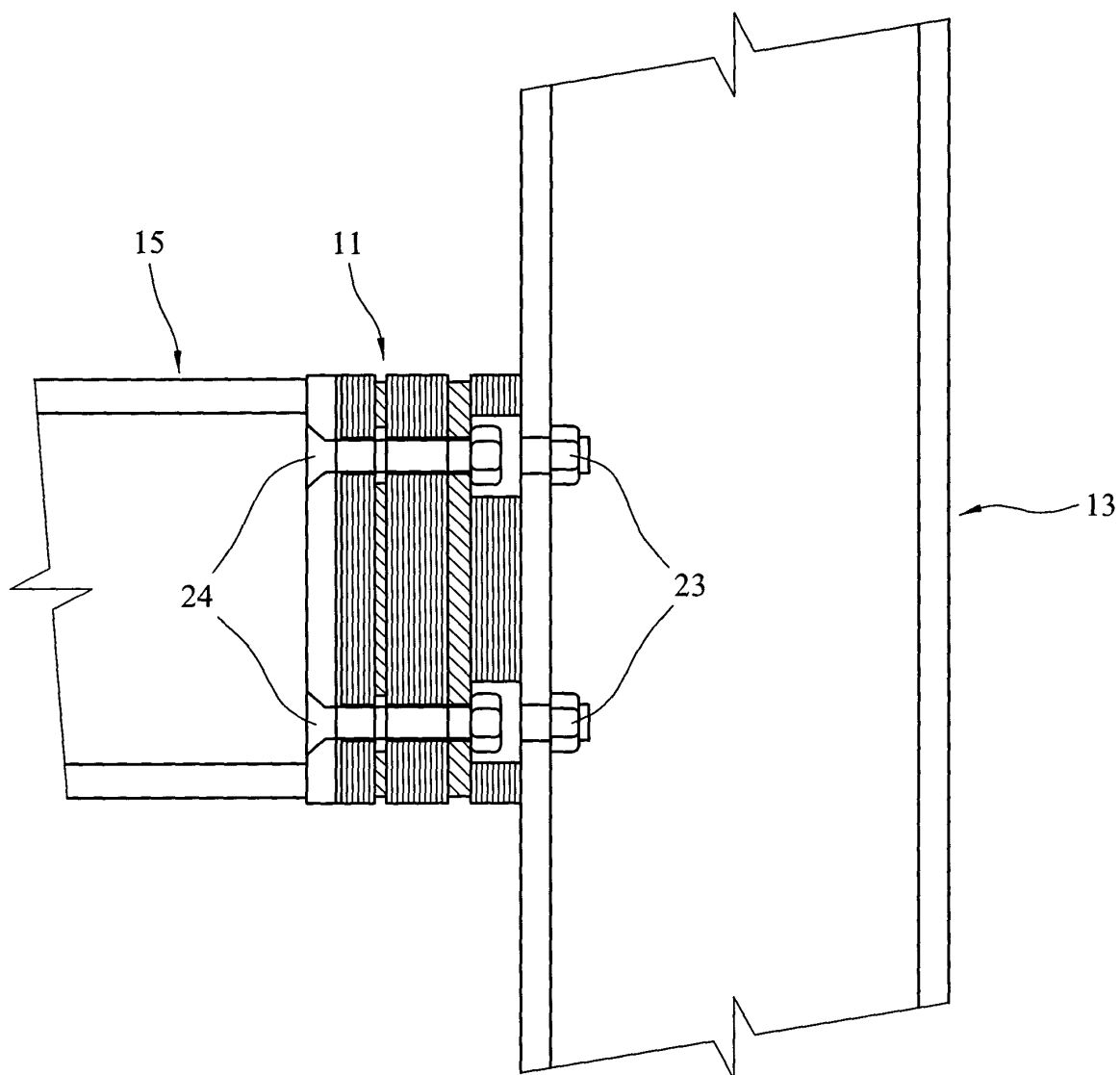
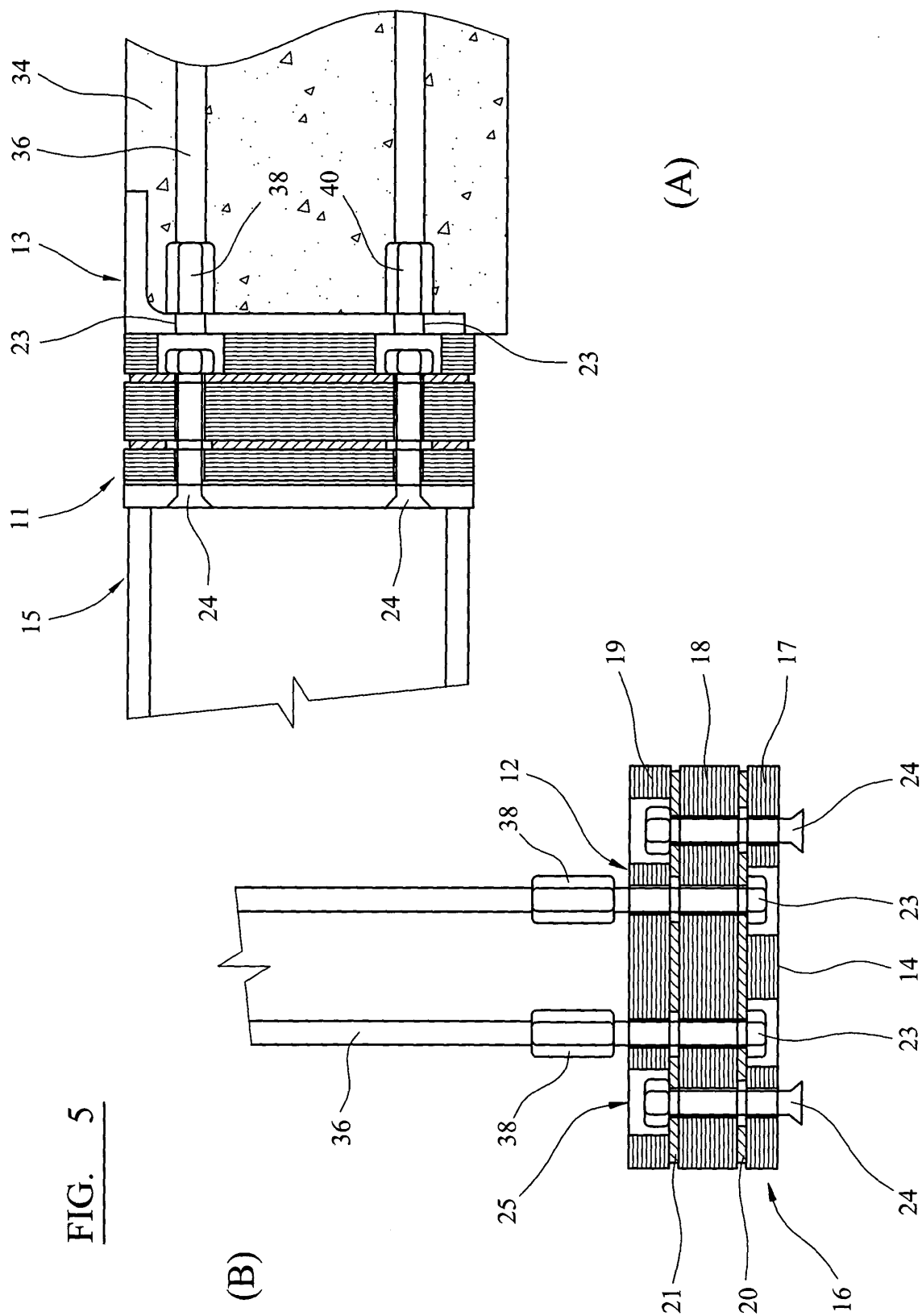


FIG. 4



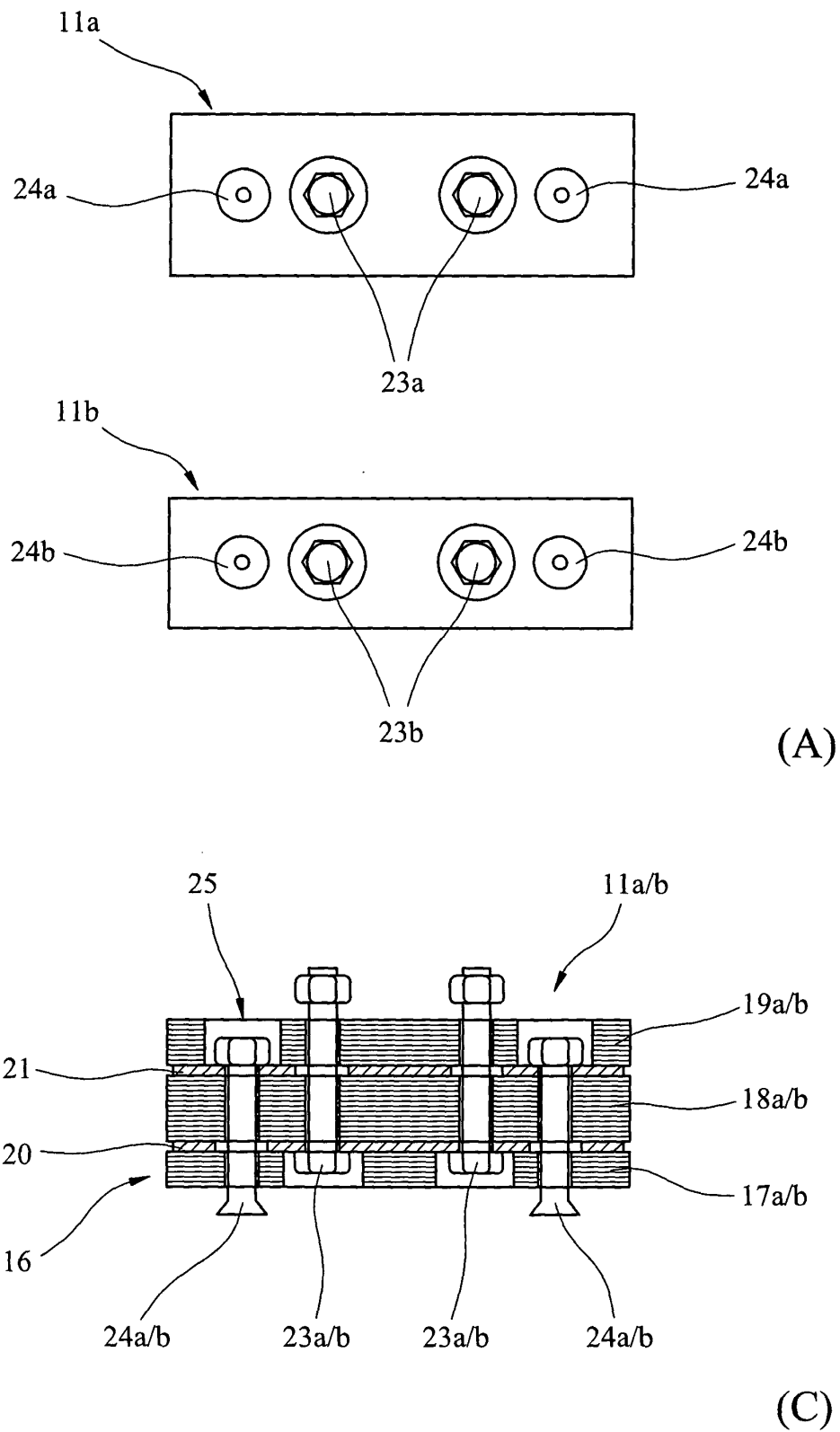
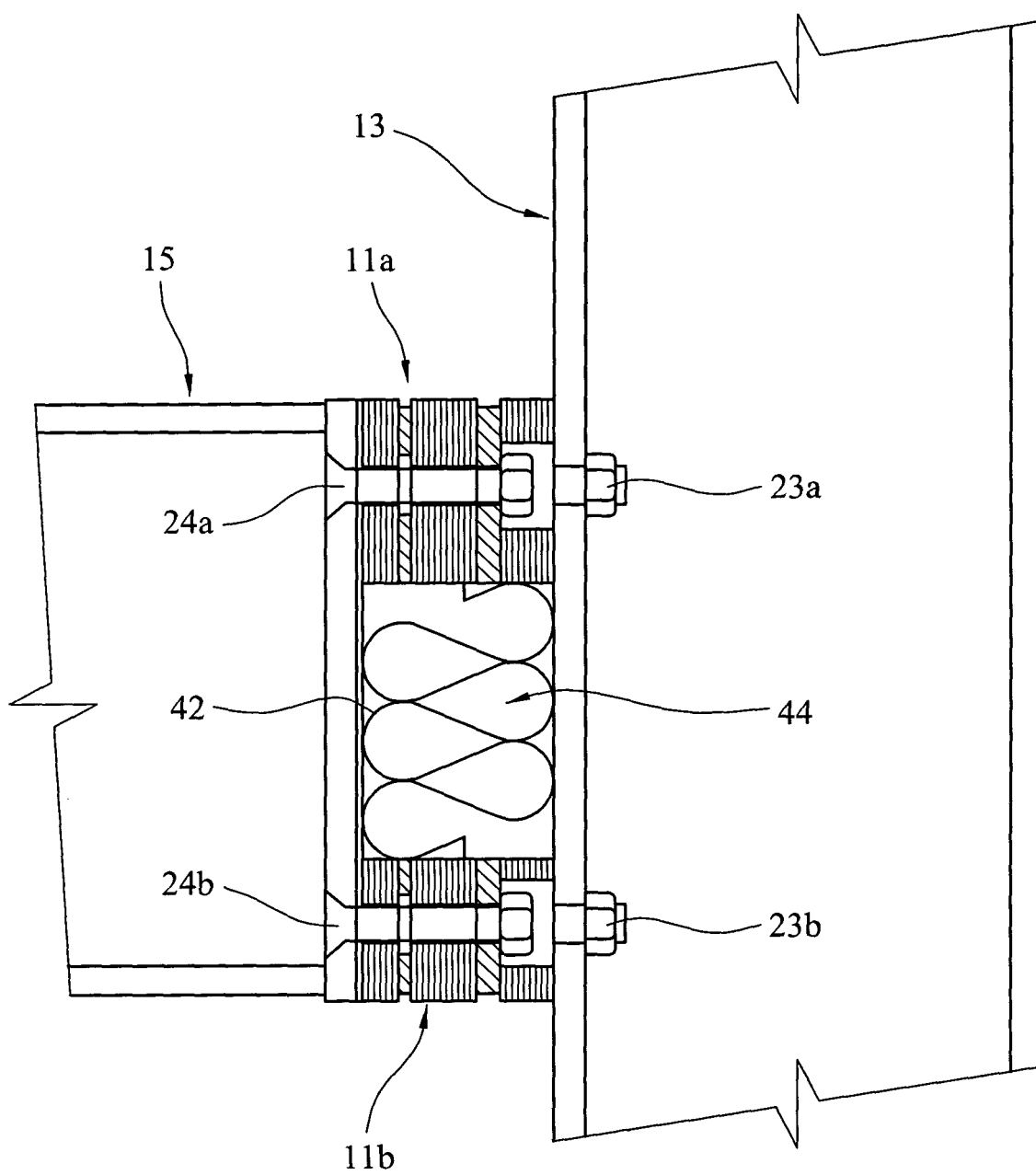


FIG. 6



(B)

FIG. 6