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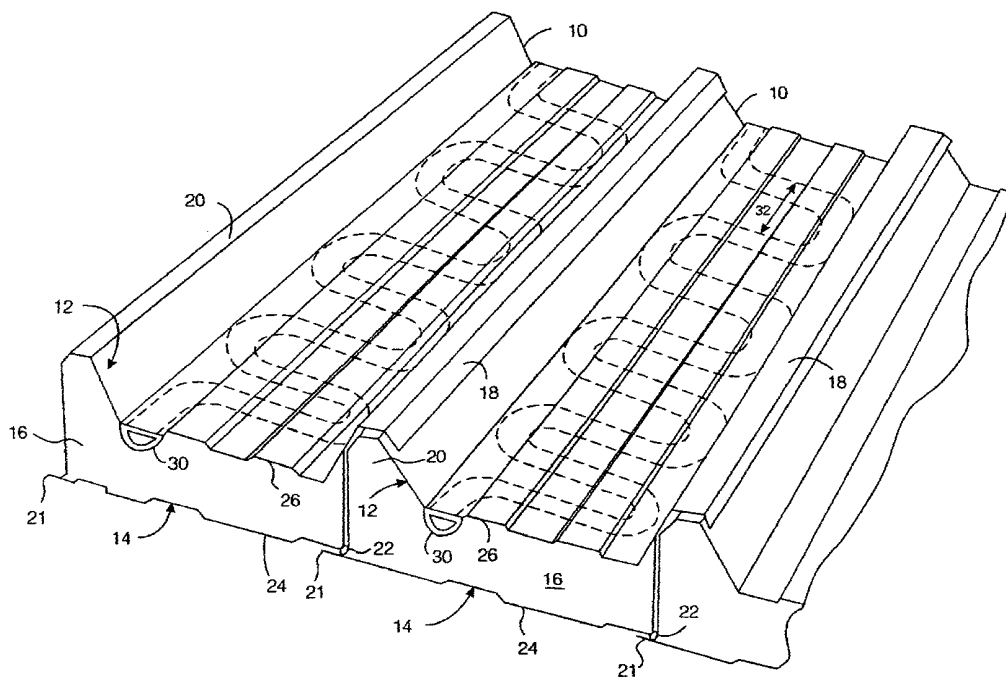
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(54) Title: BUILDING PANELS



(57) Abstract: Building panels (10) are provided, comprising a skin (12) and a conduit (30) in thermal contact with the skin (12). The conduit (30) may be used to convey a fluid for transferring heat to or from the building panel (10). The building panel (10) may be a roofing panel, a flooring panel, or a wall cladding panel, or may be used for constructing a ceiling.

## BUILDING PANELS

The present invention relates to the field of building panels, and in particular to building panels used to construct or clad roofs or walls. The present invention  
5 also relates to the field of solar panels.

Recent years have seen an increase in interest in the possibility of harnessing energy from the sun for use in heating, or otherwise. Typically, energy from the sun is  
10 absorbed by solar panels, which convert incident sunlight into a more convenient form of energy.

Solar panels may be classified into two basic groups. Electrical solar panels convert incident sunlight into  
15 electric current. Thermal solar panels convert incident sunlight into heat. Typically, a fluid such as water is heated by the sunlight and heat is then extracted from the fluid by a heat exchanger, for use in space heating, or heating a water supply, or for other heating  
20 applications. The present invention is concerned only with thermal solar panels.

Typically, a thermal solar panel comprises a number of conduit members, linked together to form a circuit for  
25 the circulation of fluid. The conduit members are coloured a dark colour, such as black, and are exposed to sunlight. Sunlight is absorbed by the conduit, which is thereby heated. A fluid circulating through the conduit carries the heat from the conduit to a heat exchanger,  
30 where the heat derived from the sunlight may be

extracted, for example for use in heating a building. Such solar panels are frequently placed on the roof of the building to be heated.

- 5 The solar panels placed on the roof are often unsightly, and their installation must be done after the roof is installed, adding to the cost of labour required in assembling the roof with solar panels.
- 10 Solar panels are typically manufactured in a limited range of standard sizes, and the number of solar panels which may be attached to any given roof will depend on the size of panel chosen, and on the construction of the roof. In any case, the solar panels will only be able to
- 15 cover a certain portion of the roof surface area, resulting in a loss of potentially useful solar energy incident on parts of the roof between the solar panels.

The present invention aims to provide a roof structure

20 including solar panels. The present invention also aims to provide solar panels which are simple to install. The present invention also aims to provide a solar panel and roof structure in which the solar panel occupies an increased proportion of the surface area of the roof, in

25 order to reduce the proportion of potentially useful solar energy which is lost through lack of coverage by solar panels. The present invention also aims to provide a solar panel which has no detrimental effect to the external appearance of the structure (eg roof) upon

30 which it is placed.

Accordingly, the invention provides a building panel comprising a first sheet member forming a first skin; and at least one conduit member for conveying a fluid, attached in thermal contact to an interior surface of the first skin.

An insulating material may cover exposed parts of the conduit member(s) and of the interior surface.

Preferably, a second sheet member forms a second skin, substantially parallel to the first skin, and is preferably insulated therefrom by the insulating material. The insulating material preferably substantially fills between the first and second skins. The insulating material preferably bonds the conduit to the first skin.

The conduit member(s) may comprise one or more of: flexible tubing; a plastic moulding; a metal, such as aluminium or copper; and a ceramic material.

The conduit member may comprise a trough, bonded at its edge to the first skin.

The conduit member(s) may each have a D-section outer surface, the flat portion of the D-section outer surface being in contact with interior surface of the first skin.

The conduit member(s) may have a cross-section of greater dimension in a direction parallel to the interior surface of the first skin than in a direction perpendicular to the interior surface of the first skin.

Panel interface means may be provided, whereby adjacent building panels may be secured together.

- 5     Conduit interface means may be provided, whereby a fluid-tight connection may be provided between conduit members of adjacent building panels, thereby to form a circuit for the conveyance of fluid.
- 10    A building panel according to the invention may be a roofing panel, a wall cladding panel, a flooring panel, or a ceiling panel.

15    In use, the first skin may be exposed to the exterior, or to the interior, of a building.

The present invention provides a roof structure comprising an array of building panels as described.

- 20    The present invention provides a solar panel, and a heating panel, each comprising at least one building panel as described.

25    The present invention provides a heating system comprising: at least one solar panel as described; means for circulating a fluid through the conduit member(s) of the solar panel(s), for heating the fluid; and heat exchanging means for extracting heat from the fluid.

- 30    Preferably, the heat exchanging means extracts heat from the fluid for space heating, or for heating water.

Preferably, the heat exchanging means comprises a radiator or a heating panel.

- 5 The present invention provides a heating system comprising means for providing a heated fluid; heat exchanging means comprising at least one heating panel as described; and means for circulating the heated fluid through the conduit member(s) of the heating panel(s).

10

The present invention provides a method of producing building panels comprising the steps of providing a first skin layer; and providing at least one conduit member in thermal contact with an interior surface of the first skin  
15 layer.

Preferably, the method further comprises providing an insulating material covering exposed parts of the conduit member(s) and the interior surface.

20

Preferably, the step of providing an insulating material comprises applying a chemical foam.

Preferably, the step of providing an insulating material  
25 also serves to bond the conduit to the first skin.

Preferably, the method further comprises providing a second skin layer, substantially parallel to the first, the insulating material substantially filling between the  
30 first and second skin layers.

In a method as described, the following steps are preferably performed in the following order: (a) providing a first skin layer; (b) providing a second skin layer, substantially parallel to the first; (c) providing at least one conduit member in thermal contact with an interior surface of the first skin layer; (d) substantially filling between the first and second skins with an insulating material which covers exposed parts of the conduit member(s) and the interior surface.

10

Preferably, the step of providing a first skin, and/or the step of providing a second skin comprise(s) rolling a sheet of steel or aluminium into a desired profile.

15 The step of providing at least one conduit member may comprise providing a flexible tubing or a plastic moulding, a metal tube or pressing, or a ceramic moulding.

The present invention provides a method for heating comprising: passing a fluid through at least one conduit member of a building panel according to any of claims 1-20; exposing the first skin to a source of heat; absorbing heat energy into the first skin and the conduit member(s), to heat the fluid; and extracting heat from the heated fluid by passing the heated fluid through a heat exchanging means.

The present invention provides a method for heating comprising: providing a heated fluid; and passing the heated fluid through a heat exchanging means comprising at least one conduit member of a building panel as described.

Such methods may further comprise the step of insulating the conduit member(s) by embedding the conduit member(s) in an insulating material, other than where the conduit member(s) contact the interior surface of the first skin.

The source of heat may be natural light, ultra violet light or infra-red light.

The present invention provides a building panel comprising a first skin, a second skin and thermally insulating material substantially filling a space between first and second skins, characterised in that the building panel further comprises a conduit member, which is attached in thermal contact with an interior surface of the first skin, and which is otherwise substantially embedded in the thermally insulating material.

The conduit member is preferably attached by the thermally insulating material.

The present invention provides a kit or a combination of parts for cladding a wall, or constructing a roof, floor or ceiling comprising at least one of each of: a first skin; a thermally insulating material; and a conduit member, for attachment in thermal contact with an interior surface of the first skin, and for otherwise being substantially embedded in the thermally insulating material.

The conduit member is preferably for attachment by the thermally insulating material.

The kit or combination of parts may further comprise a second skin for placement in a substantially parallel arrangement with respect to the first skin, with the  
5 thermally insulating material substantially filling a space between first and second skins.

The kit or combination of parts may further comprise means for linking together conduit members.

10

The present invention provides a kit or a combination of parts for constructing a heating system comprising: a kit or a combination of parts for constructing a roof, as described; circulating means for causing a fluid to  
15 circulate through the conduit; and heat exchanging means for extracting heat from the fluid.

The present invention provides a kit or a combination of parts for constructing a heating system comprising: means  
20 for providing heated fluid; a kit or a combination of parts for cladding a wall or constructing a floor or ceiling, as described, so as to provide heat exchanging means for extracting heat from the fluid; and circulating means for causing a fluid to circulate through the  
25 conduit.

The kit or combination of parts preferably further comprises means for joining together conduit means to form a circuit for the circulation of the fluid.

30

The fluid is preferably a liquid.

Certain embodiments of the invention will be described, by way of examples only, with reference to the accompanying drawings in which:

5 Fig. 1 shows a roof structure according to an embodiment of the present invention;

Fig. 2 shows a roof structure comprising roofing panels according to embodiments of the present invention; and

10

Figs. 3A to 3C show cross sections of roofing panels according to embodiments of the present invention.

Fig. 4 shows a wall cladding or flooring structure  
15 according to an embodiment of the present invention;

Fig. 5 shows a wall cladding or flooring structure comprising wall cladding or flooring panels according to embodiments of the present invention; and

20

Figs. 6A to 6B show cross sections of wall cladding or flooring panels according to embodiments of the present invention.

25 Composite building panels are well known and common in the building industry. Typically, a composite building panel will comprise an exterior skin layer which will form the outer surface of the roof, wall or floor structure. The exterior skin is bonded to a layer of  
30 insulating material which will, for example, serve to insulate the interior of a building from external

temperature. This layer is particularly important, as the exterior skin layer is typically made of a thermally conductive material such as steel or aluminium.

5 Such composite building panels may be further provided with an interior skin layer, typically an aluminium or steel layer which is thinner than the exterior skin layer. Vapour blocking means are also preferably provided in a roof, wall or floor structure, to prevent  
10 water vapour from inside the roofed building from soaking the insulating material, rendering it ineffective, and heavy. In the case of roofing panels or wall cladding panels, the vapour blocking means is necessary to prevent water vapour from reaching the external skin layer,  
15 condensing on contact with a cooler external skin layer, and dripping back into the building.

In production, the exterior skin layer is typically formed by rolling a sheet of aluminium or steel into a  
20 desired profile, and a chemical foam is then applied, which bonds to an interior surface of the exterior skin layer. Accordingly, such building panels are typically formed in lengths of up to 10m. Exceptionally, very long lengths of up to 30-40 metres may be produced. The  
25 building panels may be cut to the size required for covering a particular roof, wall, floor or ceiling structure.

Fig. 1 shows a roofing structure according to an aspect  
30 of the present invention, comprising roofing panels 10 according to an embodiment of another aspect of the

present invention. The roofing panels each comprise an exterior skin 12, an interior skin 14 and an insulating material 16 substantially filling the space between the interior and exterior skins. As is conventional, each building panel includes an overlapping portion 18, arranged to fit over a ridge 20 of an adjacent building panel, to prevent ingress of rainwater. Overlapping portions 21 and sealant 22 may be provided in conjunction with the interior skin, to provide the required vapour barrier. The inner and outer skins may include ridges 24, 26 of various heights and pitch, to provide strength to the roofing panel.

According to an aspect of the present invention, a fluid conveying conduit 30 is provided in thermal contact with the external skin 12. The conduit is provided in thermal contact with an internal surface of the external skin 12, and is embedded in the insulating material 16 on all surfaces other than where the conduit is in contact with the exterior skin.

As shown in Fig. 1, the conduit may be formed in a serpentine fashion, preferably at a fixed pitch 32. The conduit 30 may comprise a flexible hose, made of rubber or plastic or the like. The conduit may alternatively be of metal, such as aluminium or copper, ceramics or any suitable, thermally conductive material. The conduit is preferably introduced during manufacture of the roofing panel, by laying the conduit in serpentine pattern on the interior surface of the external skin, prior to applying the insulating material 16 over the top, which may serve

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both to form the insulating layer and to bond the conduit to the exterior skin. Care should be taken to avoid ingress of insulating material 16 between the conduit 30 and the exterior skin 12, as the conduit should be in thermal contact with the exterior skin. Alternatively, the conduit may be glued, or heat bonded, to the external skin before the insulating material is applied.

The conduit may be formed as an open trough, with edges bonded to the exterior skin 12, to form a closed conduit.

The presence of the interior skin layer 24 is optional. The invention may also be applied to building panels which do not include an interior skin layer 14.

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The serpentine layout of the conduit may be achieved automatically by a mechanical feed of flexible hose, laying the hose on the exterior skin after the roll forming operations are complete.

20

Fig. 2 illustrates further embodiments of the present invention. Roof panel 40 is constructed in a similar fashion as roof panels 10 of Fig. 1. However, the conduit here comprises a number of parallel sections 42 of conduit. This embodiment may be simpler to manufacture, as no serpentine or other particular layout of conduit needs to be formed. A corresponding number of reels of conduit may be provided, to lay conduit onto the interior surface of the exterior skin layer 12, as the exterior skin later is formed, and prior to addition of the insulating material 16. Again, the conduit may be

25  
30

attached to the exterior skin by the insulating material, or by gluing, or by heat bonding.

Roof panel 50 is constructed in a similar fashion as roof panels 10 of Fig. 1. However, the conduit here forms a serpentine structure 52 comprising parallel sections running the length of the roofing panel, joined by curved sections 54 of the conduit. For reasons which will become more apparent in the following discussion, each end of the conduit preferably terminates in a corresponding position across the width of the roofing panel.

The roofing panels of the present invention may be assembled to form a roof structure, having an integral solar panel.

While alternative forms of roofing panel discussed with reference to Figs 1, 2 differ in respect of the layout of the conduit, forms of conduit are illustrated in Figs. 3A to 3C.

In Fig. 3A, a roof panel is illustrated which includes conduit comprising D-section tubing. This may be flexible tubing, made of rubber or of a suitable plastics material. It may alternatively be of metal, such as aluminium or copper, ceramics or any suitable, thermally conductive material. The choice of D-section tubing, with its flat surface placed in thermal contact with the exterior skin 12, has the following advantages. The flat surface ensures that the conduit is in thermal contact

with the exterior skin over a significant portion of its surface area. This improves the efficiency of thermal conduction from the exterior skin, heated by sunlight, to a fluid which is circulated in the conduit. The curved surface of the D-section tubing provides a convenient contour for the formation of insulating material 16. The insulating material can easily conform to the shape of the curved surface of the D-section tubing, without leaving any air gaps. Air gaps could lead to a loss in received solar energy, by heat being carried away by air currents, or may provide cavities in which water may collect, to the detriment of the insulating material 16, and the efficiency of the heat transfer between the exterior skin and the fluid circulating within the conduit. The curved surface of the D-section tubing also provides resistance to crushing by expanding foam insulation 16.

The D-section conduit may be provided by a U-section trough, having its edges bonded to the exterior skin layer 12. This would ensure maximum thermal conduction between the exterior skin layer 12 and a fluid in the conduit, but may involve an increased risk of leaking fluid.

Other forms of conduit may also be suitable. For example, a triangular section conduit may also provide the advantages of significant surface area in contact with the exterior skin layer 12, while also providing crush resistance.

Alternative forms of conduit are generally less suitable, but may be acceptable in certain circumstances. For example, round-section tubing may be the simplest type of conduit to use, as there is no problem in aligning any particular surface of the conduit with the exterior skin. However, the proportion of the surface area of the conduit which is actually in contact with the exterior skin is relatively small.

Rectangular section tubing, with its wider surface placed in thermal contact with the exterior skin 12, may have the following advantages. The rectangular section allows a conduit of reduced maximum thickness to be used, as compared to the D-section tubing. Assuming that a certain minimum thickness of insulating material 16 must be provided between the conduit and the interior skin 14, use of such rectangular section tubing will allow roofing panels of reduced overall thickness to be produced, as compared with roofing panels incorporating D-section tubing. The wider surface in contact with the exterior skin ensures that the conduit is in thermal contact with the exterior skin over a significant portion of its surface area. This improves the efficiency of thermal conduction from the exterior skin, heated by sunlight, for example, to a fluid which is circulated in the conduit. The rectangular section may be significantly wider than it is deep, meaning that a given unit volume of fluid in the conduit is in thermal contact with a greater surface area of the exterior skin than in the cases where D-section tubing 30b or round section tubing 30a is used. A reduced thickness of the rectangular

section conduit should provide a relatively convenient contour for the formation of insulating material 16, which should be able to conform to the shape of the conduit without leaving any air gaps. However,  
5 rectangular section tubing may be crushed by an expanding foam insulation layer 16, if used.

Rectangular section conduit and D-section tubing may be difficult to form into tight bends. These types of  
10 conduit may be most suited to embodiments where few, if any, curved sections are required, such as the embodiments shown in Fig. 2.

The roofing panel will be attached to a roof structure  
15 using fastenings 56, such as nails, screws, bolts or the like. Care must be taken not to pass such fastenings through the conduit. This could be done by designating part of the panel as a fastening area, and keeping that clear of conduit, or by indicating the location of the  
20 conduit on the external surface of the exterior panel, so as to be recognisable by an installer. This would be simplest in a panel such as 40, where ridges in the exterior skin could be used to indicate the location of the conduit.

25

In Fig. 3B, another roof panel is illustrated which includes conduit comprising D-section tubing. This roofing panel will be attached to a roof structure using fastenings 56, such as nails, screws, bolts or the like.  
30 Care must be taken not to pass such fastenings through the conduit. In this embodiment, the fastenings 56 are

all passed through ridges 20. The ridges 20 are kept clear of conduit, and it is easy to identify the ridges when installing the roofing panel, and to avoid piercing the conduit with the fasteners 56. Such an arrangement  
5 could be applied to any of the embodiments shown in Figs. 1, 2, and may correspond to those embodiments as illustrated.

Fig. 3C shows an embodiment of the invention where the  
10 conduit is formed of a specially produced moulding, such as of a plastics material. The moulding may be produced by injection moulding, and may be produced in one or more parts. The moulding can be specifically designed to optimise heat transfer from the external skin to the  
15 fluid conveyed in the conduit by maximising the proportion of the external skin which is in contact with the conduit. In the illustrated embodiment, the moulding comprises differently shaped conduit sections 30d, 30d', depending on whether the conduit section is to contact a  
20 flat part of the exterior skin (30d), or a ridge in the exterior skin (30d'). It may be advantageous to design a moulding comprising conduit sections, which covers substantially all of the surface area of the exterior skin. In a roofing panel comprising such a moulding, the  
25 insulating material 16 may contact the exterior skin at few, if any, locations. Therefore, the moulding would need to be securely bonded to the exterior skin, and the insulating material must be securely bonded to the moulding. The conduit sections 30d and 30d' preferably  
30 comprise a curved surface, to increase their resistance to crushing by an expanding foam insulation.

When the building panels are assembled to form a structure such as a roof structure, the various panels will need to be joined to the structure, and the conduits  
5 in each panel will need to be linked together to form a circuit for the conveyance of fluid.

For example, the conduits of adjacent roofing panels may be joined together using a moulded plastic connector,  
10 suitably shaped and sized to fit snugly into the conduit portions of adjacent roofing panels. Figs. 7A, 7B illustrate a possible arrangement in which such a moulded plastic connector 62 is used to join two roofing panels placed end to end. The connector is externally  
15 dimensioned so as to snugly fit inside the conduit 30, to form a fluid-tight seal. The connector 62 should have a wall thickness sufficient to ensure the required mechanical strength and durability, but the walls should not be so thick that the circulation of fluid in the  
20 conduit 30 is unduly impeded. The connector 62 may have a projection 63 approximately midway along its length, to ensure that a sufficient length of connector is present inside the conduit 30 on either side. The projection may be accommodated in a recess caused by the conduit  
25 sections 30 ending slightly short of the end of the building panel. Preferably, the external skin 12 of one panel is extended and offset so as to overlap the external skin of the adjacent panel, helping to form a weathertight seal.

30

Fig. 8A shows, in plan view, a connector 62 in use,

connecting together conduit members 30 of building panels 10, 10', as shown in Fig. 1, joined end to end. Fig. 8A also shows building panels 40, 40', as shown in Fig. 2, having conduit members 42 joined together with a  
5 connector 64. Connector 64 may be composed of a number of connectors 62. Alternatively, a single connector 64 may be provided, having a number of connecting pieces corresponding to the number of conduit members 42 per panel, each shaped to fit inside the relevant conduit  
10 member 42. The projection 63 of connector 62 may be enlarged to link the connecting pieces of connector 64 together at the appropriate pitch.

Fig. 7 illustrates a possible arrangement in which a  
15 moulded plastic connector 62 is used to join together the conduit parts in adjacent roofing panels. The connector 66 is externally dimensioned so as to snugly fit inside the conduit 30, to form a fluid-tight seal. The connector 66 should have a wall thickness sufficient to  
20 ensure the required mechanical strength and durability, but the walls should not be so thick that the circulation of fluid in the conduit 30 is unduly impeded. The connector 66 may have a projection 63 located so as to ensure that an appropriate length of connector is present  
25 inside the conduit 30 at either end. The projection may be accommodated in a recess caused by the conduit sections 30 ending slightly short of the end of the building panel. Fig. 8A shows combinations of building panels, having their respective conduits connected  
30 together by connectors 62, 64.

Panels 10, 10', as illustrated in Fig.1 may have their conduits joined together by connectors 62, as shown in Fig.7.

5 Panels 40, 40' as illustrated in Fig.2 may have their conduits joined together using a plurality of connectors 62 as shown in Fig.7. Alternatively, a single connector 64 may be used, to connect all the required conduits. The connector 64 may resemble a number of connectors 62,  
10 whose projections 63 have been extended such that they join.

Fig.8B shows use of a connector 66, with projections 67, for joining conduits of two building panels placed side  
15 by side. Each end of connector 66 resembles one half of connector 62 and a tube is incorporated linking the ends.

In a panel such as shown at 40 in Fig. 2, connectors such as 66 (having projections 67) may be used to join  
20 together conduit members 42 of a same panel, as well as conduit members of adjacent panels.

Some roofing structures may not require panels to be placed end to end. The panels may be long enough that  
25 the roof is to be constructed of panels laid side by side. In such a construction, there is only a requirement that the conduits of the adjacent panels be joined to each other, such as discussed above in relation to Fig. 8. Such connectors 66 may be unsightly, and may  
30 be concealed under ridge coving, or guttering, at ends of the roofing panels.

Figs.9, 10 illustrate a further embodiment of roofing panels according to the present invention. Within each panel, parallel sections 74 of conduit run in the direction of the length of the panel, over most if its length. Towards each end of the roofing panel, a manifold 72 runs across the width of the panel. Each of the conduit sections 74 is connected between the manifolds 72. In use, a fluid is introduced into one manifold, the inlet manifold (typically the lower manifold, when the building panel is not used in a horizontal orientation). The liquid flows through the manifold into the conduit sections 74, where the liquid exchanges heat with the exterior skin 12. The liquid then flows into the other (outlet) manifold, either by convection of heated liquid, or under the influence of a pump. The liquid is then extracted from the panel.

Fig.10 illustrates the assembly of manifolds 72 and conduit sections 74, out of the building panel. While the conduit sections 74 are preferably formed with a D-cross-section, the manifolds 72 may have other cross-sections.

The manifolds 72 will be exposed at the edges of the building panel, and manifolds of adjacent building panels may be connected together by connectors 62, such as that illustrated in Fig. 7.

At edges of the roof structure, the manifolds 72 would need to be either blocked, other than where fluid is

introduced or evacuated, or linked to manifolds of the same type (inlet or outlet) of other groups of panels.

The roofing panels are preferably connected together such  
5 that their conduits form one or more fluid circuits for the conveyance of fluid.

A pump <sup>or</sup> ~~or~~ other means for circulating fluid is provided,  
along with a heat exchanger, to complete a solar heating  
10 system according to an aspect of the present invention.

Natural light (sunlight), ultra-violet light, infra-red light or heat from a heating source, incident on the exterior skin heats the exterior skin, which is  
15 preferably dark coloured, or black. Heat from the exterior skin is then conducted through the wall of the conduit to the fluid being conveyed through the conduit. The heated fluid is then conveyed to the heat exchanger, where the heat is extracted to provide space heating, for  
20 example, or to heat water, or for other uses at the option of the owner.

According to another aspect of the present invention, wall panels and floor panels and ceiling panels are  
25 provided with integral heating means.

Fig. 4 shows an assembly of wall, ceiling, or flooring panels 110 according to further aspects of the present invention. Wall and floor panels should not have high  
30 ridges such as those (20) shown in relation to the roofing panels of figs 1-3. The exterior skin should be

substantially planar, but may include ridges or other texture, for aesthetic reasons, to impart rigidity to the wall or flooring panel, or to increase grip for persons walking on flooring panels. Overlaps are again provided,  
5 and seals may be provided against the ingress of liquids.

As discussed in relation to roofing panels, the wall, ceiling or flooring panels of the present invention include a conduit 30, in thermal contact with the  
10 exterior skin 12. Insulating material 16 encloses the conduit on all surfaces other than those in contact with the exterior skin.

Although Fig. 4 shows an embodiment of a floor, wall or  
15 ceiling panel of the invention, modifications may be made similar to those illustrated in Figs 2-3, 9-10 in respect of roofing panels. For example, Fig. 5 illustrates floor panels 140, 150 according to further embodiments of the invention, which resemble the roofing panels 40, 50 of  
20 Fig. 2.

Figs. 6A, 6B show cross sections of flooring, wall or ceiling panels according to the present invention. For flooring or wall panels, it is undesirable to have  
25 fixings which protrude above the surface of the exterior skin. This is particularly important in the case of flooring panels. Therefore, recesses 57 may be formed in the exterior skin, for receiving the heads of fixings 56. By forming these recesses during manufacture of the  
30 flooring or wall panels, they can be aligned with gaps between the conduit 30, so that during installation one

can be sure that a fastener 56 penetrating the wall or floor panel through these recesses 57 will not damage a conduit within the panel.

5 The panels should be linked together so that the conduits of all the panels form one or more circuits for the conveyance of fluid. They may be joined by similar means to those illustrated in Figs. 7, 8A, 8B in relation to roofing panels.

10

In contrast to the roofing panels, the wall, ceiling and flooring panels of the present invention are useful as radiators, or heating panels. Fluid heated by a heating source, which may be solar panels incorporated into roofing panels according to the present invention, is  
15 conveyed through the conduit. Heat from the heated fluid is conducted through the wall of the conduit to heat the exterior skin, which itself heats the surrounding atmosphere, or any articles in contact with the exterior  
20 skin.

Ceiling panels as described could be used to provide heating at ceiling level.

25 The building panels of the present invention could also be assembled together to form a solar panel which does not form a part of a building structure.

Although the solar panels and roofing panels have been  
30 described with reference to the absorption of natural light to provide the required heating, it should be noted

that the building panels of the present invention can also be used to extract heat energy when supplied with heating radiation other than natural light, for example ultra violet light or heat sources which may emit infra-  
5 red light or may transfer heat by convection, radiation or conduction.

**CLAIMS**

1. A building panel comprising:
  - a first sheet member forming a first skin; and
  - 5       - at least one conduit member for conveying a fluid, attached in thermal contact to an interior surface of the first skin.
2. A building panel according to claim 1 wherein an  
10       insulating material covers exposed parts of the conduit member(s) and of the interior surface.
3. A building panel according to claim 2 further comprising a second sheet member forming a second skin,  
15       substantially parallel to the first skin, and insulated therefrom by the insulating material.
4. A building panel according to claim 3, wherein the  
20       insulating material substantially fills between the first and second skins.
5. A building panel according to any of claims 2-4 wherein the insulating material also bonds the conduit to the first skin.  
25
6. A building panel according to any preceding claim wherein the conduit member(s) comprise(s) flexible tubing.
- 30 7. A building panel according to any of claims 1-6 wherein the conduit member(s) comprise(s) a plastic

moulding.

8. A building panel according to any of claims 1-6 wherein the conduit member(s) comprise(s) a metal, such as aluminium or copper.

9. A building panel according to any of claims 1-6 wherein the conduit member(s) comprise(s) a ceramic material.

10

10. A building panel according to any preceding claim, wherein the conduit member comprises a trough, bonded at its edge to the first skin.

11. A building panel according to any preceding claim wherein each conduit member has a D-section outer surface, the flat portion of the D-section outer surface being in contact with interior surface of the first skin.

12. A building panel according to any preceding claim wherein the conduit member(s) has/have a cross-section of greater dimension in a direction parallel to the interior surface of the first skin than in a direction perpendicular to the interior surface of the first skin.

25

13. A building panel according to any preceding claim, provided with panel interface means whereby adjacent building panels may be secured together.

14. A building panel according to any preceding claim, provided with conduit interface means whereby a fluid-

tight connection may be provided between conduit members of adjacent building panels, thereby to form a circuit for the conveyance of fluid.

5 15. A building panel according to any preceding claim, being a roofing panel.

16. A building panel according to any of claims 1-14, being a wall cladding panel.

10

17. A building panel according to any of claims 1-14, being a flooring panel.

15

18. A building panel according to any of claims 1-14, being a ceiling panel.

19. A building panel according to any of claims 1-18 in which the first skin is exposed, in use, to the exterior of a building.

20

20. A building panel according to any of claims 1-18 in which the first skin is thermally exposed, in use, to the interior of a building.

25

21. A roof structure comprising an array of building panels according to any of claims 1-15 or 19-20.

22. A solar panel comprising at least one building panel according to any of claims 1-15 or 19.

30

23. A heating panel comprising at least one building

panel according to any of claims 1-14, 16-18 or 20.

24. A heating system comprising:

- at least one solar panel according to claim 22;
- 5        - means for circulating a fluid through the conduit member(s) of the solar panel(s), for heating the fluid; and
- heat exchanging means for extracting heat from the fluid.

10

25. A heating system according to claim 24 wherein the heat exchanging means extracts heat from the fluid for space heating, or for heating water.

15    26. A heating system according to claim 24 or 25 wherein the heat exchanging means comprises a radiator or a heating panel.

27. A heating system comprising:

- 20        - means for providing a heated fluid;
- heat exchanging means comprising at least one heating panel according to claim 23; and
- means for circulating the heated fluid through the conduit member(s) of the heating panel(s).

25

28. A method of producing building panels comprising the steps of:

- providing a first skin layer; and
  - providing at least one conduit member in
- 30    thermal contact with an interior surface of the first skin layer.

29. A method according to claim 28 further comprising:

- providing an insulating material covering exposed parts of the conduit member(s) and the interior surface.

5

30. A method according to claim 29 wherein the step of providing an insulating material comprises applying a chemical foam.

10 31. A method according to any of claims 29-30 wherein providing an insulating material also serves to bond the conduit to the first skin.

15 32. A method according to any of claims 29-31, further comprising:

providing a second skin layer, substantially parallel to the first, the insulating material substantially filling between the first and second skin layers.

20

33. A method according to claim 32, in which the following steps are performed in the following order:

(a) providing a first skin layer;

25 (b) providing a second skin layer, substantially parallel to the first;

(c) providing at least one conduit member in thermal contact with an interior surface of the first skin layer;

30 (d) substantially filling between the first and second skins with an insulating material which covers exposed parts of the conduit member(s) and the interior

surface.

34. A method according to any of claims 28-33 wherein the step of providing a first skin, and/or the step of providing a second skin comprise(s) rolling a sheet of steel or aluminium into a desired profile.

35. A method according to any of claims 28-34 wherein the step of providing at least one conduit member comprises providing a flexible tubing or a plastic moulding, a metal tube or pressing, or a ceramic moulding.

36. A method for heating comprising:

- passing a fluid through at least one conduit member of a building panel according to any of claims 1-20;
- exposing the first skin to a source of heat;
- absorbing heat energy into the first skin and the conduit member(s), to heat the fluid; and
- extracting heat from the heated fluid by passing the heated fluid through a heat exchanging means.

37. A method for heating comprising:

- providing a heated fluid; and
- passing the heated fluid through a heat exchanging means comprising at least one conduit member of a building panel according to any of claims 1-20.

38. A method according to any of claims 36-37 further comprising the step of insulating the conduit member(s) by embedding the conduit member(s) in an insulating

material, other than where the conduit member(s) contact the interior surface of the first skin.

39. A method according to any of claims 36-38 wherein  
5 the source of heat is natural light, ultra violet light or infra-red light.

40. A building panel comprising a first skin, a second skin and thermally insulating material substantially  
10 filling a space between first and second skins, characterised in that the building panel further comprises a conduit member, which is attached in thermal contact with an interior surface of the first skin, and which is otherwise substantially embedded in the  
15 thermally insulating material.

41. A building panel according to claim 40 wherein the conduit member is attached by the thermally insulating material.

20

42. A kit or a combination of parts for cladding a wall, or constructing a roof, floor or ceiling comprising at least one of each of:

- a first skin;
- 25 - a thermally insulating material; and
- a conduit member, for attachment in thermal contact with an interior surface of the first skin, and for otherwise being substantially embedded in the thermally insulating material.

30

43. A kit or combination of parts according to claim 42

wherein the conduit member is for attachment by the thermally insulating material.

44. A kit or combination of parts for cladding a wall,  
5 or constructing a roof, floor or ceiling, according to claim 42 or claim 43, further comprising a second skin for placement in a substantially parallel arrangement with respect to the first skin, with the thermally insulating material substantially filling a space between  
10 first and second skins.

45. A kit or combination of parts for cladding a wall, or constructing a roof, floor or ceiling, according to any of claims 42-44 further comprising means for linking  
15 together conduit members.

46. A kit or a combination of parts for constructing a heating system comprising:

- a kit or a combination of parts for constructing a roof, according to any of claims 42-45;
- 20 - circulating means for causing a fluid to circulate through the conduit; and
- heat exchanging means for extracting heat from the fluid.

25 47. A kit or a combination of parts for constructing a heating system comprising:

- means for providing heated fluid;
- a kit or a combination of parts, according to any of claims 42-45, for cladding a wall, or constructing  
30 a floor or ceiling so as to provide heat exchanging means for extracting heat from the fluid; and

- circulating means for causing a fluid to circulate through the conduit.

48. A kit or combination of parts according to any of  
5 claims 42-45 further comprising means for joining  
together conduit means to form a circuit for the  
circulation of the fluid.

49. A building panel, method, kit or combination of  
10 parts according to any preceding claim wherein the fluid  
is a liquid.

50. A building panel, or a heating system, or a method  
for heating, or a method of producing building panels, or  
15 a kit or combination of parts, each substantially as  
respectively described with reference to and/or as shown  
in the accompanying drawings.

1/10

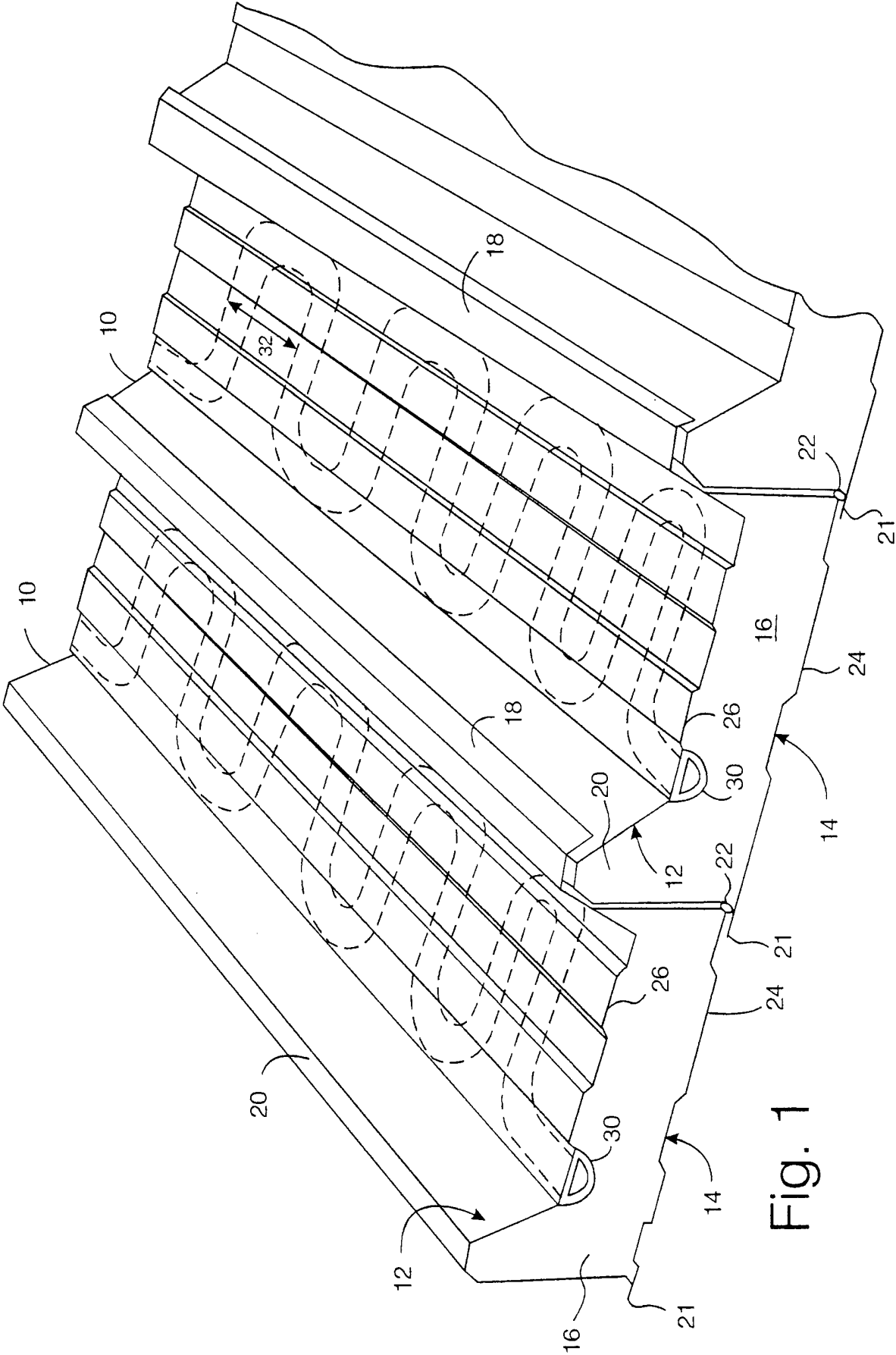


Fig. 1

2/10

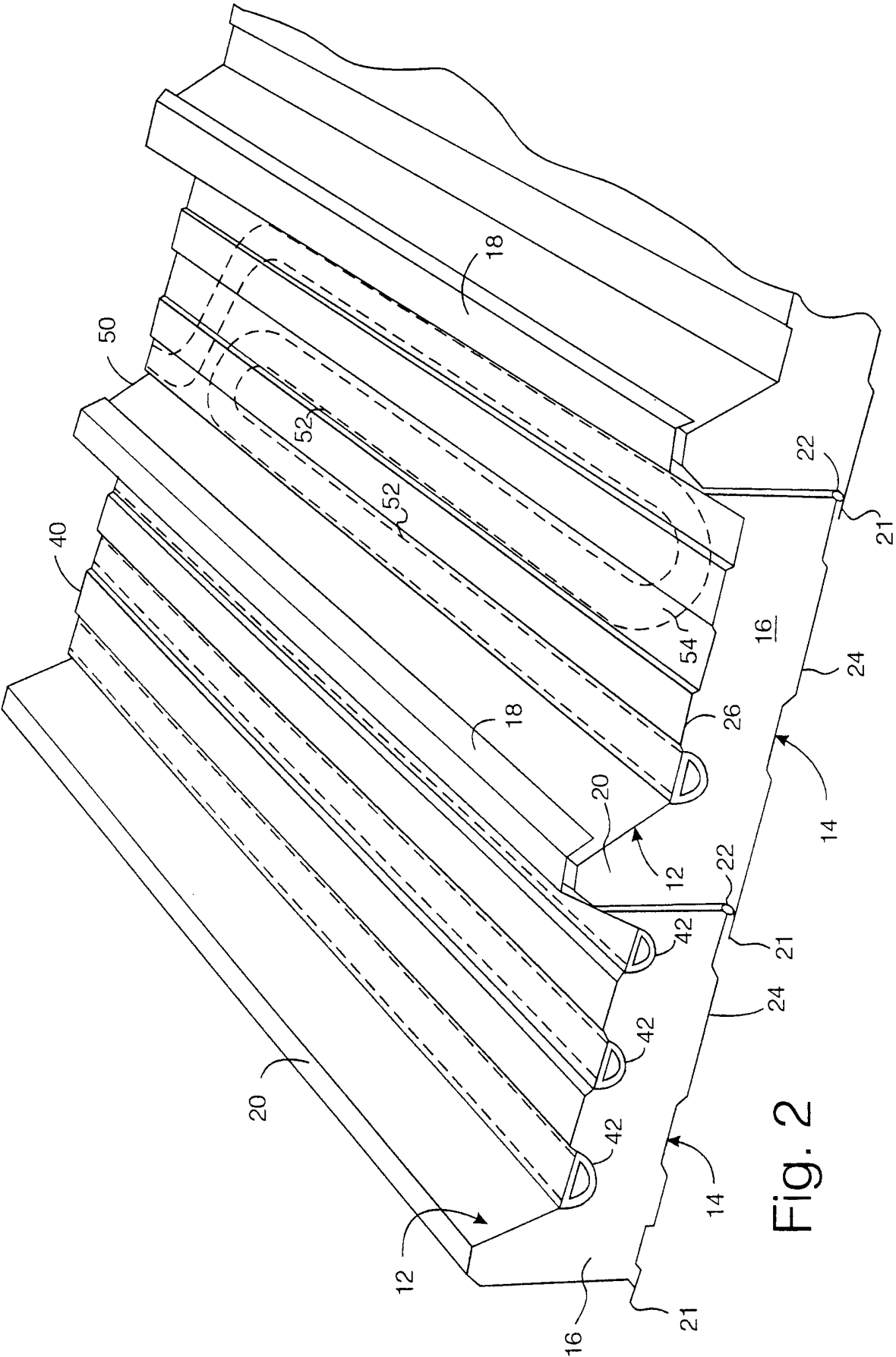
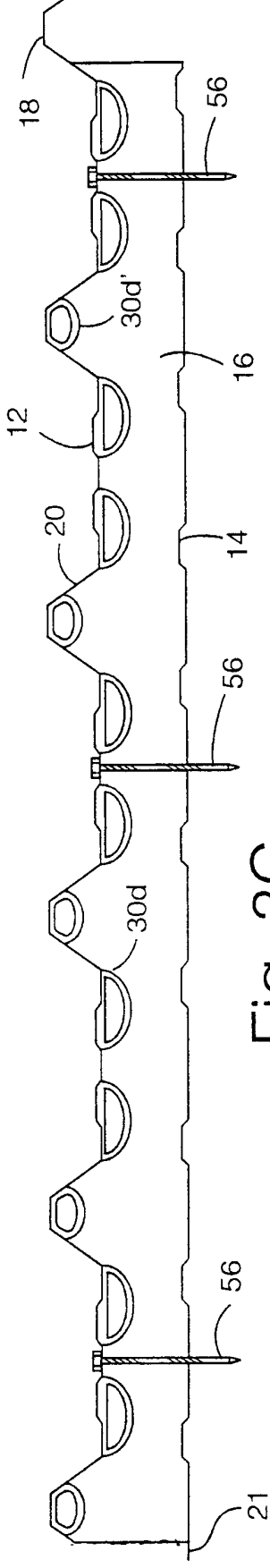
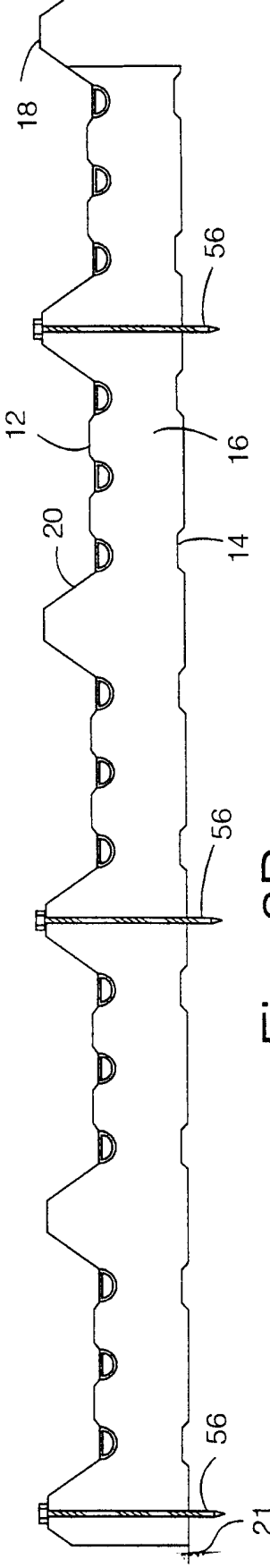
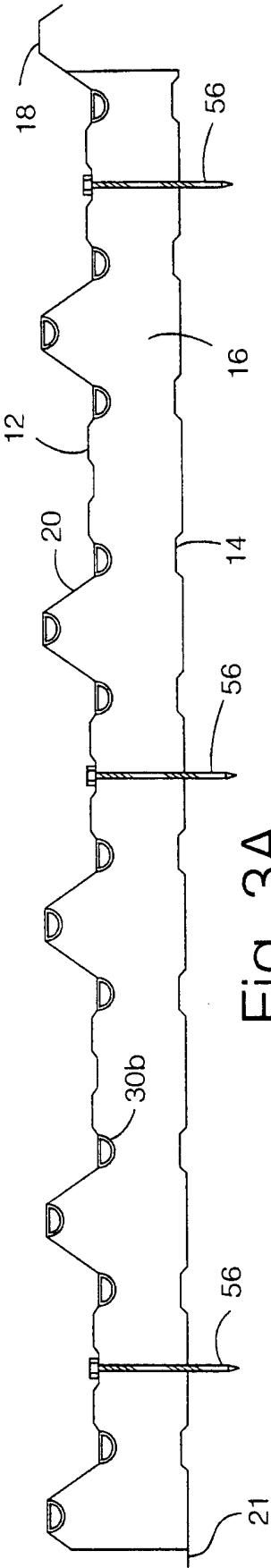


Fig. 2



4/10

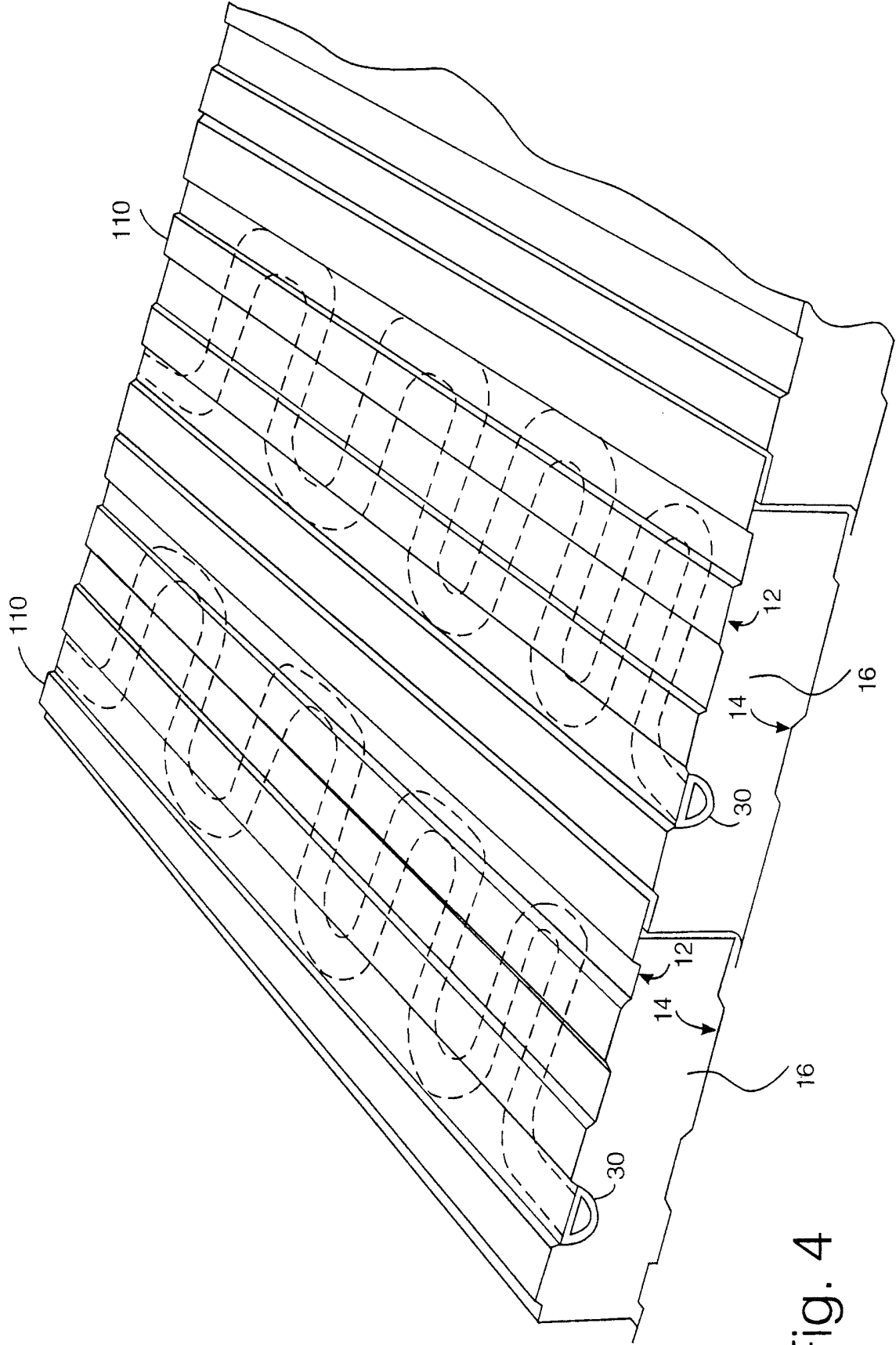


Fig. 4

5/10

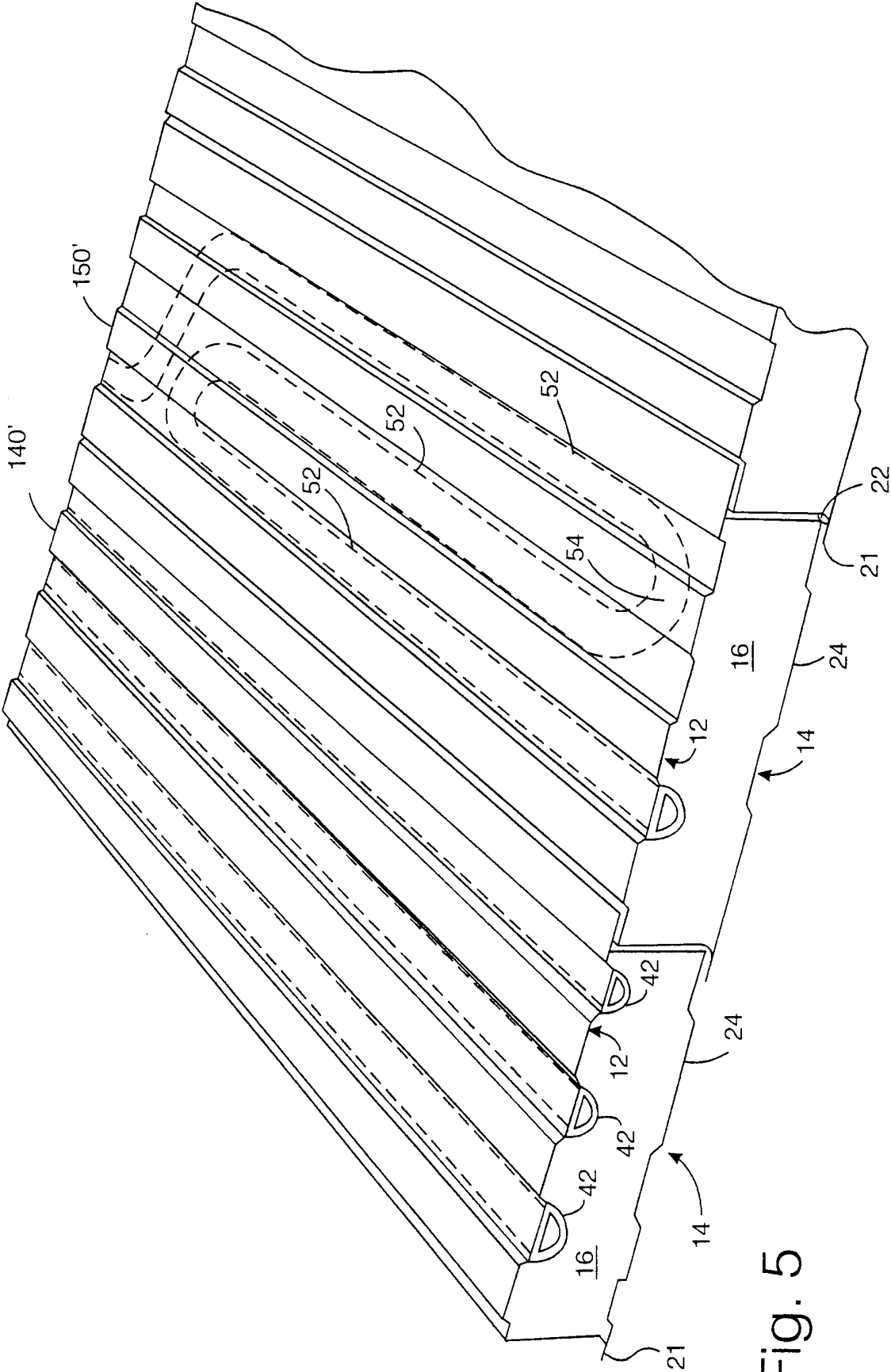


Fig. 5

6/10

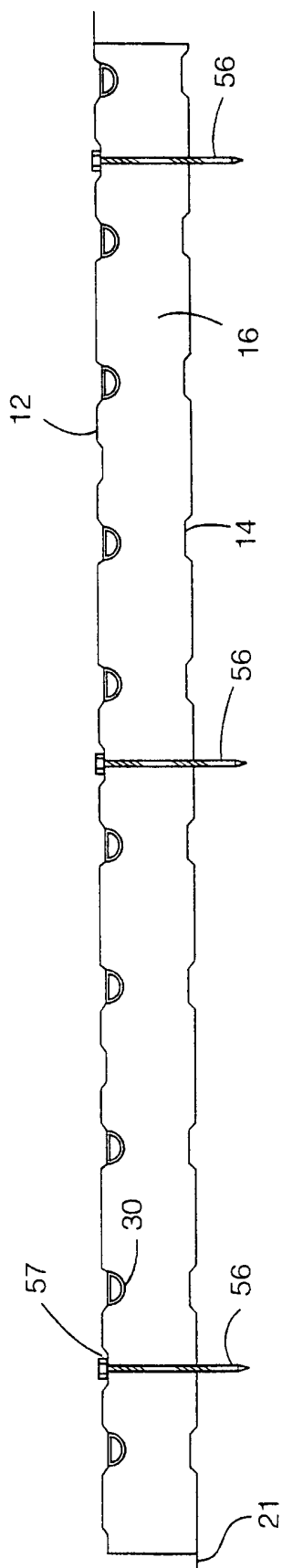


Fig. 6A

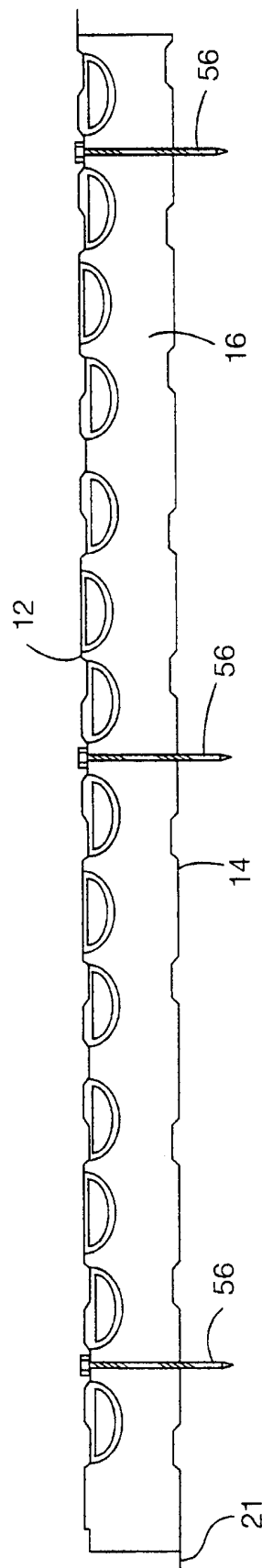
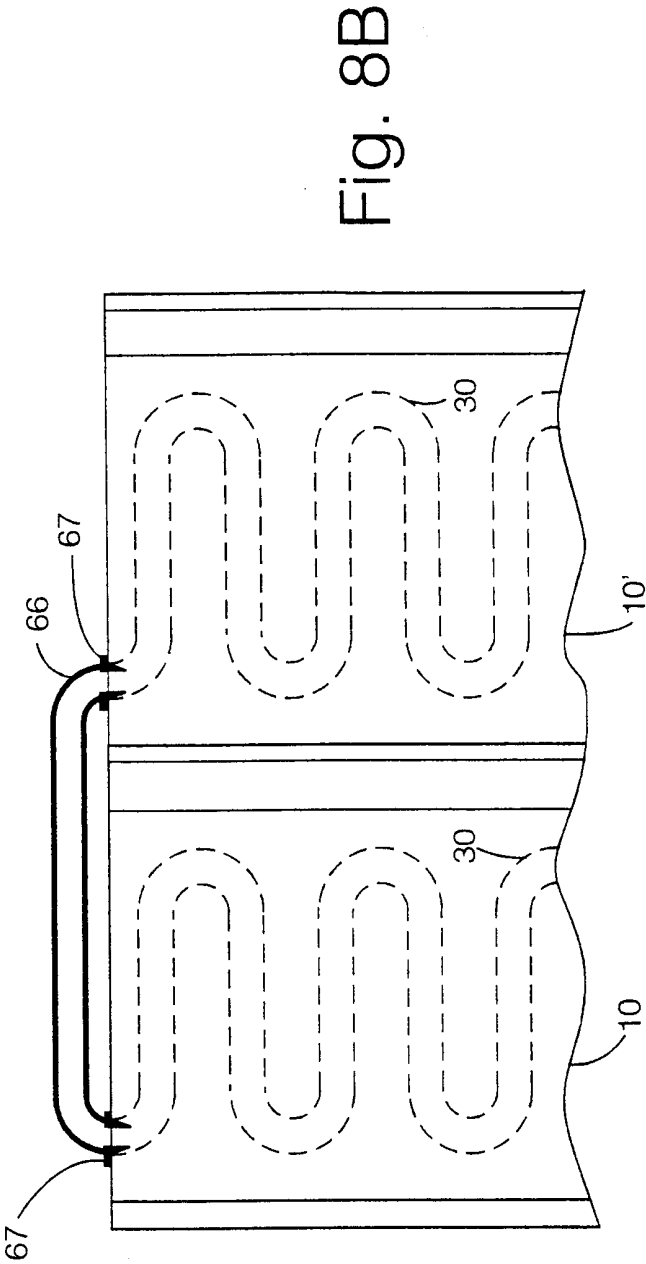
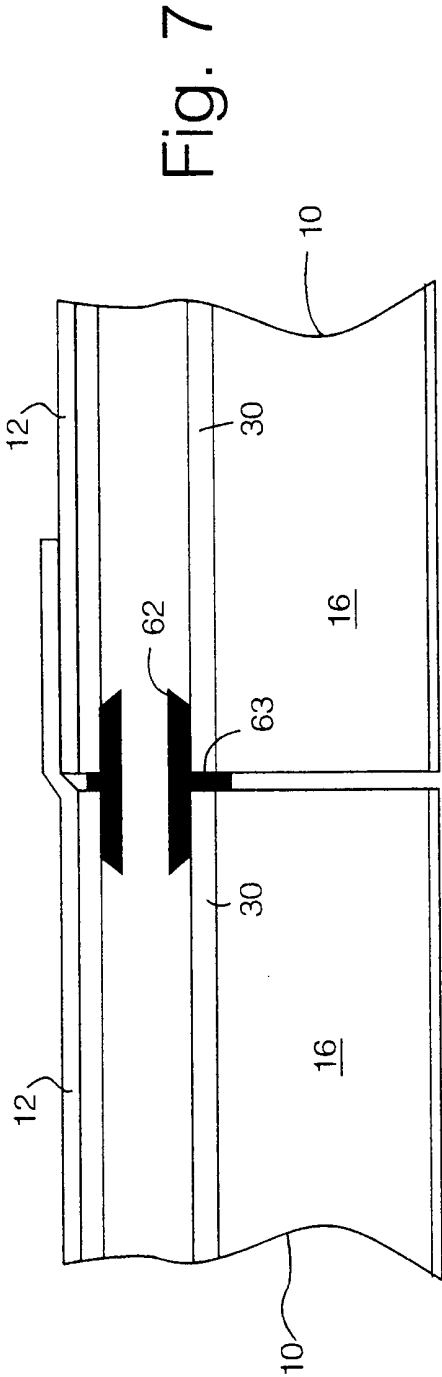


Fig. 6B



8/10

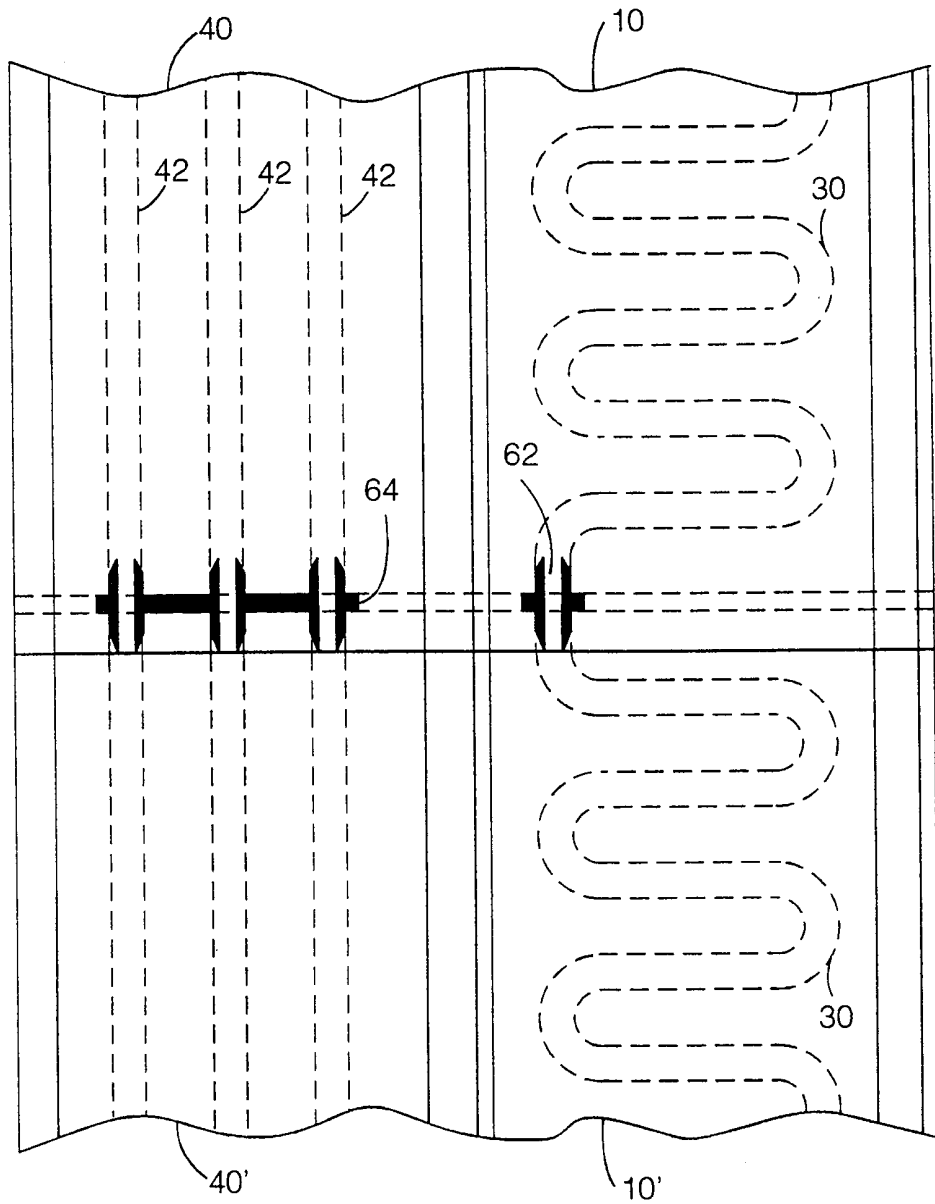
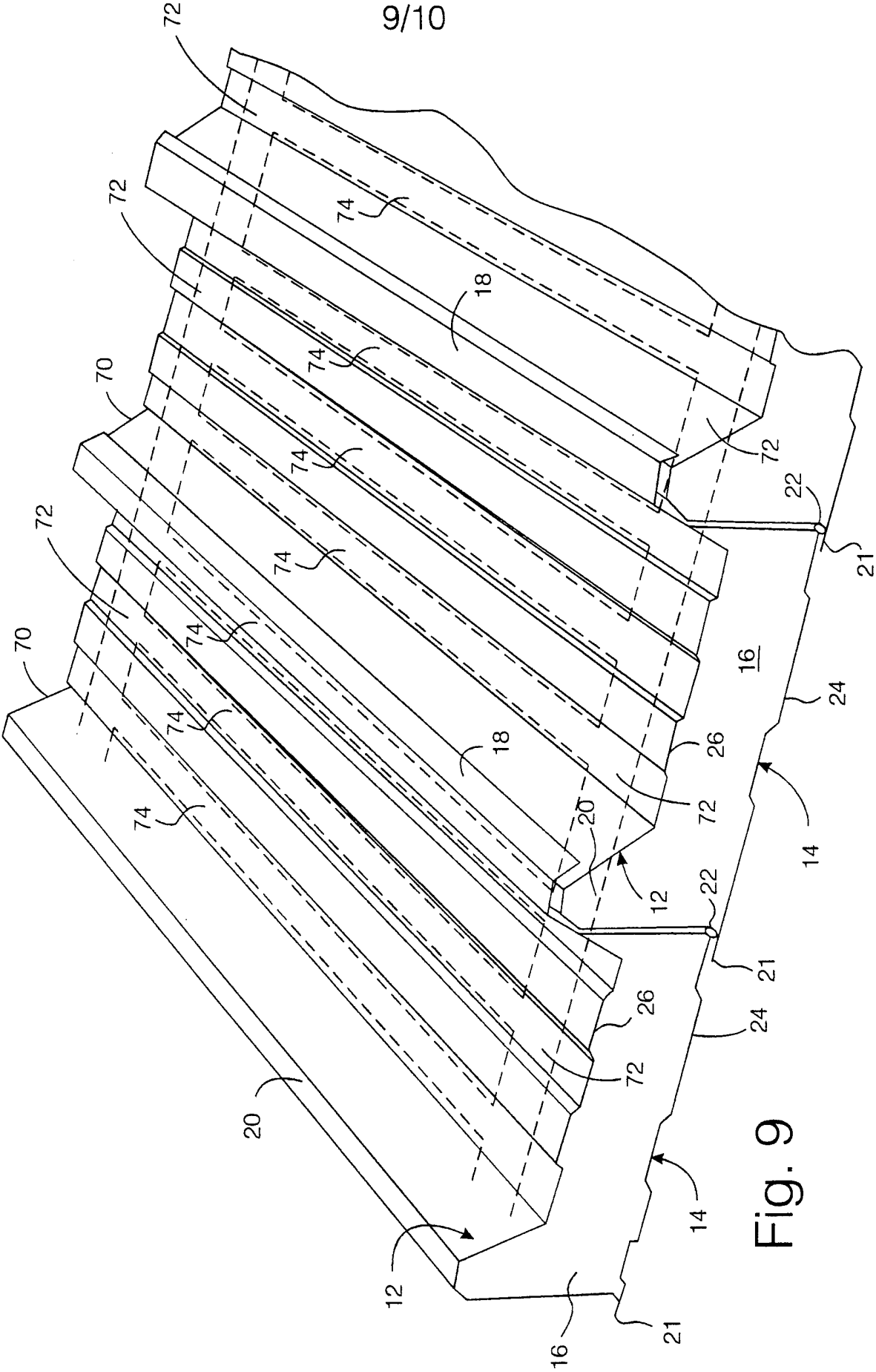


Fig. 8A



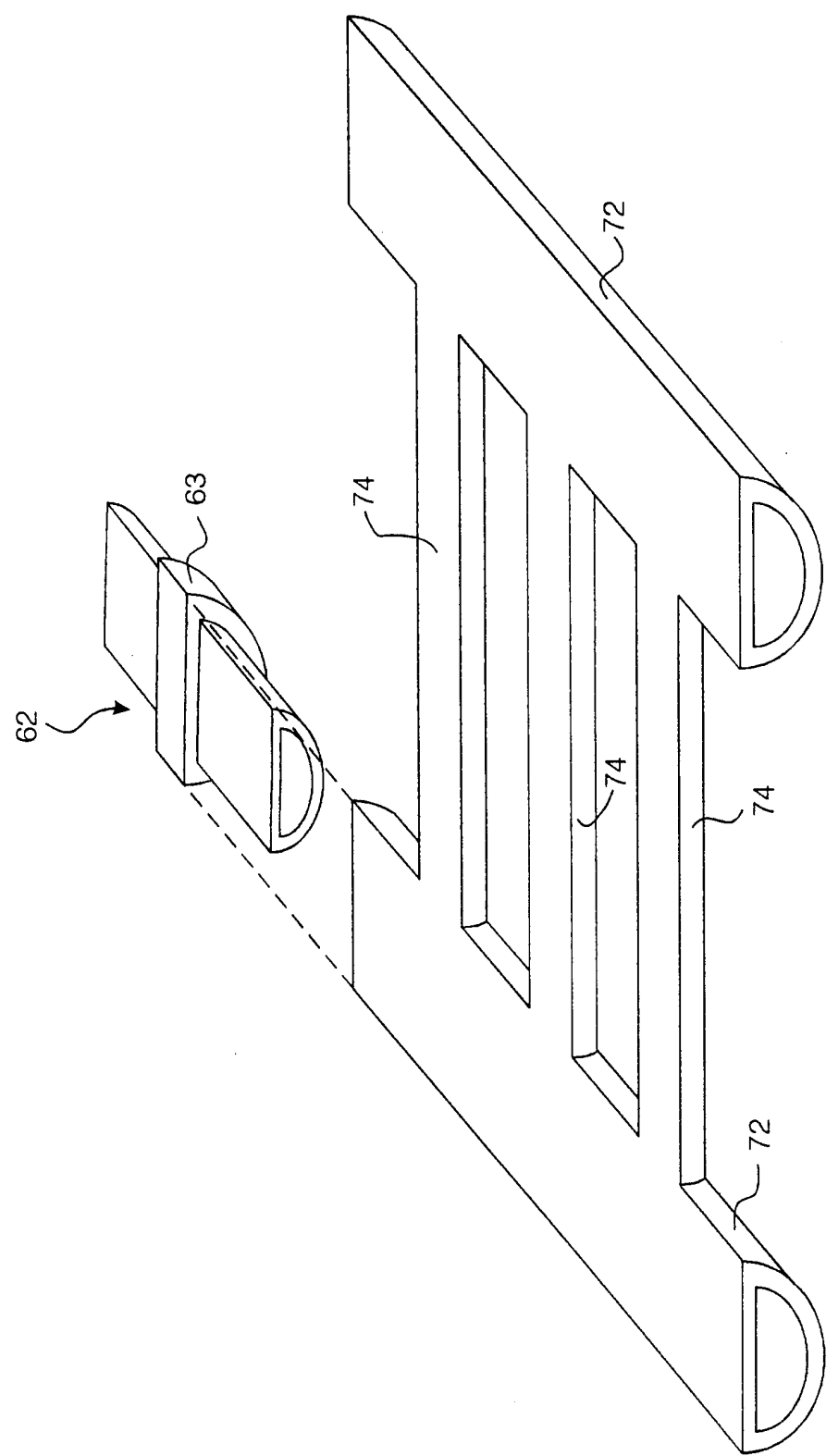


Fig. 10

# INTERNATIONAL SEARCH REPORT

Inter. .nal Application No

PCT/GB 00/02151

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 F24J2/26 E04C2/52

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)

IPC 7 F24J E04C

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

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

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 278 489 A (MAY HANS JOSEF ;SCHNETTLER ROLAND (DE); SCHWEINSBERG BERNHARD (DE)) 17 August 1988 (1988-08-17)	1-5,8, 10-12, 15-18, 20,21, 23, 27-35, 37,38, 40-44, 46,47, 49,50
Y	column 3, line 17 -column 5, line 10; figures  --- -/--	6,7,9, 13,14, 19,22, 24-26, 36,39, 45,48

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

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

5 September 2000

Date of mailing of the international search report

12/09/2000

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# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 00/02151

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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