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(56) Documents Cited:
EP 0784137 A **WO 2007/073363 A**
JP 090242233 A **JP 2001065194 A**
US 5653062 A **US 20050229509 A**
US 20040128938 A

(58) Field of Search:
INT CL **E04B, E04H**
Other: **EPODOC, WPI**

(54) Abstract Title**: Method of constructing a blast proof building and panel therefor**

(57) A method of constructing a blast proof building includes the steps of stacking structural panels configured for blast proofing the building in individual vertical columns as part of an outer skin of a building. The panels spans from floor to ceiling to provide vertical coverage at a respective storey of the building. The panels include a structural core and an attack face configured to provide impact resistance and a thermal break against the effects of a bomb blast. The attack face preferably includes one or more layers of sheet metal and a thermal break medium located between the structural core and the sheet metal. The panels are transported to the building site in a prefabricated state for immediate incorporation into the building.

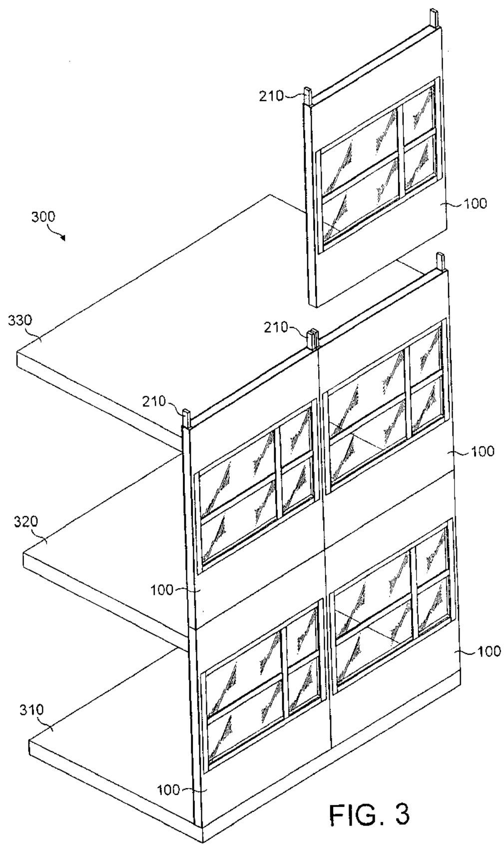

FIG. 3

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

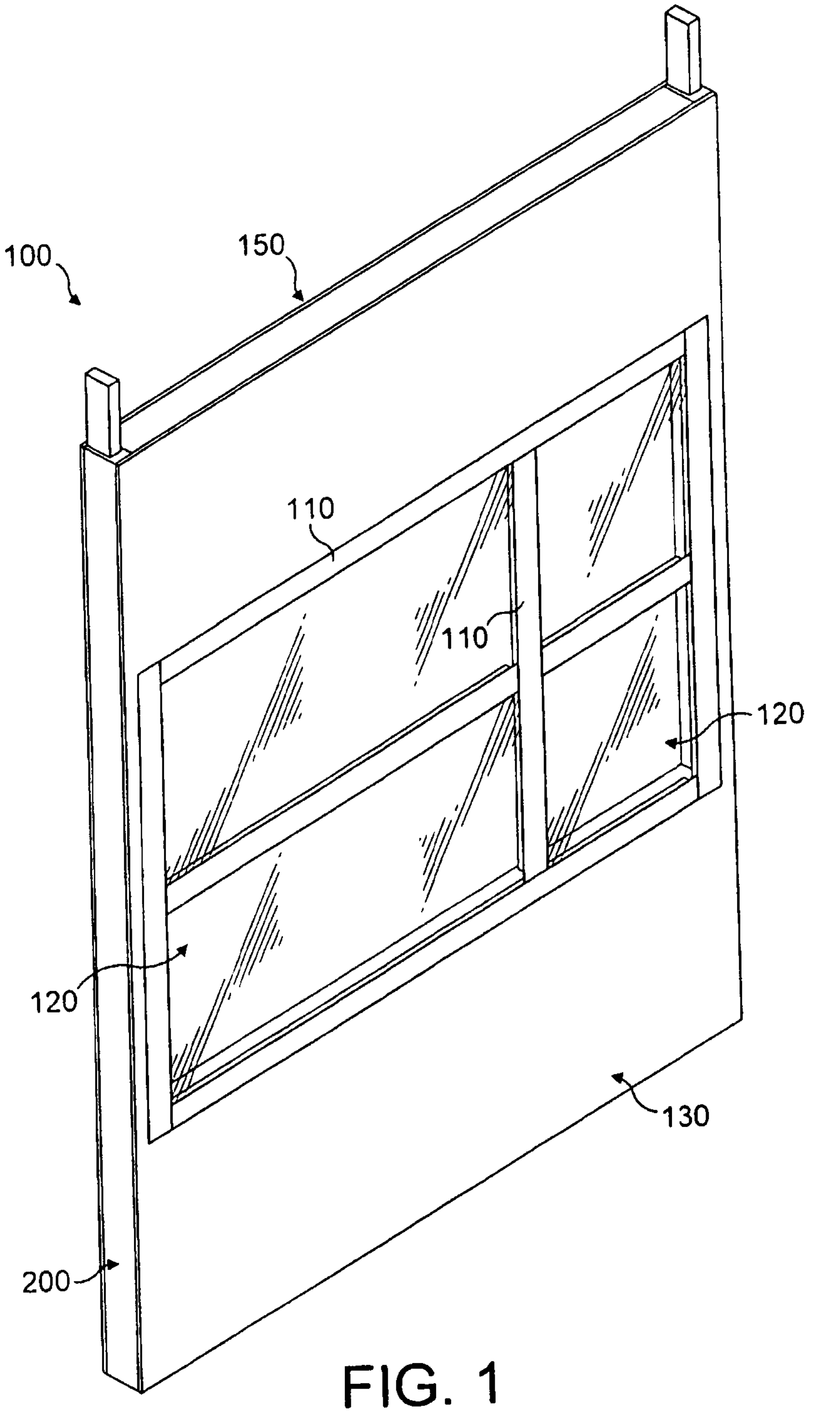

FIG. 1

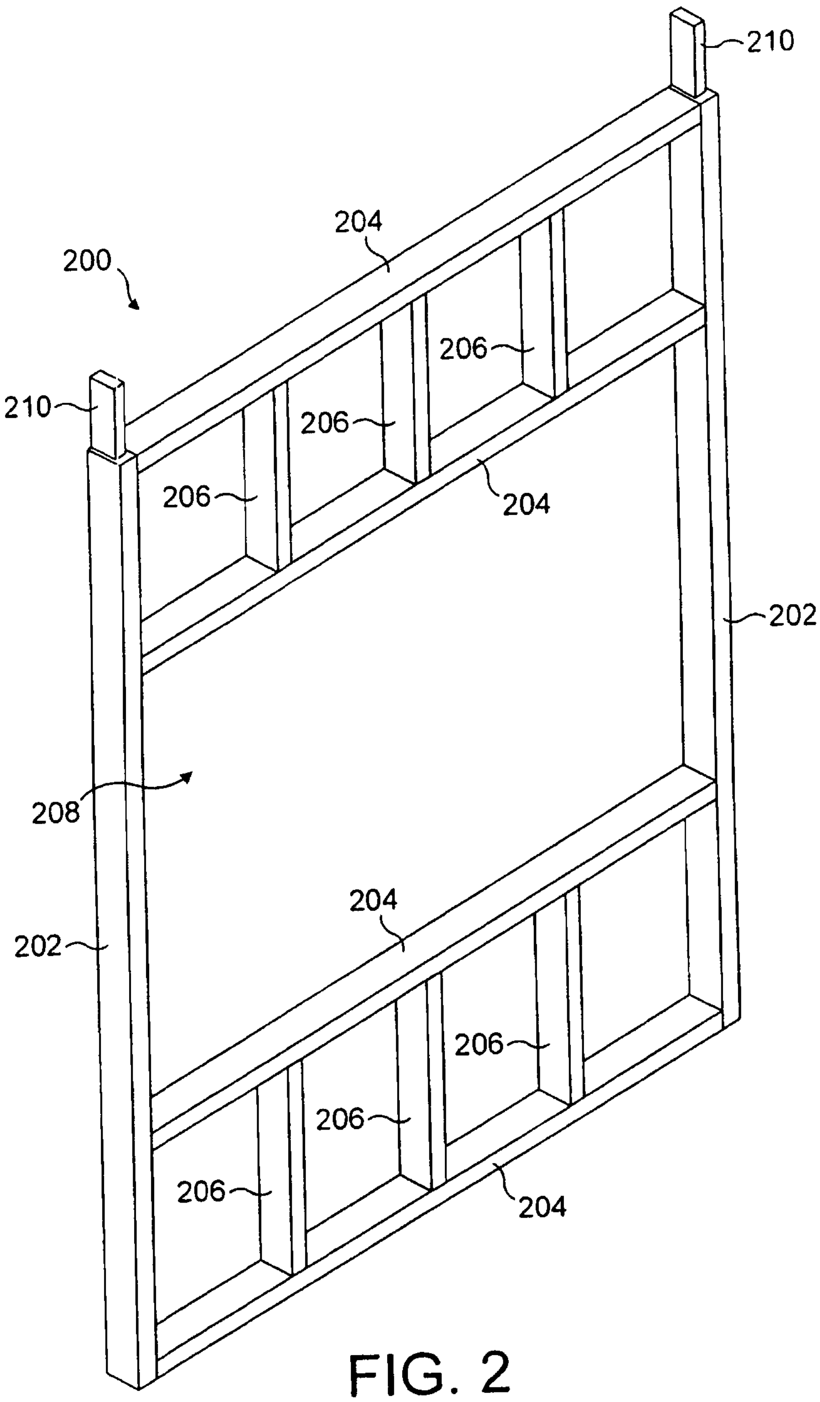

FIG. 2

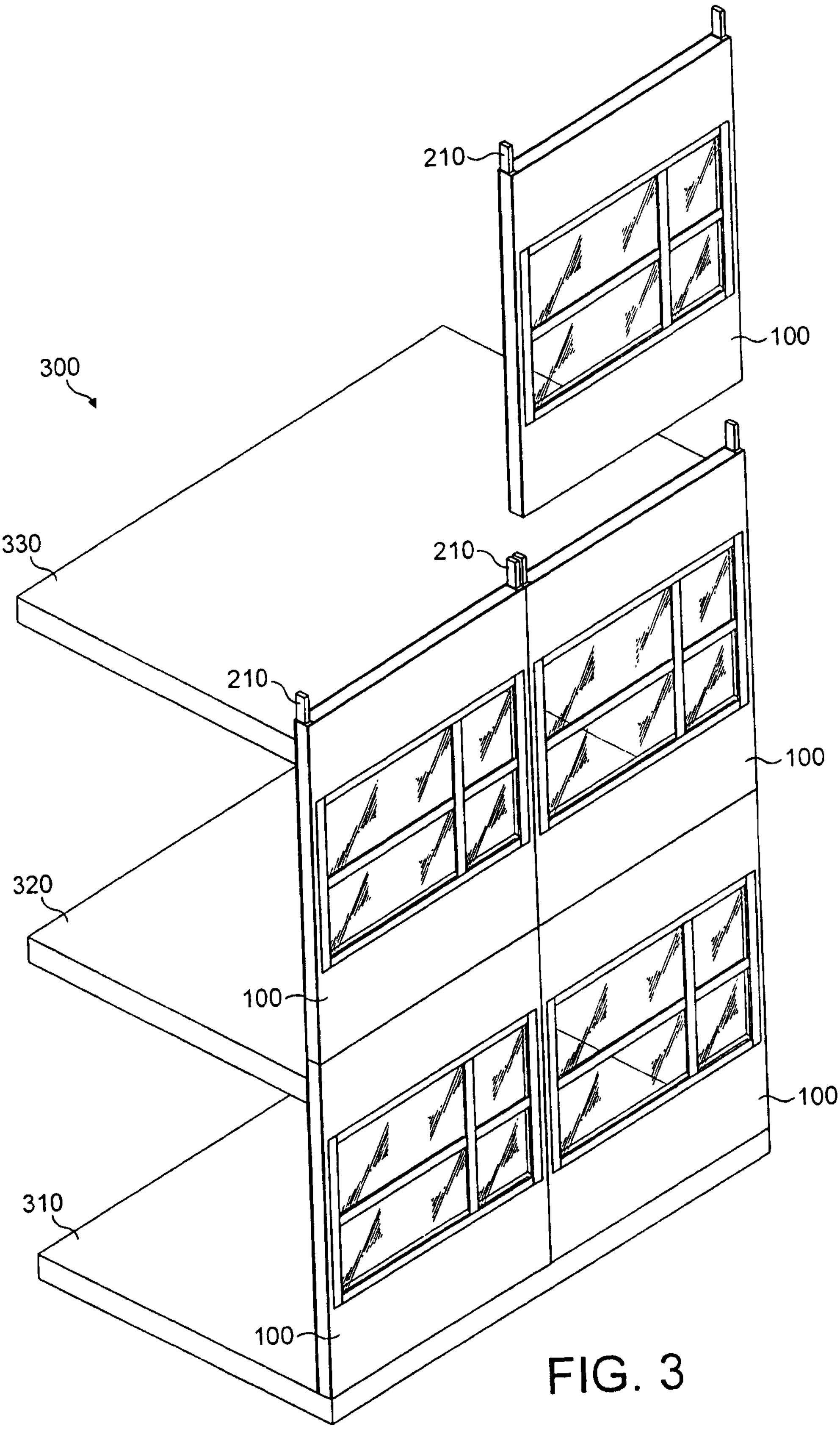

FIG. 3

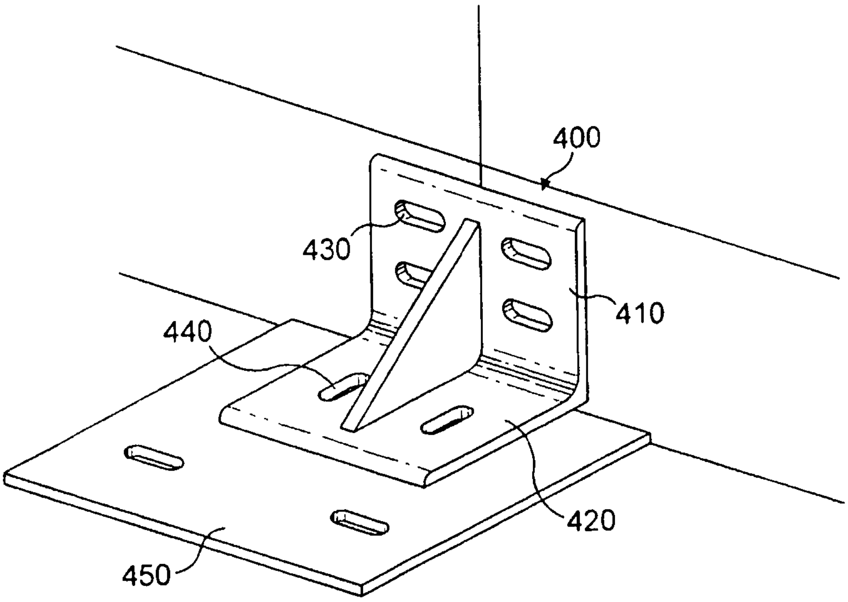

FIG. 4

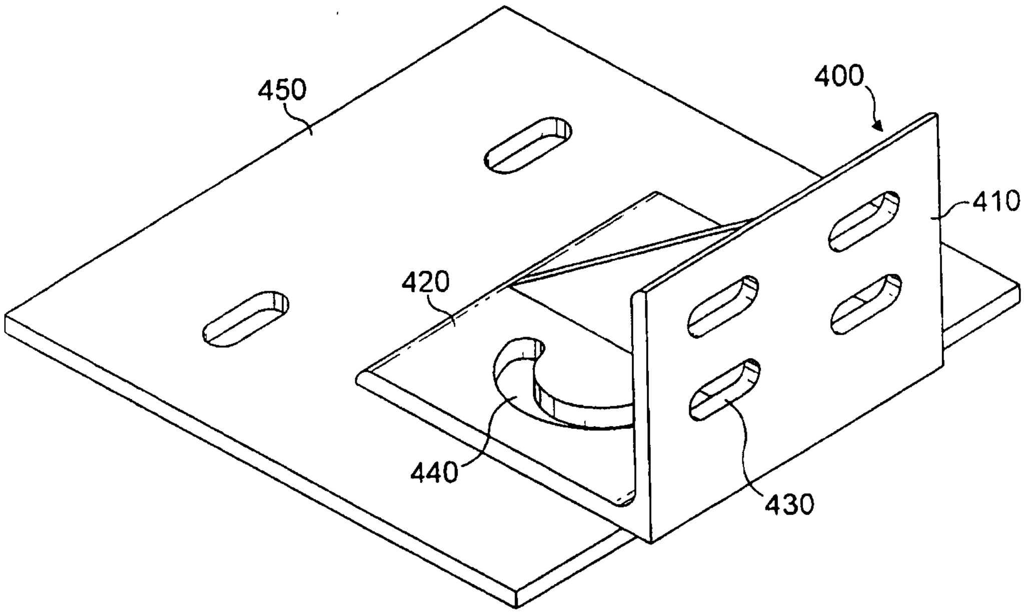

FIG. 5

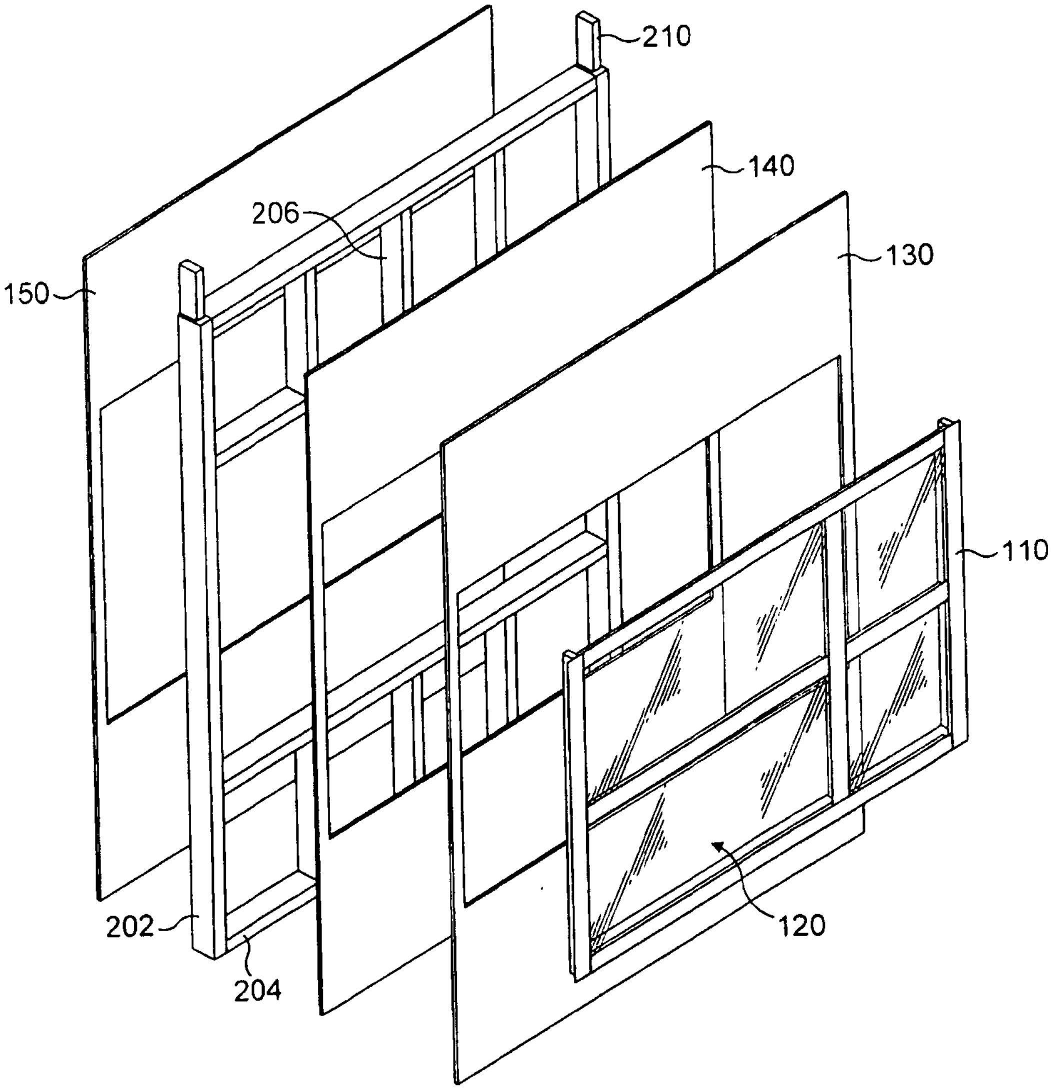

FIG. 6

Blast proof buildings

The present invention relates to blast proof buildings, including methods of construction for blast proof buildings and building materials for blast proof buildings.

It is becoming increasingly common for buildings to be constructed to withstand the effects of bomb blasts. For example, it is known for the outer skin of a building to include a thick layer of concrete, configured to provide blast and impact resistance. In one method, the concrete is poured on site. However, conventional concrete materials typically require a long period of time to reach a desired working strength, certainly longer than would be appropriate for blast proofing a temporary structure in most active conflict zones. Hence, it is also known to construct the blast proof outer skin of a building using preformed concrete blocks. However, such blocks are usually of substantial size and weight, and so the transportation of the blocks and the subsequent construction of a wall from such blocks is inherently problematic.

There is a need for an alternative to the known methods and materials for blast proofing a building, to address one or more of the problems referred to above.

According to one aspect of the invention, there is provided a blast proof panel for use in blast proofing a building, including a structural core and an attack face mounted on the core, wherein the attack face is configured to provide impact resistance and the panel provides a thermal break against the effects of a bomb blast.

The blast-proof panels are advantageous in that they can be readily used as an external cladding or structural component (e.g. as part of a section of wall) for blast proofing a building, thereby providing impact resistance and a thermal break against the effects of a bomb blast at the exterior of the building.

In preferred embodiments, the panel defines a wall section configured to span from floor to ceiling at a respective storey of a building. This is particularly preferred, since it means that whole storeys can be covered in an expedient manner.

Most preferably, the panels are prefabricated, i.e. assembled at a remote location, and so can be transported in a prefabricated state ready for immediate incorporation into a building. This optimises construction time and also inhibits inspection of the panel's internal structure during installation, which may be critical in active conflict zones.

The attack face preferably includes one or more layers of sheet metal, for example steel, in order to provide impact resistant layer for the protection of persons located on the inside of a building incorporating said panels, in the event of a blast exterior to the building. Each layer of sheet metal may be unitary in nature (i.e. as a single piece of sheet material spanning across the panel) or formed from multiple pieces of sheet material.

The panel preferably includes a thermal break medium for providing heat resistance to persons located on the inside of a building incorporating said panels, in the event of a blast exterior to the building. The thermal break medium may be provided by a layer of cementitious board material located inwardly of the impact resistant layer of the attack face, for example.

In other embodiments, the attack face may comprise a composite material having suitable impact resistance and thermal break properties for blast proofing purposes.

In a preferred embodiment, the structural core is in the form of a metal framework, e.g. fabricated from steel section. The core preferably defines a lattice and filler material is provided within the lattice, e.g. for sound insulation. The panel preferably incorporates a window and/or a door located within an aperture in the structural core.

The structural core may be sandwiched between the attack face and an internal skin. In one embodiment, the attack face includes a single layer of sheet metal and a single layer of cementitious board and the internal skin is formed from a single layer of sheet metal.

Preferably, each panel includes one or more lugs or projection at its upper end and one or more correspondingly arranged hollows or recesses at its lower end, wherein two of said panels can be stacked together, one on top of the other, with the hollow(s) on the upper panel located over the projection(s) on the lower panel. Each lug or projection preferably includes a lifting eye or other formation configured for receiving a lifting hook or the like, by means of which the panel can be lifted from storage and lowered into position during installation in a building. Alternatively or in addition, lugs or projections may extend downwardly from the lower end of the panel and the upper end of the panel may include recesses for accommodating the downwardly projecting lugs from another of said panels.

A further aspect of the invention provides a blast proof panel for use in blast proofing a building, the blast proof panel including a structural core and an outer skin mounted on said core, wherein the panel in the form of a prefabricated item.

In preferred embodiments, the panel is configured to cover the height of a storey in a building, e.g. from floor to ceiling. This is particularly preferred, since it means that whole storeys can be covered in an expedient manner.

The outer skin is preferably configured to provide impact resistance and thermal break properties, for protecting the structural core of the panel and persons located internally of the panel in use. In one embodiment, the outer skin has an external layer, e.g. of sheet metal, to provide impact resistance, and a thermal break layer (e.g. a cementitious board material) arranged for location between the structural core and the external layer. In other embodiments, the attack face may comprise a composite material having suitable impact resistance and thermal break properties for blast proofing purposes.

In a preferred embodiment, the structural core is in the form of a metal framework, e.g. fabricated from steel section. The core preferably defines a lattice and filler material is provided within the lattice, e.g. for sound insulation. The panel preferably incorporates a window and/or a door located within an aperture in the structural core.

The structural core may be sandwiched between the attack face and an internal skin. In one embodiment, the attack face includes a single layer of sheet metal and a single layer of cementitious board and the internal skin is formed from a single layer of sheet metal.

Preferably, each panel includes one or more lugs or projection at its upper end and one or more correspondingly arranged hollows or recesses at its lower end, wherein two of said panels can be stacked together, one on top of the other, with the hollow(s) on the upper panel located over the projection(s) on the lower panel. Each lug or projection preferably includes a lifting eye or other formation configured for receiving a lifting hook or the like, by means of which the panel can be lifted from storage and lowered into position during installation in a building. Alternatively or in addition, lugs or projections may extend downwardly from the lower end of the panel and the upper end of the panel may include recesses for accommodating the downwardly projecting lugs from another of said panels.

A still further aspect of the invention provides a blast proof panel for use in blast proofing a building, the blast proof panel including a structural core and an outer skin mounted on said core, wherein the panel is configured to define the height of a storey in a building.

Preferably, the panels are prefabricated, i.e. assembled at a remote location, and so can transported in a prefabricated state ready for immediate incorporation into the building. This optimises construction time and also inhibits inspection of the panel's internal structure during installation, which may be critical in active conflict zones.

The outer skin is preferably configured to provide impact resistance and thermal break properties, for protecting the structural core of the panel and persons located internally of the panel in use. In one embodiment, the outer skin has an external layer, e.g. of sheet metal, to provide impact resistance, and a thermal break layer (e.g. a cementitious board material) arranged for location between the structural core and the external layer. In other embodiments, the attack face may comprise a composite material having suitable impact resistance and thermal break properties for blast proofing purposes.

In a preferred embodiment, the structural core is in the form of a metal framework, e.g. fabricated from steel section. The core preferably defines a lattice and filler material is provided within the lattice, e.g. for sound insulation. The panel preferably incorporates a window and/or a door located within an aperture in the structural core.

The structural core may be sandwiched between the attack face and an internal skin. In one embodiment, the attack face includes a single layer of sheet metal and a single layer of cementitious board and the internal skin is formed from a single layer of sheet metal.

Preferably, each panel includes one or more lugs or projection at its upper end and one or more correspondingly arranged hollows or recesses at its lower end, wherein two of said panels can be stacked together, one on top of the other, with the hollow(s) on the upper panel located over the projection(s) on the lower panel. Each lug or projection preferably includes a lifting eye or other formation configured for receiving a lifting hook or the like, by means of which the panel can be lifted from storage and lowered into position during installation in a building. Alternatively or in addition, lugs or projections may extend downwardly from the lower end of the panel and the upper end of the panel may include recesses for accommodating the downwardly projecting lugs from another of said panels.

According to another aspect of the invention there is provided a building incorporating a blast proof panel in accordance with one or more of the above aspects of the invention.

According to another aspect of the invention, there is provided a method of blast proofing a building or a method of providing a blast proof facing for a building, including the steps of providing a plurality of structural panels configured for blast proofing the building and using said panels to define an array of individual vertical columns as part of an outer skin of a building, more preferably wherein each column includes a plurality of said panels stacked one on top of another.

The panels preferably include an outer skin or 'attack face' intended for providing impact resistance in the event of a blast on the attack side of the panel. The attack face may include one or more layers of sheet metal, for example steel. Each layer may be unitary in nature (i.e. as a single piece of sheet material) or formed from multiple pieces of sheet material.

The panels preferably include a thermal break for providing heat resistance to persons located on the inside of a building incorporating said panels, in the event of a blast exterior to the building. The thermal break may be provided by a layer of cementitious board material located inwardly of the attack face. In another embodiment, the attack face may comprise a composite material having both impact resistance and thermal break properties.

In a preferred embodiment, the panel the attack face is mounted on a structural core, e.g. a metal framework formed from steel section. The structural core may be sandwiched between the attack face and an internal skin. In one embodiment, the attack face and internal skin are each formed from a single layer of sheet metal.

The panels are preferably assembled at a remote location and can transported in a prefabricated state ready for immediate incorporation into the building. This optimises construction time and also inhibits inspection of the panel's internal structure during installation, which may be critical in active conflict zones.

In a preferred method, the building is a multi storey building, and each panel is configured to span from floor to ceiling at a respective storey of the building. This is particularly preferred, since it means that whole storeys can be covered in an expedient manner.

Preferably, a first of said panels includes a projection at its upper end and a second of said panels includes a hollow or recess at its lower end, wherein the second panel is lowered on to the first panel with the hollow in said second panel located over the projection on the first panel. The lugs or projections may include lifting eye or other formation configured for receiving a lifting hook or the like, by means of which the panel can be lifted from storage and lowered into position during installation in a building.

Alternatively or in addition, lugs or projections may extend downwardly from the lower end of the panel and the upper end of the panel may include recesses for accommodating the downwardly projecting lugs from another of said panels.

The method may include the preceding step of providing a building substructure, and then the step of coupling each column to the substructure in such a manner as to be independently movable relative to adjacent columns. Such an arrangement is advantageous in that each stack of panels is able to react in a generally independent manner, thus reducing the risk of shearing across the face of the building in the event of an explosion or bomb blast at the exterior of the building.

Furthermore, each panel may be individually coupled to the substructure in such a manner as to be independently movable relative to adjacent panels. This may involve a coupling which includes a locating pin associated with either the panel or the substructure and an aperture associated with the other of said panel or substructure, wherein the aperture is oversized relative to the locating pin to allow relative movement between the aperture and pin, in use.

Accordingly, the method may include the step of affixing a bracket to the panel, the bracket having a limb which extends relative to the panel and wherein said aperture is formed in the extending limb, the method further including the step of locating the aperture over a pin extending from said substructure.

According to yet another aspect of the invention provides a building made in accordance with the above 'method' aspect of the invention.

According to yet a further aspect of the invention, there is provided a coupling for use in mounting a panel in a building, the coupling including a bracket having a first limb for connection to a panel and a second limb for connection to a building, the second limb including an aperture, and the coupling further including a pin for locating in the aperture in said bracket, wherein the aperture is oversized relative to said pin, to enable the panel to move relative to the building, in use.

The aperture preferably defines a guide configured to enable the panel to move along a predefined path. The aperture may be arcuate to permit turning of the panel in use

Preferably, the pin extends from a base plate. The coupling preferably comprises two apertures and two pins.

According to a further aspect of the invention, there is provided a bracket for use in mounting a panel in a building, the bracket including a vertical limb for connection to the panel and a horizontal limb for connection to the building, wherein the bracket is configured to allow movement of the panel relative to the building.

Such brackets are advantageous in that they enable independent movement of the panels, in use, thus enabling the panels to absorb energy from an explosion or impact, and thereby reduce the effect of the explosion or impact on the building.

Other aspects and features of the invention will be readily apparent from the claims and following description, which is made, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of an armoured building section, in the form of a modular wall panel;
Figure 2 is similar to Figure 1, showing an internal framework for use in the building section of Figure 1;
Figure 3 shows a method of constructing a building using modular panels of the kind shown in Figure 1;

Figures 4 and 5 show examples of brackets for securing the panel of Figure 1 in the construction of Figure 3; and

Figure 6 is an exploded schematic perspective view of a modified armoured building section.

Referring firstly to Figure 1, a prefabricated blast proof building panel for use in blast proofing a building is indicated generally at 100. The term 'prefabricated' is intended to mean that the panel 100 is made at a location remote from its intended destination, e.g. for incorporation in a building erected at least a kilometre from the location at which the panel is made.

In general terms, the panel 100 includes a structural core in the form of a rigid metal framework 200 arranged between an outer skin 130 and an inner skin 150.

As will be described in more detail below, the outer skin 130 (also referred to as the 'attack face') is configured to provide impact resistance from shrapnel and/or armour piercing material, in the event of a blast exterior to the building. The panel is also configured to provide heat resistance for the protection of persons located on the inside of a building incorporating one or more of said panels,

In this embodiment, the panel 100 is in the form of a wall section configured to correspond at least substantially to the height of a given storey in a building, for the purpose of spanning between adjacent floors in a building (e.g. from first floor to second floor in a multi storey building, or from ground floor to ceiling in a single storey building). It may be preferred to use a plurality of said panels 100, e.g. in a side-by side array, for providing coverage across a particular storey in a building. The panel 100 includes a window frame 110 with glazing 120.

In the embodiment of Figure 1, the outer skin 130 is formed from two layers metal, one on top of the other, and which together form an armoured or 'shrapnel-resistant' facing. The sheet metal in each layer may be unitary in nature (i.e. a single piece of sheet material extending across the face of the panel) or may be formed from multiple pieces of sheet material. The outer skin 130 also includes a layer of cementitious board (shown only in Figure 6 at 140) arranged inwardly of the sheet metal, and which acts as a thermal break to provide heat resistance for the protection of persons located on the inside of a building incorporating one or more of said panels. The sheet metal is preferably steel and the cementitious board is preferably of known form, for example of the kind sold in the UK under the trade name PYROK.

In other embodiments, the outer skin 130 may be in the form of single layer of material, specifically configured to provide both the shrapnel-resistant and thermal break properties referred to above.

For enhanced resistance to bullets, the attack face of the panel may be provided by or include a sheet of specially tempered steel, for example as sold in the UK under the trade name COMPASS (RTM) or other bullet resistant medium (for example a GRP-type armour product as sold in the UK under the trade name OPTIMAL by Optimal Armour Ltd).

In the event of a blast on the 'attack' side of the panel 100, the attack face provides shrapnel protection to persons on the opposite side of the panel 100, and the thermal break inhibits the transfer of heat to the metal framework or persons on the opposite side of the panel 100.

To minimise the risk of tearing due to twisting forces from a blast or impact, at least the outermost layer of the outer skin 130 is preferably secured to the structural core 200 using mechanical fixings (e.g. pins or screws) arranged at a uniform spacing from one another.

An example of a framework 200 suitable for use in the panel 100 is illustrated in Figure 2. In this embodiment, the framework 200 consists of a matrix or lattice defined by an array of vertical columns 202, transverse beams 204 and brace members 206. The framework 200 is preferably constructed from steel sections secured together, e.g. welded, screwed and/or bolted together.

The inner transverse beams 204 defines an aperture 208 intended for locating a window. In addition or as an alternative, the framework 200 may define an aperture for a door (not shown). In other embodiments, the framework 200 may be devoid of any window or door aperture(s).

The framework 200 is generally rectangular, wherein the vertical columns 202 are longer than the transverse beams 204. In other embodiments, columns 202 may be equal or shorter in length than the transverse beams 204.

The upper end of the panel 100 includes lugs or projections 210, by means of which it may be preferable to lift the panel 100. In the illustrated embodiment of Figure 1, the lugs 210 are provided at the upper end of the columns 202 on either side of the framework 200. The lugs 210 may include lifting eyes or another formation (not illustrated) suitable for accepting a lifting hook or the like.

The lower end of the panel 100 preferably includes recesses (not shown), so that a plurality of said panels 100 can be stacked one on top of another, with the lugs 210 on a lower panel 100 received in the hollow section or recess in an upper panel 100. In this sense, the panel 100 can be used as a part of a modular construction, e.g. incorporating stacks of such panels. It will be understood that the panels 100 are thereby readily demountable, and ideal for temporary installations. In the illustrated embodiment of Figure 1, at least the lower end of each side column 202 is hollow, for receiving the lugs 210 on a subjacent panel 100.

The inner skin 150 of the panel 100 may be constructed from any suitable material, e.g. cementitious board and affixed to the core 200 in any suitable manner. However, in the embodiment of Figure 6, the inner skin 150 is formed by a layer of sheet metal. Through empirical testing conducted at a blast testing range, this configuration (which includes a thermal break medium as part of the attack face, e.g. a layer of cementitious board 140 separating the outer sheet metal layer from the structural core 200) has been found to increase the flexibility of the panel 100 under load, which enables the panel to withstand greater levels of impulse loading without risk of failure.

Filler material (not illustrated) may be provided between the apertures in the framework, preferably in the form of sound deadening material of known form, for example of the kind as sold in the UK under the name Rockwool by Rockwool Limited.

In crude embodiments, the inner skin 150 and/or the filler material is omitted.

It is preferred if at least the framework 200 and outer skin 130 are assembled together at a remote location. In conflict zones, it is particularly preferred if the inner skin and any glazing/doors are also incorporated at the remote location, so that the panels 100 can be transported to their desired destination and immediately incorporated into a building in a working state.

The use of prefabricated sections of the kind described above has the advantage that the internal construction of the protective outer skin of the building cannot be readily ascertained by the public. Moreover, the prefabricated wall sections provide a much quicker solution for blast proofing buildings than conventional poured concrete or concrete block techniques.

A single-storey building can be readily constructed using three or more of the panels 100 arranged in such a manner as to define the exterior walls of the building (e.g. triangular or rectangular in plan view). A conventional finish or cladding may then be provided over the outer skin of the panels 100.

Part of a multi-storey building constructed from panels 100 of the kind described above is indicated at 300 in Figure 3. As can be seen, the panels 100 are stacked one on top of another, wherein each panel 100 spans from floor to ceiling to provide vertical coverage at a respective storey 310, 320, 330 of the building 300, with the lowermost panels 100 upstanding from the lowermost floor level of the building 300.

It is particularly preferred if the panels 100 are arranged in vertical columns, that is to say, without interleaving of the panels. Moreover, it is preferred if laterally adjacent panels are not structurally coupled together. This has the advantage of enabling the columns to react independently to the effects of a blast at the exterior of the building, whereby a significant proportion of the load from a blast may be transferred down to the floor of the building via said columns, rather than across the face of the building.

The panels 100 are preferably secured to a substructure of the building 300, e.g. the internal structural framework and/or floor and/or ceiling sections of the building 300, in such a manner as to allow independent movement of each panel 100. Hence, the building 300 differs significantly from concrete-faced blast proof buildings, which are wholly rigid and resist the effects of a blast by shear strength. The building 300 on the other hand, consists of movable parts and is effectively able to flex, so as to absorb energy from a bomb blast or the like.

Each panel is preferably tied back to the building using at least one bracket which is configured to allow movement of the panel relative to the building. It may be preferred to use two or more brackets per panel, e.g. at the top and bottom of each panel, more preferably at or adjacent the corners of the panel.

Figures 4 and 5 show examples of brackets 400 for use when incorporating the panels 100 in a building. Each bracket 400 includes a vertical limb 410 for connection to the panel 100 and a horizontal limb 420 for connection to the inner structure of the building, e.g. a structural column or beam, or a preformed floor or ceiling section. The vertical limb 410 includes apertures 430 for bolting the bracket 400 to a panel 100. The horizontal limb 420 includes oversize apertures 440 by means of which the bracket 400 can be located on one or more pins (not shown) extending from the building, e.g. from a base plate 450. The apertures 440 are configured to provide clearance from the pins in at least one direction, to enable the bracket to pivot or otherwise move relative to the pins. Hence, the panel will be able to move relative to the substructure of the building and any laterally adjacent panels 100, e.g. in the event of a bomb blast.

In Figure 5, the apertures 440 are curved and act as guides to enable an associated panel 100 to move along a predefined path in the event of a blast.

Claims

1. A method of constructing a blast proof facing for a building, including the steps of providing a plurality of structural panels configured for blast proofing the building and using said panels to define an array of individual vertical columns as part of an outer skin of a building.

2. The method of claim 1 wherein the building is a multi storey building, and wherein each panel spans from floor to ceiling to provide vertical coverage at a respective storey of the building.

3. The method of claim 1 or claim 2 wherein the panels are transported to the building site in a prefabricated state for immediate incorporation into the building.

4. The method of any preceding claim wherein said panels are blast proof building sections which include a structural core and an attack face configured to provide impact resistance, wherein the panels are also configured to provide a thermal break against the effects of a bomb blast.

5. The method of claim 4 wherein the attack face includes an external layer of sheet metal and a thermal break medium located between the structural core and the external layer.

6. The method of claim 5 wherein the thermal break medium is a layer of cementitious board.

7. The method according to any of claims 4 to 6 wherein the structural core comprises a metal framework of steel section.

8. The method according to any of claims 4 to 7 wherein the panel further comprises an inner skin of sheet metal.

9. The method according to any of claims 1 to 8 wherein each column includes a stack of said panels mounted one on top of another.

10. The method of claim 9 wherein a first panel in the stack includes a projection at its upper end, a second panel in the stack includes a hollow or recess at its lower end, and wherein the second panel is lowered on to the first panel with the hollow or recess in said second panel located over the projection on the first panel.

11. The method according to any of claims 1 to 10, including the preceding step of providing a building substructure, and then the step of coupling each column to the substructure in such a manner as to be independently movable relative to adjacent columns.

12. The method of claim 11 including the step of individually coupling a panel to the substructure in such a manner as to be independently movable relative to adjacent panels.

13. The method of claim 12, including the step of using a coupling which includes a locating pin associated with either the panel or the substructure and an aperture associated with the other of said panel or substructure, wherein the aperture is oversized relative to the locating pin to allow relative movement between the aperture and pin, in use.

14. The method of claim 13, including the step of affixing a bracket to the panel, the bracket having a limb which extends relative to the panel and wherein said aperture is formed in the extending limb, and further including the step of locating the aperture over a pin extending from said substructure.

15. The method according to any of claims 1 to 14 wherein one or more of the panels include a window and/or a door.

16. A blast proof building made in accordance with the method of any of claims 1 to 15.

17. A blast proof panel for use in blast proofing a building, wherein the blast proof panel includes a structural core and an attack face mounted on the core, the attack face configured to provide impact resistance and the panel is configured to provide a thermal break against the effects of a bomb blast.

18. A blast proof panel according to claim 17 wherein the panel defines a wall section configured to span from floor to ceiling at a respective storey of a building.

19. A blast proof panel according to claim 17 or claim 18 wherein the panels are prefabricated for immediate incorporation into a building.

20. A blast proof panel according to any of claims 17 to 19 wherein the attack face includes one or more layers of sheet metal.

21. A blast proof panel according to any of claims 17 to 20 wherein the attack face includes a thermal break medium, preferably located behind an impact resistant layer.

22. A blast proof panel according to claim 21 wherein the thermal break is provided by a layer of cementitious board material.

23. A blast proof panel according to any of claims 17 to 23 wherein the structural core is in the form of a metal framework.

24. A blast proof panel according to any of claims 17 to 24 wherein the structural core is sandwiched between the attack face and an internal skin.

25. A blast proof panel according to claim 24 wherein the attack face includes a single layer of sheet metal and a single layer of cementitious board and the internal skin is formed from a single layer of sheet metal.

26. A blast proof panel according to any of claims 17 to 26 wherein the panel includes one or more lugs or projections at its upper end and one or more

correspondingly arranged hollows or recesses at its lower end, wherein two of said panels can be stacked together, one on top of the other, with the hollow(s) on the upper panel located over the projection(s) on the lower panel.

27. A blast proof panel according to claim 26 wherein each lug or projection includes a lifting eye or other formation configured for receiving a lifting hook or the like, by means of which the panel can be lifted from storage and lowered into position during installation in a building.

28. A building incorporating a blast proof panel in accordance with one or more of claims 17 to 27.

INTELLECTUAL PROPERTY OFFICE

Application No: GB0817231.4 **Examiner:** Eleanor Wade
Claims searched: 1-16 **Date of search:** 23 December 2008

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-4,9,10-13,15,16	US5653062 A Shustov see figures
X	1-5,7,9,15,16	WO2007/073363 A Life Shield Engineered Systems see figures
X	1-4,9,10,11,12,15,16	JP09242233 A Obayashi see figures
X	1-3,9,11-13,15,16	EP0784137 A Air House Company see figures
X	1,3,4,9,15,16	JP2001065194 A Daiwa House see figures
X	1-3,9,15,16	US2005/229509 A Majlessi see figures
X	1,3,9,15,16	US2004/128938 A Cure see figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

E04B; E04H

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
E04B	0001/98	01/01/2006
E04H	0009/04	01/01/2006
E04H	0009/06	01/01/2006