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(54) PRECAST CONCRETE PANELS USED AS SURFACE LINING OF PERIMETER SURFACES OF EXCAVATIONS

BETONFERTIGPLATTEN ZUR VERWENDUNG ALS OBERFLÄCHENVERKLEIDUNG VON UMFANGSFLÄCHEN VON AUSGRABUNGEN

PANNEAUX EN BÉTON PRÉFABRIQUÉ UTILISÉS COMME REVÊTEMENT DE SURFACE DE SURFACES PÉRIPHÉRIQUES D'EXCAVATIONS

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Description

TECHNICAL FIELD

[0001] The present invention relates to a system for the construction of excavations such as underground structures, including but not limited to car parks, train stations or containment cells for contaminated materials. More particularly, although not exclusively, the system comprises lining (and in some instances further including waterproofing) a perimeter surface (which may include horizontal and vertical surfaces) of an excavation with precast (in some instances prestressed and/or post tensioned) concrete panels affixed to solid structures to form a lining in the form of a wall or floor structure.

BACKGROUND

[0002] Shoring systems are constructed to retain earth and the adjacent structures when a bulk excavation is required. Traditionally, a shoring system comprises piles inserted vertically into the ground at the design spacing around the exterior of the perimeter of a new structure. The area in front and between the piles is excavated in increments (maximum 2.00 meters), which is a time consuming and difficult task. As excavation progresses the piles can be reinforced by bracing with temporary anchors and installing steel dowels between the piles before creating a shotcrete wall interface (see figure 1).

[0003] Ensuring that permanent underground wall structures and floors remain watertight is not a trivial task. Several methods have been used including; constructing a concrete block wall in front of the piles from the basement up to the ground level, to "hide from view" the water leakages and the uneven surface of the piles and the shotcrete walls. In addition, a vertical geosynthetic drainage strip material can be attached to the rear side of the reinforcing steel dowels prior to shotcreting to provide a direct flow of passage of seepage to the basement prior to pumping it out. In the case where the ground has a particularly high water table, a secant piles wall may be used to provide the tanking of the underground structure.

[0004] WO 2011/009219 A1 to Alfonso Gonzalez, SFS Structures Ltd. discloses the use of precast concrete panels to build a wall in a shoring-free excavation and basement construction apparatus and method. The concrete panels in WO 2011/009219 A1 are moulded with a parabolic cross section and lateral faces of the panels are attached between the piles-columns using a bolt system. The bolt system comprises a bolt through the metal post to a steel plate bonded to the backside of the concrete panel. The bolt mechanism acts to prevent the panel from any downward movement during the excavation process. This system does not allow any tolerance on the installation of the columns / soldier piles and requires the soil/earth between the piles-columns to be excavated.

[0005] US 6,220,789 B1 to Richard White discloses a method of constructing an underground building structure without the use of a conventional shoring system. The shoring method requires inserting columns into the ground and vertically arranging concrete or shoring panels against the exterior wall columns. Thus the panels vertically exert force on the ground whilst being reinforced with temporary braces. In this technique the panels are not permanently bolted in place.

[0006] DE 197 23 554 A1 discloses an excavation perimeter surface lining system and method according to the preamble of claims 1 and 8, respectively.

[0007] US 4 913 594 A discloses a rigid connection system for adjustably connecting facing panels to soldier piles so as to support the cut face of an excavation, said system comprising: a first rigid bracket coupled to the rear face of a facing panel; a second rigid bracket coupled to the front face of a soldier pile substantially opposite said first bracket; at least one rigid connecting plate coupled between said first bracket and said second bracket, and adjustment means provided by said first bracket, said second bracket and said rigid connecting plate for providing three degrees of adjustment between said soldier pile and said facing panel.

[0008] Some of the main disadvantages of the traditional shoring method using piles and shotcrete walls are time consuming steps including excavating the earth between the piles and the additional supply and installation of dowel bars. Furthermore, shotcreting is not only time-consuming but also extremely sensitive to inclement weather. The traditional shoring method cannot provide waterproofed walls and strip drains are difficult to install and most of the time inefficient. Generally, the construction of an additional concrete block wall in front of the piles is required to overcome these problems. Overall, the construction of underground structures is a long and complex activity, that is expensive and requires the expertise of tradesmen in areas such as: diggers, steel fixers, shotcreters and brick layers

[0009] It would be advantageous if a system and method could be provided which did not require the participation of multiple trades and yet provided for a means of shoring, even in unstable or water laden ground. It would be further advantageous in at least some forms to provide a waterproofing seal at the soldier pile interface. It would be further advantageous if a system and method could be provided which did not require the construction of additional facades in order to provide a finished, functional lining for the perimeter surface of an excavation.

[0010] It is an object of the present invention to address or at least ameliorate some of the above disadvantages.

Notes

[0011] The term "comprising" (and grammatical variations thereof) is used in this specification in the inclusive sense of "having" or "including", and not in the exclusive sense of "consisting only of". The above discussion of the prior art in the Background of the invention, is not an admission

SUMMARY OF INVENTION

[0012] Accordingly, in one broad form of the invention, there is provided an excavation perimeter surface lining system for lining a perimeter surface of an excavation; the perimeter surface defined by a solid structure; characterized in that the perimeter surface lined by means of precast concrete panels which are affixed to the solid structure; wherein the solid structure is a rock face; wherein the solid structure comprises a plurality of columns; wherein the precast concrete panels are affixed to a front portion of the columns; wherein material in the volume between the columns is not excavated; wherein the precast concrete panels are arranged with their edges in a juxtaposed relationship; wherein the precast concrete panels adjoin at a location between the columns; wherein the precast concrete panels adjoin vertically; where the precast concrete panels adjoin horizontally; wherein the columns are substantially parallel to each other; and wherein the concrete panels are arranged in juxtaposed relationship such that an overlap component of a flexible seal member of a first type overlaps at least a portion of a surface component of a flexible seal member of a second type so as to form an elongated weld zone along edges of the juxtaposed concrete panels; and wherein a welding operation is performed along the length of the elongated weld zone whereby the overlap component of the flexible seal member of the first type is welded to the flexible seal member of the second type substantially along the elongated weld zone thereby to form a substantially water tight flexible seal between the juxtaposed concrete panels; and wherein the overlap component of the overlap components of the flexible seal members proximate the vertical edge of first and second vertical concrete panels are welded.

[0013] Accordingly, in another broad form of the invention, there is provided an excavation perimeter surface lining method for lining a perimeter surface of an excavation; the perimeter surface defined by a solid structure; characterized in that the perimeter surface lined by means of precast concrete panels which are affixed to the solid structure ; and wherein the solid structure is a rock face; and wherein the solid structure comprises a plurality of columns; and wherein the precast concrete panels are affixed to a front portion of the columns; and wherein material in the volume between the columns is not excavated; and wherein the precast concrete panels are arranged with their edges in a juxtaposed relationship; and wherein the precast concrete panels adjoin at a location between the columns; and wherein the precast concrete panels adjoin vertically; and wherein the precast concrete panels adjoin horizontally; and wherein the columns are substantially parallel to each other; and wherein the concrete panels are arranged in juxtaposed relationship such that an overlap component of a flexible seal member of a first type overlaps at least a portion of a surface component of a flexible seal member of a second type so as to form an elongated weld zone along edges of the juxtaposed concrete panels; and wherein a welding operation is performed along the length of the elongated weld zone whereby the overlap component of the flexible seal member of the first type is welded to the flexible seal member of the second type substantially along the elongated weld zone thereby to form a substantially water tight flexible seal between the juxtaposed concrete panels; and wherein the overlap component of the overlap components of the flexible seal members proximate the vertical edge of first and second vertical concrete panels are welded

[0014] Accordingly, in another broad form of the invention there is provided a system for lining a perimeter surface of an excavation; the perimeter surface defined by a solid structure; the perimeter surface lined by means of precast concrete panels which are affixed to the solid structure.

[0015] Accordingly, in a further broad form of the invention there is provided a system for lining a perimeter vertical and horizontal surface of an excavation for the purpose of waterproof tanking including the base floor area; the perimeter surface defined by a solid structure; the perimeter surface lined by means of precast concrete panels which are affixed to the solid structure.

[0016] Accordingly, in a further broad form of the invention there is provided a method for lining a perimeter surface of an excavation; the perimeter surface defined by a solid structure; the perimeter surface lined by means of precast concrete panels which are affixed to the solid structure.

[0017] Preferably the perimeter surface is a vertical surface.

[0018] Preferably the perimeter surface is a horizontal surface.

[0019] Accordingly, in yet a further broad form of the invention there is provided a top-down method of affixing precast concrete panels to piles; said method including the steps of:

(a) inserting piles to design depth around the exterior of a design perimeter of an underground structure with a predetermined horizontal pile spacing.
(b) Excavate in increments.
(c) Affix precast concrete panels to the piles.
(d) Install temporary anchors progressively, with the advancement of the excavation and the installation of precast concrete panels.
(e) Stress the temporary anchors.

[0020] Accordingly, in yet a further broad form of the invention there is provided a bottom-up method for the construction of an underground structure can be used subsequent to the completion of the formation level of the precast concrete panel system affixed to piles; said method including the steps of:

(a) Constructing internal footings, drainage and sewer systems.

(b) Constructing lift shafts.
(c) Constructing additional underground structure including basement slabs and wall.
(d) Progressively destress the relevant temporary anchors and remove the anchor plates and protruding portions of the temporary anchors.

[0021] Accordingly, in yet a further broad form of the invention there is provided a top-down method of affixing precast concrete panels to a rock face; said method including the steps of:

(a) Excavate in increments.
(b) Affix precast concrete panels to the rock face thereby to line the rock face with the precast concrete panels preparatory to commencing the next increment of excavation.

[0022] Accordingly, in yet a further broad form of the invention there is provided a bottom-up method for the construction of the underground structure can be used subsequent to the completion of the formation level of the precast concrete panel system affixed to rock a face; said method including the steps of:

(a) Constructing internal footings, drainage and sewer systems,
(b) Constructing lift shafts.
(c) Constructing underground structure: basement slabs and wall

[0023] Accordingly, in yet a further broad form of the invention there is provided a top-down method of affixing precast concrete panels to canopy tubes; said method including the steps of:

(a) Inserting hollow canopy tubes into soil/earth in an arched formation slightly above the intended arched formation,
(b) Fill canopy tubes with grout.
(c) Excavate in increments below the tubes to commence tunnelling.
(d) Affix precast concrete panels to grout filled canopy tubes

[0024] Preferably the solid structure is a rock face.
[0025] Preferably the solid structure comprises a plurality of columns.
[0026] Preferably the precast concrete panels are affixed to a front portion of the columns.
[0027] Preferably the material in the volume between the columns is not excavated.
[0028] Preferably the precast concrete panels are arranged with their edges in a juxtaposed relationship.
[0029] Preferably an expansion seal, gasket or wall seal system (as described further in this patent application) can be utilized to seal between the adjacent precast concrete panels.
[0030] Preferably the precast concrete panels adjoin at a location between the columns.
[0031] Preferably the precast concrete panels adjoin vertically.
[0032] Preferably the precast concrete panels adjoin horizontally.
[0033] Preferably the columns are substantially parallel to each other.
[0034] Preferably the columns comprise piles.
[0035] Preferably the piles comprise soldier piles.
[0036] Preferably the piles comprise of contiguous piles
[0037] Preferably the piles comprise of secant piles.
[0038] Preferably the piles are comprised of reinforced concrete.
[0039] Preferably each pile of the piles is formed by the step of drilling so as to define a tubular cavity followed by the step of inserting reinforcement material into the tubular cavity followed by the step of pouring concrete into the tubular cavity and allowing it to set thereby to construct the pile.
[0040] Preferably the columns comprise canopy tubes.
[0041] Preferably the canopy tubes are filled with grout.
[0042] Preferably the perimeter surface is substantially planar.
[0043] Preferably the perimeter surface is substantially curved.
[0044] Preferably the precast concrete panels are comprised of steel and/or fibre reinforced concrete.
[0045] Preferably the precast concrete panels are cast in a mould.
[0046] Preferably the precast concrete panels are cast with a fully covering vertical drainage structure void HDPE mesh.
[0047] In a preferred form the mesh is covered both sides with a geotextile being a composite material that is adhered to the reverse side of the precast concrete panels.
[0048] Preferably the reverse side of the precast concrete panels comprising said fully covering vertical drainage structure void HDPE mesh.
[0049] In a preferred form the mesh is covered both sides with a geotextile being a composite material that is positioned against the solid structure to which the precast concrete panels are affixed.
[0050] Preferably the precast concrete panels are cast with an encapsulated flexible seal member extending from at least one edge of the precast concrete panels.
[0051] Preferably the precast concrete panels are affixed to the solid structure by means of rock bolts.
[0052] Preferably the precast concrete panels are affixed to the solid structure by means of chemical bolts.
[0053] Preferably the precast concrete panels are affixed to the solid structure by means of mechanical bolts.
[0054] Preferably the precast concrete panels are affixed in a first step by means of anchors extending beyond the perimeter surface into material located be-

hind the perimeter surface.

[0055] Preferably the anchors are deactivated after alternative support structures are implemented.

[0056] Preferably the anchors are deactivated after the basement floors are built.

[0057] Preferably excavation occurs at a maximum of 2 metre increments.

[0058] Preferably if tanking of the underground structure is required, install the precast concrete panels horizontally on the lowest basement and vertically on the perimeter of the structure.

[0059] Preferably there is a further step of sealing all joints between adjacent panels.

[0060] Preferably sealing is performed utilising overlapping seals, expansion seal, gasket or the wall seal system as described further in this application.

BRIEF DESCRIPTION OF DRAWINGS

[0061] Embodiments of the present invention will now be described with reference to the accompanying drawings wherein:

Figure 1, is a prior art illustration of a conventional pile and shotcrete wall shoring system used for lining excavations. The inset figure 1B illustrates detail of the piles and intervening shotcrete fill construction.

Figures 2 A, B and C, illustrate respectively a plan, side and front view a precast concrete panel system applied to piles for the construction of walls lining the perimeter surface of an excavation, in accordance with a first preferred embodiment of the present invention.

Figure 3 illustrates, in a first preferred embodiment, a detailed side section view of the piles and precast concrete panel system of figure 2 incorporating a drainage system in accordance with a further embodiment.

Figure 4 A, B and C illustrate respectively the plan, front and side views of the system of figure 2 or figure 3 with a joint sealing system in accordance with a further preferred embodiment.

Figure 5 shows a side section view of the joint sealing system of figure 4.

Figures 6 A, B and C, illustrate respectively a plan, side and front view of the system of precast concrete panels affixed directly to a rock face for the construction of walls lining the perimeter surface of an excavation, in accordance with a further preferred embodiment.

Figure 7 illustrates an end cross section view of a precast concrete panels system in accordance with a further embodiment affixed to canopy tubes installed in an arch formation for the construction of a tunnel.

Figure 8 comprises views as illustrated of a flexible seal system in accordance with a first preferred embodiment applied to adjacent concrete panels;

Figure 9A comprises a side section detail view of a welded portion of the flexible seal of members of Fig8;

Figures 9B and 9C comprise a further plan and sectioned end view with enlargements of the flexible seal members of Fig 8;

Figure 10 comprises views as illustrated of a flexible seal system in accordance with a second preferred embodiment applied to adjacent concrete panels;

Figures 10A and 10B comprise view of variations of the flexible seal system of Figure 10;

Figure 11 comprises views as illustrated of a flexible seal system in accordance with a third preferred embodiment applied to adjacent concrete panels;

Figure 11A comprises a side section detail view of a welded portion of the flexible seal of members of Fig 11

Figure 12 illustrates a wall panel arrangement constructed from the embodiments of any one of Figures 8 to 11;

Figure 13 is a diagrammatic arrangement of a methodology for defining a landfill volume;

Figure 14 illustrates a methodology for defining a landfill volume which can advantageously utilise the wall seal system of any one of Figures 8 to 11;

Figure 15 comprises views as illustrated of a flexible seal system in accordance with a fourth preferred embodiment, applicable to any of the above-described methodologies

figure 16 is a perspective view of an alternative embodiment for sealing adjoined precast concrete panels,

figure 17 is a perspective view of a further embodiment of a precast concrete panel incorporating surface cavities.

DETAILED DESCRIPTION OF PREFERED EMBODIMENTS

[0062] Embodiments of the present invention are con-

cerned with the use of precast concrete panels affixed to solid structures to form the interior walls or linings of excavations such as tunnels or underground structures which may be in the form of car parks, train stations and containment cells for contaminated materials. In one form components of the system may be used to form a shoring system to facilitate formation of the excavations.

First Embodiment

[0063] With reference to figure 2A, there is illustrated a plan view of a first embodiment of the present invention where the solid structures in this instance comprise vertical piles 121.

[0064] In this preferred embodiment, the excavation is built utilizing a precast concrete panel system 100 in this instance by way of a top-down construction method. Once the formation of the excavation has been achieved, the construction of the underground structure can start using a bottom-up method.

[0065] In the first embodiment of the precast concrete panels system 100 piles 121 are inserted into the ground at a horizontal spacing 145 around the exterior perimeter 144 of the underground structure 146 to be formed. In preferred forms the horizontal spacing 145 between the piles is calculated preferably using the vertical loads and the side loads exerted on the piles. A typical, non-limiting spacing is approximately 2 - 2.5 metres.

[0066] With reference to figure 2C, in the first preferred embodiment, the material directly in front of the piles 121 may be excavated in vertical increments 147 (preferably maximum 2 metres) to avoid ground collapse. At each excavated vertical increment 147, the rectangular precast concrete panels 122 are affixed, in this instance, to the front portion of two or more piles 121. In a preferred form the precast concrete panels 122 are oriented with their longest dimension parallel to the ground. In another form the precast concrete panels 122 may include decorative features. In one form these features may include relief patterns.

[0067] With reference to figure 2C, the preferred juxtaposed relationship between precast concrete panels 121 ensures that they vertically adjoin at a region 149 located intermediate the piles. In a preferred form there may be a gap, for example of up to 20 mm, between adjacent precast concrete panels. In this embodiment the region 149 at no stage is located flush with the front 148 of the piles 121.

[0068] In this instance the preferred method of affixing the precast concrete panels to the piles 21 is by means of bolts 26 passing through the precast concrete panels 122 and into the piles 121. In a particular preferred form, a minimum of 4 bolts 126 is utilised to affix each precast concrete panel 122 to piles 121.

[0069] In a preferred embodiment, a temporary anchor 120 is inserted through a steel plate 123 and driven at an angle into a precast concrete panel 122. In a preferred form the temporary anchor 120 passes through the precast concrete panel 122 and then through the soldier pile 121 to which the precast concrete panel is abutted. The temporary anchor 120 then extends into the material 151 located behind the perimeter surface 144 (see figure 2B) thereby to anchor the precast concrete panels 122 into the material 151. There remains a portion of the temporary anchor 120 which protrudes at an angle from the surface of the wall 150. This arrangement provides at least temporary bracing or shoring of the precast concrete panels 122 pending utilisation of alternative forms of bracing or shoring.

[0070] In a preferred embodiment, the basement slabs 127 may form the floor of each respective level. The slabs 127 are installed sequentially from the lowest level up. The floors provide the required bracing or shoring for the precast concrete panel system 100. As each floor is installed the relevant temporary anchor 120 may be destressed and the anchor plates 123 and protruding section of the temporary anchor 150 removed.

[0071] In a preferred embodiment, the precast concrete panels 122 are cast with a fully covering vertical drainage structure 125 on the reverse side. The vertical drainage structure 125 includes either a bi-dimensional or tri-dimensional HDPE mesh void structure, encapsulated by a geotextile fabric. The vertical drainage structure 125 may function as a conveyance passage for water and/or gas emissions. In addition, or in the alternative it may be used as a thermal and/or noise insulator.

Second Preferred Embodiment

[0072] With reference to figure 4A, B and C and figure 5 there is illustrated a second preferred embodiment of the present precast concrete panel system 200 wherein the gaps between the affixed precast concrete panels 122 are sealed using a flexible seal system for provision of a substantially watertight seal between adjacent concrete panels.

[0073] In a preferred embodiment the precast concrete panels are cast with an encapsulated flexible seal member extending from at least one edge of the precast concrete panels.

[0074] In this second preferred embodiment the precast concrete panels are constructed from a method comprising pouring concrete into formers moulds; suspending flexible seal members into the concrete prior to its setting such that at least the anchor portion of the flexible seal member is encased within the concrete; The concrete then sets to form a solid concrete panel having one or more flexible seal members anchored therein.

[0075] The concrete panels are arranged in juxtaposed relationship such that an overlap component of a flexible seal member of a first type overlaps at least a portion of a surface component of a flexible seal member of a second type so as to form an elongated weld zone along edges of the juxtaposed concrete panels. A welding operation is performed along the length of the elongated weld zone whereby the overlap component of the flexible seal mem-

ber of the first type is welded to the flexible seal member of the second type substantially along the elongated weld zone thereby to form a substantially water tight flexible seal between the juxtaposed concrete panels. The overlap component of the overlap components of the flexible seal members proximate the vertical edge of first and second vertical concrete panels are welded. Panels may be stacked on the longitudinal alignment of panels

[0076] With reference to inset figure 5 one particular form of the wall seal system comprises an F shaped membrane 130 having an overlap component 130A is anchored into precast concrete panel 122 by means of anchor component 130B. The overlap component 130A is dimensioned so as to, in use, overlay an external portion of C shaped membrane 131 and to which it is subsequently welded by double weld 132. The C shaped membrane is anchored into the adjacent panel 122 by means of anchor components 131B.

[0077] In this instance a tongue in groove or male/female joint 128 is utilised to position and retain adjacent precast concrete panels 122 in juxtaposed relationship.

[0078] In one form the precast concrete panels 122 are fixed in a manner to suit the construction sequence of the underground structure and seek to avoid the male-female interlocking joints 128 from interfering with basement slabs 127 and walls.

[0079] In an instance where the ground water table is very high partial or full tanking of the underground structure may be required. In this case the lowest basement is built using the precast concrete panels 122 placed horizontally. The joints 128 between the precast concrete panels may be waterproofed using the Wall Seal System 124.

[0080] Further examples of the wall seal system 124 which may be applied to any of the described above embodiments, are described later in this specification.

[0081] In the precast concrete panels system 200 shown in figure 4A the solid structure illustrated comprises piles 121 arranged in soldier pile format. In a further preferred embodiment the horizontal spacing between the piles 145 becomes negligible and the solid structure takes the form of contiguous piles 171. A plan view of such an arrangement is shown in Figure 1D. The precast concrete panels 121 may then be affixed directly to the front region 148 of the contiguous piles in a juxtaposed relationship. In preferred forms the gaps between the affixed precast concrete panels 122 are sealed using sealing material. In a particular preferred form, a flexible seal system (as described elsewhere in the specification) for provision of a substantially watertight seal between adjacent concrete panels may be adopted. In this instance the fully covering vertical drainage structure void HDPE mesh adhered to the reverse side of the precast concrete panels acts as a drainage system between the contiguous piles and the inner wall.

[0082] In the precast concrete panels system 200 shown in figure 4A the solid structure illustrated is piles 121. In a further preferred embodiment, where the material 151 has a high water table, the piles 121 may be cast such that they are interlocked and the solid structure takes the form of secant piles (see figure 1D). The construction of secant piles involves casting primary (female) piles 172 first with secondary (male) piles 173, cutting into the primary piles forming a continuous wall. In one form the primary and secondary piles may be cast from different concrete. In this instance the fully covering vertical drainage structure void HDPE mesh adhered to the reverse side of the precast concrete panels acts as the drainage system between the piles and the inner wall.

Third Preferred Embodiment

[0083] With reference to figure 6A, B and C there is illustrated a third preferred embodiment of the present precast concrete panel system 300 wherein precast concrete panels 122 are affixed directly to a rock face 133 to line the perimeter surface 144 of an excavation 146 in this instance defined substantially by the rock face 133.

[0084] In this embodiment, particularly where the perimeter surface 144 of an excavation is too dense to insert any additional solid fixtures, the precast concrete panels 122 may be directly affixed to the rock face 133 or rocky ground. In this instance, the preferred method of affixing the precast concrete panels to the rock face 133 is by means of rock bolts 134 passing through the precast concrete panel 122 and into the rock face 133. In this instance, no temporary anchor bolts are required. In a preferred form, the rock bolts 134 are used to support the panels 122 in place on a permanent basis.

Fourth Preferred Embodiment

[0085] With reference to figure 7, there is illustrated a fourth embodiment of the present precast concrete panel system 400 wherein curved precast concrete panels 135 are affixed to canopy tubes 142, to line the perimeter surface 144 of an arch formation 152.

[0086] In the fourth preferred embodiment hollow canopy tubes 142 are driven into material 151 at a distance slightly higher than the perimeter surface 144 of the intended arch formation 152. The canopy tubes 142 are filled with grout 153 and the material 151 directly below is excavated in increments. The curved precast concrete panels 135 are affixed to the grout filled canopy tubes, in this instance using stainless steel bolts 136, as the excavation progresses.

[0087] In a preferred embodiment, the curved precast concrete panels 135 may include on the reverse side a fully covered drainage structure which in a preferred form comprises of a biplanar or tri-planar HDPE mesh void structure encapsulated by a geotextile fabric 125. Adjacent curved precast panels 135 may be joined using the flexible seal system 124 described earlier. In preferred forms the flexible seal system 124 acts to form a waterproof joint between adjacent panels 135.

[0088] With reference to figure 16, there is illustrated a

perspective view of an alternative embodiment for sealing the reverse side of adjacent precast concrete panels. The precast concrete panel 122 is defined by surface edges 154. In this instance the perimeter of the precast concrete panel 122 near the surface edge 163 is rimmed with a conductor, preferably copper wire positioned beneath a layer of the flexible seal system 124. A through channel 161 is formed communicating from the front side 122A to the reverse side of the precast concrete panel 122. The edges 154 of two adjacent precast concrete panels 122 may be sealed by electrofusion welding by means of heating the copper wire 165 using the through channel 161 to establish an electrical connection with the copper wire on the reverse side of the precast concrete panel 122. In a particular preferred form electro conductive welding is utilised to weld both the front layers of the flexible seal system and the reverse side layers of the panels 122 thereby providing a double seal.

[0089] With reference to figure 17, there is illustrated a perspective view of a further embodiment of a precast concrete panel 122 incorporating cavities 160. The cavities 160 in this instance comprise hollowed out passages through the precast concrete panel from one surface edge 154 to another. These cavities 160 can be used to house services such as electrical and communication cables thereby to facilitate the enclosed transportation of services around the perimeter of the underground structure 146.

Flexible seal system

[0090] The flexible seal system 124 described above may take a number of forms when used to assist in sealing any of the above described embodiments. Further examples of the flexible seal system are described below and with reference to figures 8 to 15.

[0091] The flexible seal system is for sealing the joints between abutting concrete (or other settable material) panels. In each of the below described embodiments, each panel is prepared when cast with flexible seal members of two distinct configurations; a first flexible seal member and a second flexible seal member. Both the flexible seal members include at least one anchor component embedded within the concrete and a surface portion which extends over, or overlays, a portion of the outer surface of the panel. The first flexible seal member is distinguished from the second flexible seal member in that an overlap portion extends from its surface portion in such a way that the overlap portion extends beyond the edge of the panel.

[0092] With reference to Figure 8, there is illustrated a first embodiment of a flexible seal system 10 used to create a substantially watertight seal between, in this instance, a first concrete panel 11 and a second concrete panel 12. As shown in the plan view there is a first flexible seal member 13 proximate a first end of concrete panel 12. First flexible seal member 13 includes a surface component 24 extending over, and anchored into, a surface region 14 first concrete panel 11. In this instance the first flexible seal member 13 further includes at least an anchor component formed as legs or elongate flanges 15A,15B which, in this instance project substantially normal from and are cast into the surface region 14 of the first concrete panel 11, leaving the surface component 24 exposed above surface region 14. Each of the legs 15A, 15B ends in an enlarged portion for securely embedding the anchor components in the concrete of the panel. The first flexible seal member 13 further includes an overlap component 16 mechanically supported by and extending from the surface component 24 to extend past the end of the concrete panel 11. The first flexible seal member 13 thus described is shown in profile 1 of Figure 8.

[0093] The flexible seal system 10 further comprises a second flexible seal member 17, disposed proximate a second end of an abutting concrete panel 12, comprising, in this instance, a surface component 18 extending over a portion of the surface region 20. Second flexible seal member further includes an anchor component 19 in this instance in the form of a first leg 19 A and a second leg 19 B projecting preferably substantially at right angles from surface component 18, The legs 19 A and 19 B are cast into the surface region 20 of second concrete panel 12 in such a way as to anchor surface component 18 reliably into the second concrete panel 12 whilst leaving surface component 18 exposed above surface region 20.

[0094] The flexible seal members are arranged so that each concrete panel is provided with a first flexible seal member along each of a first pair of contiguous edges and with a second flexible seal member along each of a second pair of contiguous edges. Thus the differences between the first and second flexible seal members provides, in this embodiment, for sealing around both the vertical and horizontal edges of the panel.

[0095] As shown in the plan view of a concrete panel 11 prepared with the flexible seal system of the invention in Figures 9B, the ends of the first flexible seal members 13 at their intersection 42 are mitrered and welded to form a watertight continuous seal surface. Similarly, the second flexible seal members 17 at their intersection 44 are mitrered and welded. The junctions 46 between first and second flexible seal members are also mitrered and welded so that there is formed a continuous seal surface at the perimeter of the concrete panel. The cross sectioned view and enlargements of Figure 9C show the disposition of each of the first and second flexible seal members and their anchor portions relative the opposite edges of the concrete panel.

[0096] The concrete panels of this preferred embodiment may be formed as follows. The flexible seal members are prepared in lengths to suit the dimensions of the panel to which they are to be applied and the ends mitrered as described above. The first and second flexible seal members are then welded at their intersections to form the continuous seal surface and positioned over formwork for the pouring of the concrete, with the anchor

members suspended relative the formwork so as to become embedded within the concrete, and leaving the surface components extending over the surface. One the concrete has set; pressure testing of the flexible seal members completes the process.

[0097] Each of the first and second flexible seal members comprises an integral polymer structure. In use the first concrete panel 11 and the second concrete panel 12 are juxtaposed in sufficiently close relationship that overlap component 16 or at least a portion of it overlaps a longitudinal length of at least a portion of the surface component 18 as shown in the plan view of Figure 1 thereby to define a weld zone 21.

[0098] It should be noted that the surface component extending along an outer surface of the concrete panel with the overlap portion disposed as shown in Figures 8 and 9A, affords considerable flexibility to the seal of the invention, allowing some movement between two adjacent panels in at least two directions. Moreover, the relatively short distance the anchor components of the two flexible seal members intrude into the concrete allows the flexible seal system of the invention to be used with relatively thin concrete panels. This may be contrasted for example with the arrangement of FR2415693 to Bachy discussed above, in which the arrangement of the flexible seal members require a much greater thickness of panel. It is noted also that the Bachy system creates an inherent weakness in the concrete by the long intrusion likely to lead to cracking.

[0099] The overlap component 16 and surface component 18 are made from a weldable plastics material whereby, following the juxtaposition of the adjacent panels the overlap component 16 is welded along its length to the surface component 18 by means not shown. Preferably, the overlap component of the first flexible seal member is of thinner or more pliable than the anchor components.

[0100] Preferred materials for the flexible seal members 13, 17 include plastics materials, in particular, plastic materials which have the capacity to stretch and flex and preferably to be welded one to the other.

[0101] Suitable materials include polymers; HDPE; PVC; Teflon and polymer blends. Preferably these materials may be particularly selected and optimized for properties such as elongation, resistance to chemicals, and resistance to heat. Polyethylene and polypropylene are particularly suited for petrochemical applications. PVC or PET may be suited to water applications.

[0102] Preferably the same material is used for both the first flexible seal member 13 and the second flexible seal member 17 thereby to assist in homogeneity of the weld (see below).

[0103] A preferred process of welding is thermal fusion welding utilising a modified plastics extruder machine (not shown) that can be hand operated and which extrudes a molten bead of High Elongation resin through a "stepped" die head over an overlapping weld zone 21. Preferably the weld zone 21 is prepared via abrasion prior to extrusion welding to remove surface grit and contamination.

[0104] In preferred forms the weld consumable comprises the same material composition as that of the first flexible seal member 13 and second flexible seal member 17. At figure 9A is a side section view of a preferred form of weld showing the consumable 40 enveloping a beveled edge portion of the overlap component 16 and at least a portion of the surface component 18.

[0105] Preferably, each weld is tested for water tightness at the completion of the weld. In a preferred method, after preparing the seal to be tested with a suitable liquid, a plexiglass dome, provided with a seal around its periphery, is placed over the area to be tested and a partial vacuum created under the dome to show up any imperfections. This testing is facilitated by the ready access available to the overlap component of the first flexible seal member and the bead of welding along the overlap edge.

[0106] With reference to the wall panel plan view of fig 8 a preferred arrangement for the first concrete panel 11 is to have a flexible seal member of the first flexible seal member 13 aligned along a first edge 22 thereof and to have a second flexible seal member 17 aligned along an opposite parallel second edge 23 thereof as illustrated. Panels of like types and flexible seal member arrangements can then be juxtaposed side-by-side in the manner illustrated in the adjacent wall panels plan view of Figure 8. In this embodiment a preferred distance between edges of adjacent panels is approximately 20 mm and with the opposed anchor component inset approximately 50 mm from an edge of an opposed panel edge with the overlap component extending approximately 130 mm from an edge of the panel into which it is anchored so as to thereby provide a weld zone of around 60 mm and where the face of the surface region of the second flexible seal member over which it extends is of the order of 90 mm in width.

[0107] Typical precast concrete panel or cast in situ panel dimensions can be of the order of 4000mm mm x 2000mm or as large as 2000mm x 6000mm mm or as required by the application. The panels themselves may be square, rectangular, cruciform, arched or other suitable shapes preferably adapted for adjacent abutting of long edges thereof.

[0108] In preferred forms the flexible seal members are applied on the "inside" of the resulting barrier structure. That is to say on the side abutting the material or liquid which is being retained by the structure.

[0109] With reference to Figure 10 there is illustrated a further embodiment of a flexible seal system 210 wherein like components are numbered as for the first embodiment described with reference to Figure 8 except in the 200s series. In this instance first flexible seal member 213 includes a single anchor component 215 subtending from a surface component 24 which, in this instance, then extends integrally to the overlap component 216.

[0110] The overlaps of the arrangement of Figure 10

are approximately the same as for the arrangement of Figure 8.

[0111] With reference to Figure 11 there is illustrated a further embodiment of a flexible seal system 310 where like components are numbered as for the embodiment described with reference to Figure 8 except in the 300s series. The construction of the flexible seal members 313, 317 is substantially the same as that for the first embodiment. In this instance the second flexible seal member is placed as close to an edge of the concrete panel as possible rather than inset 50 mm as was the case with the arrangement of Figure 8. Correspondingly the extension of the overlap component 316 may be reduced to 75 mm as a result.

[0112] As shown in Figure 12 further panels can then be stacked on the initial longitudinal alignment of panels and joined by welds along all four edges to create a wall structure of substantially any length and any height. In this instance a wall structure 29 is comprised of lower juxtaposed panels 25, 26 joined at weld zone 30 above which are placed further panels 27, 28 which are themselves joined at weld zone 31. Upper panel 27 is joined at weld zone 32 to lower panel 25 whilst upper panel 28 is joined to lower panel 26 at weld zone 33 thereby to form a wall structure comprised of four concrete panels.

[0113] The wall panel arrangement of Figure 12 can be used by way on non-limiting example of a dam wall, tunnel arch, tank farm vertical bund wall, sea wall.

[0114] In addition, in respect of any one of the above described embodiments, a fire-resistant/heat-resistant/chemical-resistant/UV-resistant expandable and/or flexible sealant or mastic may be inserted in the gap region between adjacent panels. In some forms this will be for the purpose of providing UV resistance. In other forms it will be for the purpose of providing heat resistance. In some forms this will be particularly for protecting the welded flexible seal.

Reclamation System

[0115] The above described system of any previous embodiments including those of figures 1 to 7 can be utilised as part of a methodology to reclaim landfill volume.

[0116] With reference to Figure 13 there is illustrated a berm 50 traditionally used to define a boundary for a landfill volume.

[0117] An alternative arrangement which permits use of substantially the volume of the berm involves use of a substantially vertical wall structure 51 thereby permitting use of volume 52 that otherwise would be occupied by the berm itself.

[0118] Advantageously, the vertical wall structure 51 is constructed utilising the arrangements described with reference to the earlier embodiments of Figures 8 to 12.

[0119] With reference to Figure 14, a preferred system which can be used as part of a landfill system includes:

(a) defining a substantially flat filling area 60 defined in part by at least a far edge region 61 separated from a near edge region 62

(b) constructing a first substantially vertical wall structure 63 from concrete panels to a first panel height h1 substantially along the far edge region 61

(c) placing landfill 64 up to the level of the first panel height h1

(d) constructing a substantially vertical second wall structure 65 along top edges of the first substantially vertical wall structure 63 to a second panel height h2

(e) placing landfill 66 to the level of the second panel height h2. The process may be continued as necessary until a desired maximum wall height hn is achieved.

[0120] In some applications a liner may be applied to the filling area 60. In some applications a contiguous liner may be applied over the inside face of the wall structure 63, 65...

[0121] Applications for embodiments of the invention described above include, but not are limited to:

(a) Water retained structures

(b) Hydraulic barrier structures such as sea walls or cut off walls

(c) Chemical spill barrier structures in tankfarm bundwall storages

(d) Retaining wall barriers

(e) Waterproofing of the low grade concrete structures

(f) Waterproofing of tunnel arch structures

(g) Volume capacity reclaiming structures for landfills

[0122] In a preferred arrangement in which the concrete panels with the flexible seal system of the invention are used for the sequential erection of a wall defining the boundary of refuse land fill, the concrete panels are erected with the flexible seal members on the rear surface of the panels, that is away from refuse land fill. In this arrangement, the flexible seal member along the lower horizontal edge of the lowermost or first row of panels of the wall, is the second flexible seal member described above and designated 17 in Figures 8 and 9A. A liquid proof seal between the wall and ground cover sheet of the land fill area can then be made by extending the polymer ground sheet of the land fill surface to lie under the foundation or toe of the wall to curve upward and, after the concrete panels are erected, welding the edge of the ground cover sheet to the flexible seal member of the panel.

[0123] With reference to Figure 15, there is illustrated a wall seal system 410, in accordance with a further preferred embodiment of the invention, wherein like components are numbered as for earlier embodiments, except in the 400 series.

[0124] In this instance, the overlap component 416 comprises a separate component from the first flexible

seal member 413 and the second flexible seal member 417. Accordingly, in use, the adjacent wall panels 411, 412 are juxtaposed and then the overlap component 416 is applied so as to overlap at least a portion of both the first flexible seal member 413 and the second flexible seal member 417, and substantially along the entire length thereof. The overlap component 416 is then welded to both flexible seal members 413, 417.

[0125] This embodiment is suited for use in most situations where the previously-described embodiments are applicable.

Claims

1. An excavation perimeter surface lining system for lining a perimeter surface (144) of an excavation (146); the perimeter surface (144) defined by a solid structure (133; 146); **characterized in that** the perimeter surface lined by means of precast concrete panels (122; 135) which are affixed to the solid structure (133; 146); wherein the solid structure (133; 146) is a rock face (133); wherein the solid structure comprises a plurality of columns (121); wherein the precast concrete panels (122; 135) are affixed to a front portion of the columns (121); wherein material in the volume between the columns (121) is not excavated; wherein the precast concrete panels (122; 135) are arranged with their edges in a juxtaposed relationship; wherein the precast concrete panels (122; 135) adjoin at a location (149) between the columns (121); wherein the precast concrete panels (122; 135) adjoin vertically; where the precast concrete panels (122; 135) adjoin horizontally; wherein the columns (121) are substantially parallel to each other; and wherein the concrete panels (122; 135) are arranged in juxtaposed relationship such that an overlap component of a flexible seal member of a first type overlaps at least a portion of a surface component of a flexible seal member of a second type so as to form an elongated weld zone along edges of the juxtaposed concrete panels; and wherein a welding operation is performed along the length of the elongated weld zone whereby the overlap component of the flexible seal member of the first type is welded to the flexible seal member of the second type substantially along the elongated weld zone thereby to form a substantially water tight flexible seal between the juxtaposed concrete panels; and wherein the overlap component of the overlap components of the flexible seal members proximate the vertical edge of first and second vertical concrete panels are welded.

2. The system of claim 1 wherein the precast concrete panels (122; 135) are comprised of steel and/or fibre reinforced concrete.

3. The system of claim 1 or 2 wherein the precast concrete panels (122; 135) are cast in a mould.

4. The system of claim 3 wherein the precast concrete panels (122; 135) are cast with a fully covering vertical drainage structure void HDPE mesh adhered to the reverse side of the precast concrete panels (122; 135).

5. The system of claim 4 wherein the reverse side of the precast concrete panels (122; 135) comprising said fully covering vertical drainage structure void HDPE mesh covered both sides with a geotextile being a composite material is positioned against the solid structure (133; 146) to which the precast concrete panels (122; 135) are affixed.

6. The system of any one of claims 3 to 5 wherein the precast concrete panels (122; 135) are cast with an encapsulated flexible seal member extending from at least one edge of the precast concrete panels (122; 135).

7. The system of any one of claims 1 to 6 wherein the precast concrete panels (122) are affixed to the solid structure (133) by means of rock bolts (134).

8. An excavation perimeter surface lining method for lining a perimeter surface (144) of an excavation (146); the perimeter surface (144) defined by a solid structure (133; 146); **characterized in that** the perimeter surface (144) lined by means of precast concrete panels (122; 135) which are affixed to the solid structure (133; 146) ; and wherein the solid structure (133; 146) is a rock face (133); and wherein the solid structure (133; 146) comprises a plurality of columns (121); and wherein the precast concrete panels (122; 135) are affixed to a front portion of the columns (121); and wherein material in the volume between the columns (121) is not excavated; and wherein the precast concrete panels (122; 135) are arranged with their edges in a juxtaposed relationship; and wherein the precast concrete panels (122; 135) adjoin at a location (149) between the columns (121); and wherein the precast concrete panels (122; 135) adjoin vertically; and wherein the precast concrete panels (122; 135) adjoin horizontally; and wherein the columns (121) are substantially parallel to each other; and wherein the concrete panels (122; 135) are arranged in juxtaposed relationship such that an overlap component of a flexible seal member of a first type overlaps at least a portion of a surface component of a flexible seal member of a second type so as to form an elongated weld zone along edges of the juxtaposed concrete panels; and wherein a welding operation is performed along the length of the elongated weld zone whereby the overlap component of the flexible seal member of the first type is welded to

the flexible seal member of the second type substantially along the elongated weld zone thereby to form a substantially water tight flexible seal between the juxtaposed concrete panels; and wherein the overlap component of the overlap components of the flexible seal members proximate the vertical edge of first and second vertical concrete panels are welded.

9. The method of claim 8 wherein the precast concrete panels (122; 135) are comprised of steel and/or fibre reinforced concrete.

10. The method of claim 8 or 9 wherein the precast concrete panels (122; 135) are cast in a mould.

11. The method of claim 10 wherein the precast concrete panels (122; 135) are cast with a fully covering vertical drainage structure void HDPE mesh covered both sides with a geotextile being a composite material adhered to the reverse side of the precast concrete panels (122; 135).

12. The method of claim 11 wherein the reverse side of the precast concrete panels (122; 135) comprising said fully covering vertical drainage structure void HDPE mesh covered both sides with a geotextile being a composite material is positioned against the solid structure (133; 146) to which the precast concrete panels (122; 135) are affixed.

13. The method of any one of claims 10 to 12 wherein the precast concrete panels (122; 135) are cast with an encapsulated flexible seal member extending from at least one edge of the precast concrete panels (122; 135).

14. The method of any one of claims 8 to 10 wherein the precast concrete panels (122; 135) are affixed to the solid structure (133) by means of rock bolts (134).

15. The method of any one of claims 8 to 14 wherein the precast concrete panels (122; 135) are affixed in a first step by means of anchors extending beyond the perimeter surface into material located behind the perimeter surface.

Patentansprüche

1. System zum Auskleiden einer Umfangsfläche (144) einer Ausgrabung (146), wobei die Umfangsfläche (144) durch eine massive Struktur (133; 146) definiert ist, **dadurch gekennzeichnet, dass** die Umfangsfläche mittels vorgefertigter Betonplatten (122; 135) ausgekleidet ist, die an der massiven Struktur (133; 146) befestigt sind; wobei die massive Struktur (133; 146) eine Felswand (133) ist; wobei die massive Struktur eine Vielzahl von Säulen (121) umfasst; wobei die vorgefertigten Betonplatten (122; 135) an einem vorderen Abschnitt der Säulen (121) befestigt sind; wobei das Material in dem Volumen zwischen den Säulen (121) nicht ausgegraben wird; wobei die vorgefertigten Betonplatten (122; 135) mit ihren Kanten in einer nebeneinander liegenden Beziehung angeordnet sind; wobei die vorgefertigten Betonplatten (122; 135) an einer Stelle (149) zwischen den Säulen (121) aneinander angrenzen; wobei die vorgefertigten Betonplatten (122; 135) vertikal aneinander angrenzen; wobei die vorgefertigten Betonplatten (122; 135) horizontal aneinander angrenzen; wobei die Säulen (121) im Wesentlichen parallel zueinander sind; und wobei die Betonplatten (122; 135) in einer nebeneinander liegenden Beziehung angeordnet sind, so dass eine Überlappungskomponente eines flexiblen Dichtungselements eines ersten Typs mindestens einen Teil einer Oberflächenkomponente eines flexiblen Dichtungselements eines zweiten Typs überlappt, um eine längliche Schweißzone entlang der Kanten der nebeneinander liegenden Betonplatten zu bilden; und wobei ein Schweißvorgang entlang der Länge der länglichen Schweißzone durchgeführt wird, wodurch die Überlappungskomponente des flexiblen Dichtungselements des ersten Typs mit dem flexiblen Dichtungselement des zweiten Typs im Wesentlichen entlang der länglichen Schweißzone verschweißt wird, um dadurch eine im Wesentlichen wasserdichte flexible Dichtung zwischen den nebeneinander liegenden Betonplatten zu bilden; und wobei die Überlappungskomponente der Überlappungskomponenten der flexiblen Dichtungselemente in der Nähe der vertikalen Kante der ersten und zweiten vertikalen Betonplatten verschweißt werden.

2. System nach Anspruch 1, bei dem die vorgefertigten Betonplatten (122; 135) aus stahl- und/oder faserverstärktem Beton bestehen.

3. System nach Anspruch 1 oder 2, bei dem die vorgefertigten Betonplatten (122; 135) in einer Form gegossen werden.

4. System nach Anspruch 3, bei dem die vorgefertigten Betonplatten (122; 135) mit einer vollständig abdeckenden vertikalen Drainagestruktur void HDPE Netz gegossen werden, die an der Rückseite der vorgefertigten Betonplatten (122; 135) haftet.

5. System nach Anspruch 4, bei dem die Rückseite der vorgefertigten Betonplatten (122; 135), die die vollständig abdeckende vertikale Drainagestruktur void HDPE netz umfasst, die beidseitig mit einem Geotextil aus einem Verbundmaterial bedeckt ist, gegen die massive Struktur (133; 146) positioniert ist, an

der die vorgefertigten Betonplatten (122; 135) befestigt sind.

6. System nach einem der Ansprüche 3 bis 5, wobei die vorgefertigten Betonplatten (122; 135) mit einem eingekapselten flexiblen Dichtungselement gegossen werden, das sich von mindestens einer Kante der vorgefertigten Betonplatten (122; 135) erstreckt.

7. System nach einem der Ansprüche 1 bis 6, bei dem die vorgefertigten Betonplatten (122) mit Hilfe von Felsbolzen (134) an der massiven Struktur (133) befestigt sind.

8. Verfahren zum Auskleiden einer Umfangsfläche (144) einer Ausgrabung (146), wobei die Umfangsfläche (144) durch eine massive Struktur (133; 146) definiert ist, **dadurch gekennzeichnet, dass** die Umfangsfläche (144) mittels vorgefertigter Betonplatten (122; 135) ausgekleidet wird, die an der massiven Struktur (133; 146) befestigt sind; und wobei die massive Struktur (133; 146) eine Felswand (133) ist; und wobei die massive Struktur (133; 146) eine Vielzahl von Säulen (121) umfasst; und wobei die vorgefertigten Betonplatten (122; 135) an einem vorderen Abschnitt der Säulen (121) befestigt sind; und wobei das Material in dem Volumen zwischen den Säulen (121) nicht ausgegraben wird; und wobei die vorgefertigten Betonplatten (122; 135) mit ihren Kanten in einer nebeneinander liegenden Beziehung angeordnet sind; und wobei die vorgefertigten Betonplatten (122; 135) an einer Stelle (149) zwischen den Säulen (121) aneinander angrenzen; und wobei die vorgefertigten Betonplatten (122; 135) vertikal aneinander angrenzen; und wobei die vorgefertigten Betonplatten (122; 135) horizontal aneinander angrenzen; und wobei die Säulen (121) im Wesentlichen parallel zueinander sind; und wobei die Betonplatten (122; 135) in einer nebeneinander liegenden Beziehung angeordnet sind, so dass eine Überlappungskomponente eines flexiblen Dichtungselements eines ersten Typs mindestens einen Teil einer Oberflächenkomponente eines flexiblen Dichtungselements eines zweiten Typs überlappt, um eine längliche Schweißzone entlang der Kanten der nebeneinander liegenden Betonplatten zu bilden und wobei ein Schweißvorgang entlang der Länge der länglichen Schweißzone durchgeführt wird, wodurch die Überlappungskomponente des flexiblen Dichtungselements des ersten Typs mit dem flexiblen Dichtungselement des zweiten Typs im Wesentlichen entlang der länglichen Schweißzone verschweißt wird, um dadurch eine im Wesentlichen wasserdichte flexible Dichtung zwischen den nebeneinander liegenden Betonplatten zu bilden; und wobei die Überlappungskomponente der Überlappungskomponenten der flexiblen Dichtungselemente in der Nähe der vertikalen Kante der ersten und zweiten vertikalen Betonplatten verschweißt werden.

9. Verfahren nach Anspruch 8, wobei die vorgefertigten Betonplatten (122; 135) aus stahl- und/oder faserverstärktem Beton bestehen.

10. Verfahren nach Anspruch 8 oder 9, bei dem die vorgefertigten Betonplatten (122; 135) in eine Form gegossen werden.

11. Verfahren nach Anspruch 10, bei dem die vorgefertigten Betonplatten (122; 135) mit einer vollständig abdeckenden vertikalen Drainagestruktur void HDPE Netz gegossen werden, die beidseitig mit ein Geotextil aus einem Verbundmaterial bedeckt ist, das an der Rückseite der vorgefertigten Betonplatten (122; 135) haftet.

12. Verfahren nach Anspruch 11, bei dem die Rückseite der vorgefertigten Betonplatten (122; 135), die die vollständig abdeckende vertikale Drainagestruktur void HDPE Netz umfasst, die beidseitig mit einem Geotextil aus einem Verbundmaterial bedeckt ist, gegen die massive Struktur (133; 146) positioniert wird, an der die vorgefertigten Betonplatten (122; 135) befestigt sind.

13. Verfahren nach einem der Ansprüche 10 bis 12, wobei die vorgefertigten Betonplatten (122; 135) mit einem eingekapselten flexiblen Dichtungselement gegossen werden, das sich von mindestens einer Kante der Betonfertigteilplatten (122; 135) erstreckt.

14. Verfahren nach einem der Ansprüche 8 bis 10, bei dem die vorgefertigten Betonplatten (122; 135) mit Hilfe von Felsbolzen (134) an der massiven Struktur (133) befestigt werden.

15. Verfahren nach einem der Ansprüche 8 bis 14, bei dem die vorgefertigten Betonplatten (122; 135) in einem ersten Schritt mit Hilfe von Ankern befestigt werden, die sich über die Umfangsfläche hinaus in das hinter der Umfangsfläche befindliche Material erstrecken.

Revendications

1. - Système de revêtement de surface périphérique d'excavation pour revêtir une surface périphérique (144) d'une excavation (146) ; la surface périphérique (144) étant définie par une structure massive (133 ; 146) ; **caractérisé par le fait que** la surface périphérique est revêtue au moyen de panneaux en béton préfabriqué (122 ; 135) qui sont fixés à la structure massive (133 ; 146) ; la structure massive

(133 ; 146) étant une paroi rocheuse (133) ; la structure massive comprenant une pluralité de colonnes (121) ; les panneaux en béton préfabriqué (122 ; 135) étant fixés à une partie avant des colonnes (121) ; du matériau dans le volume entre les colonnes (121) n'étant pas excavé ; les panneaux en béton préfabriqué (122 ; 135) étant disposés avec leurs bords dans une relation de juxtaposition ; les panneaux en béton préfabriqué (122 ; 135) étant contigus à un emplacement (149) entre les colonnes (121) ; les panneaux en béton préfabriqué (122 ; 135) étant contigus verticalement ; les panneaux en béton préfabriqué (122 ; 135) étant contigus horizontalement ; les colonnes (121) étant sensiblement parallèles les unes aux autres ; et les panneaux en béton (122 ; 135) étant disposés en relation de juxtaposition, de telle sorte qu'un composant de chevauchement d'un élément joint souple d'un premier type chevauche au moins une partie d'un composant de surface d'un élément joint souple d'un second type de façon à former une zone de soudure allongée le long de bords des panneaux en béton juxtaposés ; et une opération de soudage étant réalisée sur la longueur de la zone de soudure allongée, ce par quoi le composant de chevauchement de l'élément joint souple du premier type est soudé à l'élément joint souple du second type sensiblement le long de la zone de soudure allongée pour former ainsi un joint souple sensiblement étanche à l'eau entre les panneaux en béton juxtaposés ; et le composant de chevauchement des composants de chevauchement des éléments joints souples à proximité du bord vertical des premier et second panneaux en béton verticaux sont soudés.

2. - Système selon la revendication 1, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont faits de béton renforcé d'acier et/ou de fibres.

3. - Système selon la revendication 1 ou 2, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont coulés dans un moule.

4. - Système selon la revendication 3, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont coulés avec une structure de drainage verticale totalement couvrante maille vide HDPE, amenée à adhérer à l'envers des panneaux en béton préfabriqué (122 ; 135).

5. - Système selon la revendication 4, dans lequel l'envers des panneaux en béton préfabriqué (122 ; 135) comprenant ladite structure de drainage verticale totalement couvrante maille vide HDPE, recouverte des deux côtés d'un géotextile en matériau composite, est positionné contre la structure massive (133 ; 146) à laquelle les panneaux en béton préfabriqué (122 ; 135) sont fixés.

6. - Système selon l'une quelconque des revendications 3 à 5, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont coulés avec un élément joint souple encapsulé s'étendant à partir d'au moins un bord des panneaux en béton préfabriqué (122 ; 135).

7. - Système selon l'une quelconque des revendications 1 à 6, dans lequel les panneaux en béton préfabriqué (122) sont fixés à la structure massive (133) au moyen de boulons d'ancrage (134).

8. - Procédé de revêtement de surface périphérique d'excavation pour revêtir une surface périphérique (144) d'une excavation (146) ; la surface périphérique (144) étant définie par une structure massive (133 ; 146) ; **caractérisé par le fait que** la surface périphérique (144) est revêtue au moyen de panneaux en béton préfabriqué (122 ; 135) qui sont fixés à la structure massive (133 ; 146) ; et la structure massive (133 ; 146) étant une paroi rocheuse (133) ; et la structure massive (133 ; 146) comprenant une pluralité de colonnes (121) ; et les panneaux en béton préfabriqué (122 ; 135) étant fixés à une partie avant des colonnes (121) ; et du matériau dans le volume entre les colonnes (121) n'étant pas excavé ; et les panneaux en béton préfabriqué (122 ; 135) étant disposés avec leurs bords dans une relation de juxtaposition ; et les panneaux en béton préfabriqué (122 ; 135) étant contigus à un emplacement (149) entre les colonnes (121) ; et les panneaux en béton préfabriqué (122 ; 135) étant contigus verticalement ; et les panneaux en béton préfabriqué (122 ; 135) étant contigus horizontalement ; et les colonnes (121) étant sensiblement parallèles les unes aux autres ; et les panneaux en béton (122 ; 135) étant disposés en relation de juxtaposition, de telle sorte qu'un composant de chevauchement d'un élément joint souple d'un premier type chevauche au moins une partie d'un composant de surface d'un élément joint souple d'un second type de façon à former une zone de soudure allongée le long de bords des panneaux en béton juxtaposés ; et une opération de soudage étant réalisée sur la longueur de la zone de soudure allongée, ce par quoi le composant de chevauchement de l'élément joint souple du premier type est soudé à l'élément joint souple du second type sensiblement le long de la zone de soudure allongée pour former ainsi un joint souple sensiblement étanche à l'eau entre les panneaux en béton juxtaposés ; et le composant de chevauchement des composants de chevauchement des éléments joints souples à proximité du bord vertical des premier et second panneaux en béton verticaux sont soudés.

9. - Procédé selon la revendication 8, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont faits de béton renforcé d'acier et/ou de fibres.

10. - Procédé selon la revendication 8 ou 9, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont coulés dans un moule.

11. - Procédé selon la revendication 10, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont coulés avec une structure de drainage verticale totalement couvrante maille vide HDPE, recouverte des deux côtés d'un géotextile en matériau composite, amenée à adhérer à l'envers des panneaux en béton préfabriqué (122 ; 135).

12. - Procédé selon la revendication 11, dans lequel l'envers des panneaux en béton préfabriqué (122 ; 135) comprenant ladite structure de drainage verticale totalement couvrante maille vide HDPE, recouverte des deux côtés d'un géotextile en matériau composite, est positionné contre la structure massive (133 ; 146) à laquelle les panneaux en béton préfabriqué (122 ; 135) sont fixés.

13. - Procédé selon l'une quelconque des revendications 10 à 12, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont coulés avec un élément joint souple encapsulé s'étendant à partir d'au moins un bord des panneaux en béton préfabriqué (122 ; 135).

14. - Procédé selon l'une quelconque des revendications 8 à 10, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont fixés à la structure massive (133) au moyen de boulons d'ancrage (134).

15. - Procédé selon l'une quelconque des revendications 8 à 14, dans lequel les panneaux en béton préfabriqué (122 ; 135) sont fixés dans une première étape au moyen d'ancrages s'étendant au-delà de la surface périphérique dans du matériau situé derrière la surface périphérique.

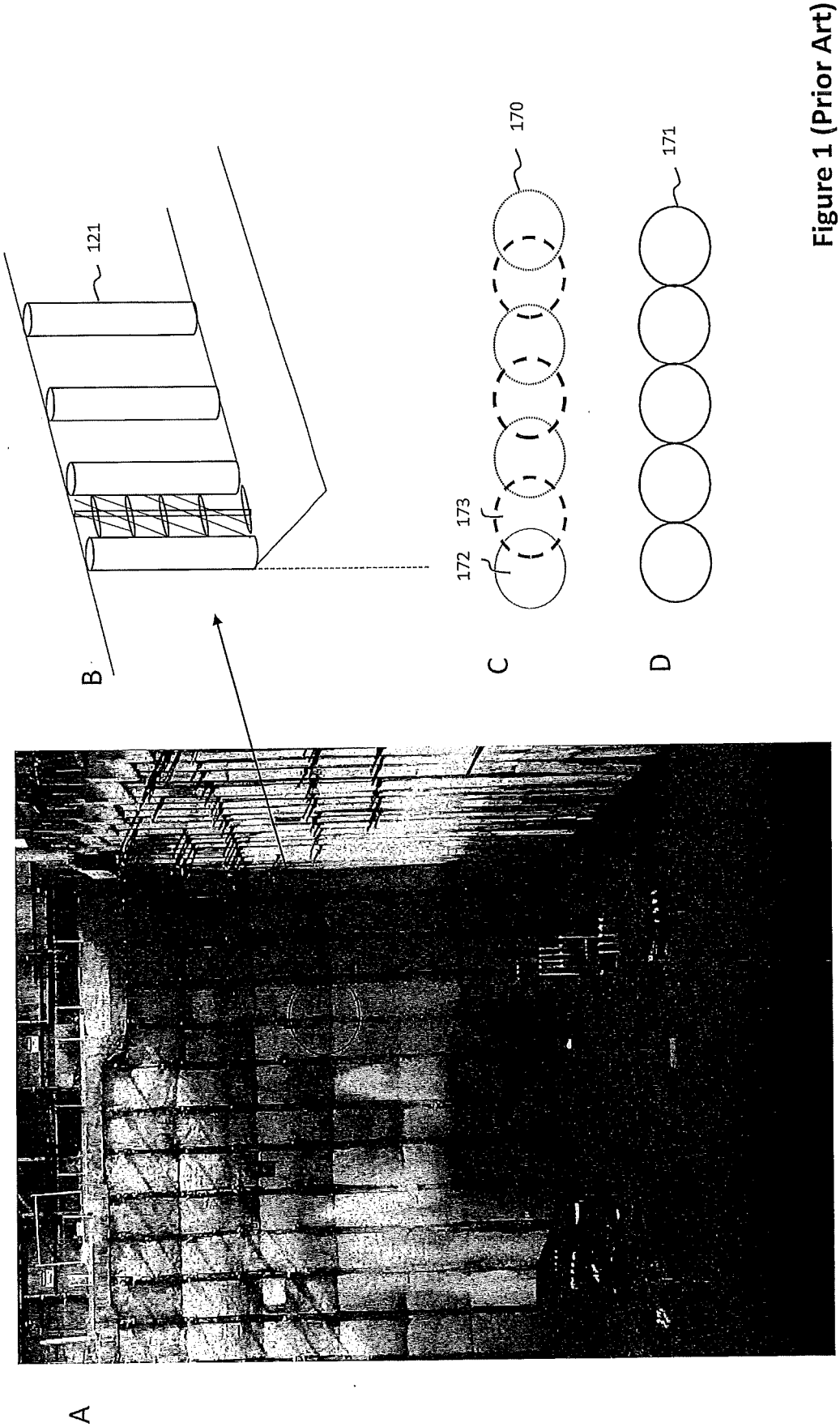

Figure 1 (Prior Art)

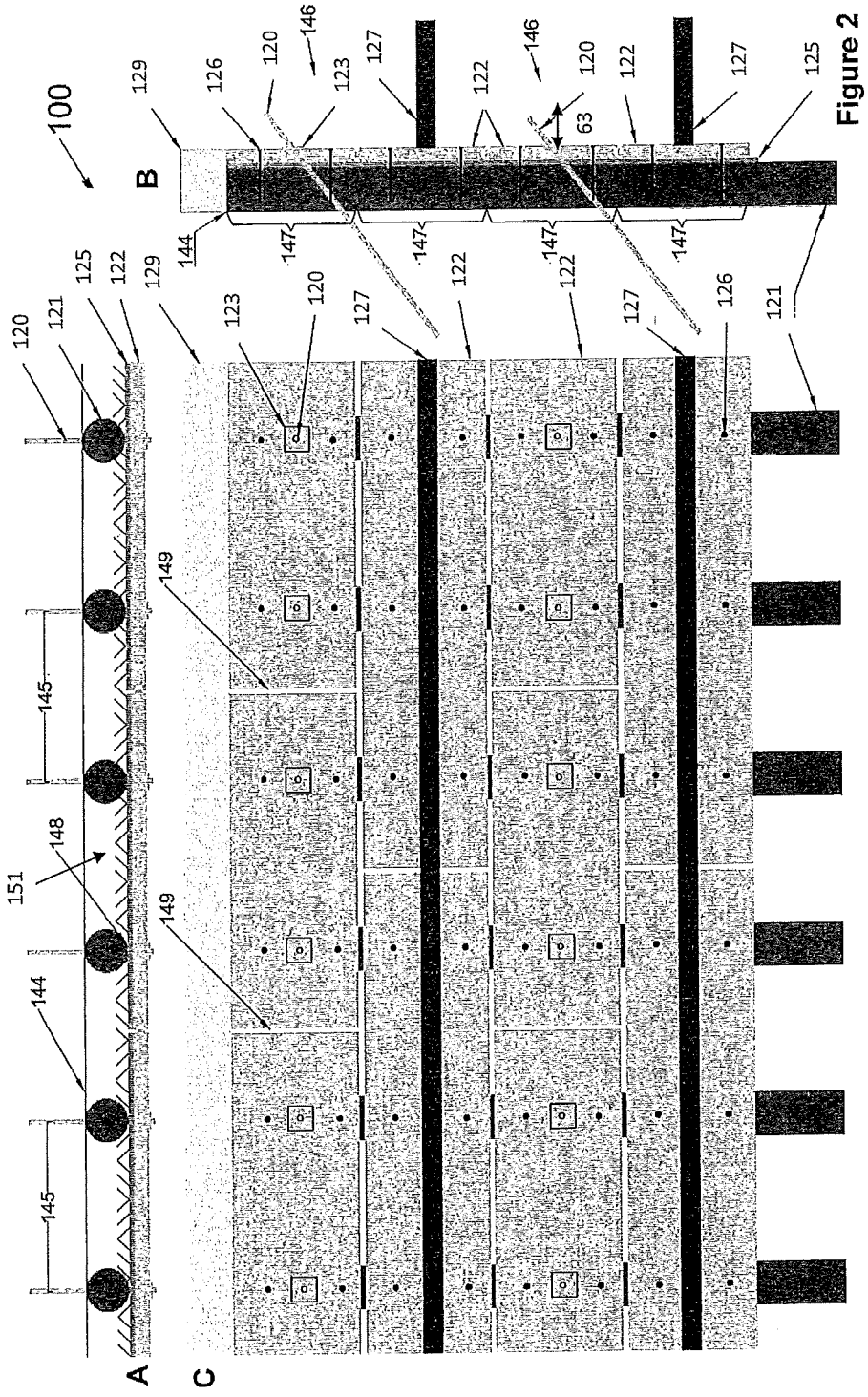
100
A
B
C
120
121
125
122
129
123
127
126
146
147
144
145
148
149
151
63

Figure 2

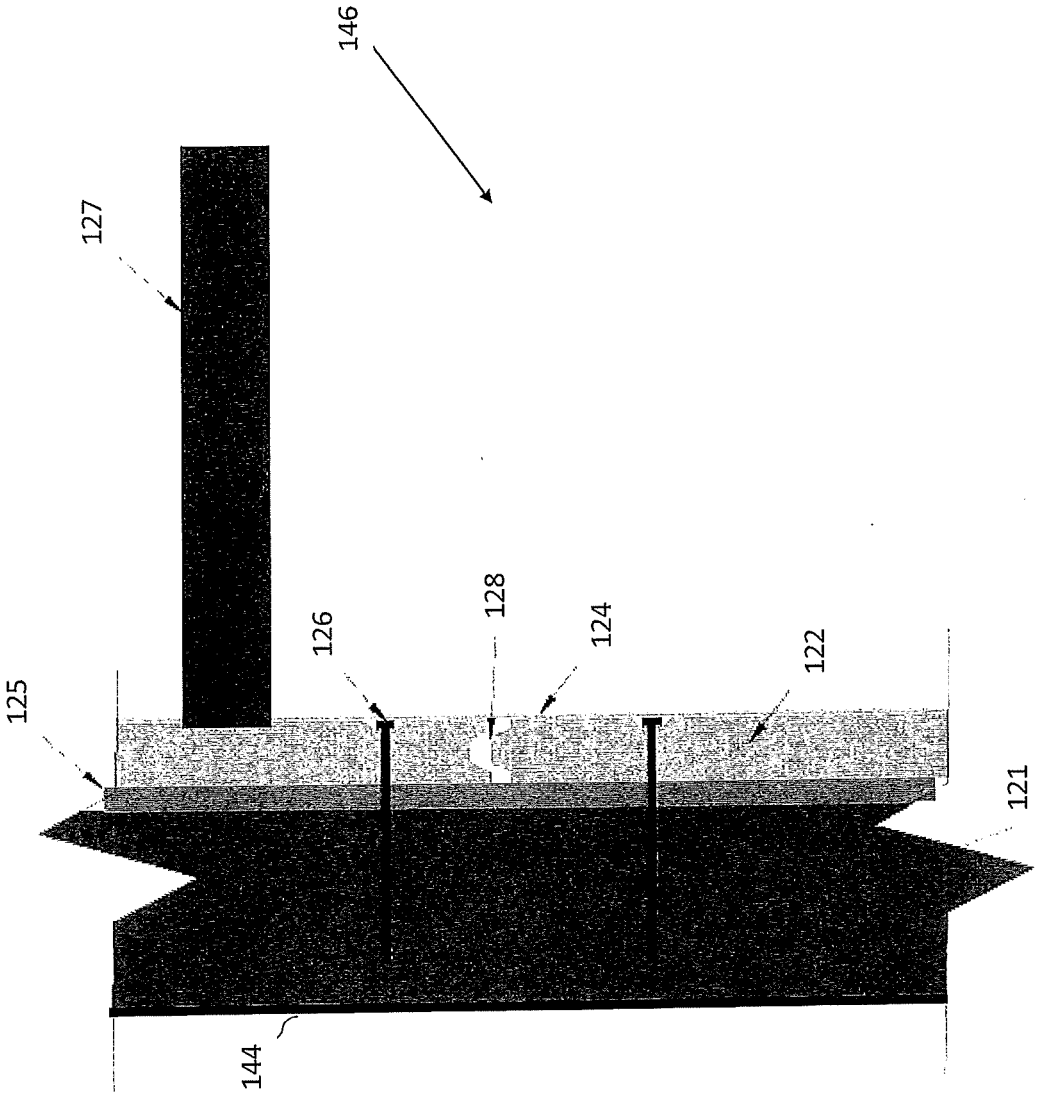

Figure 3

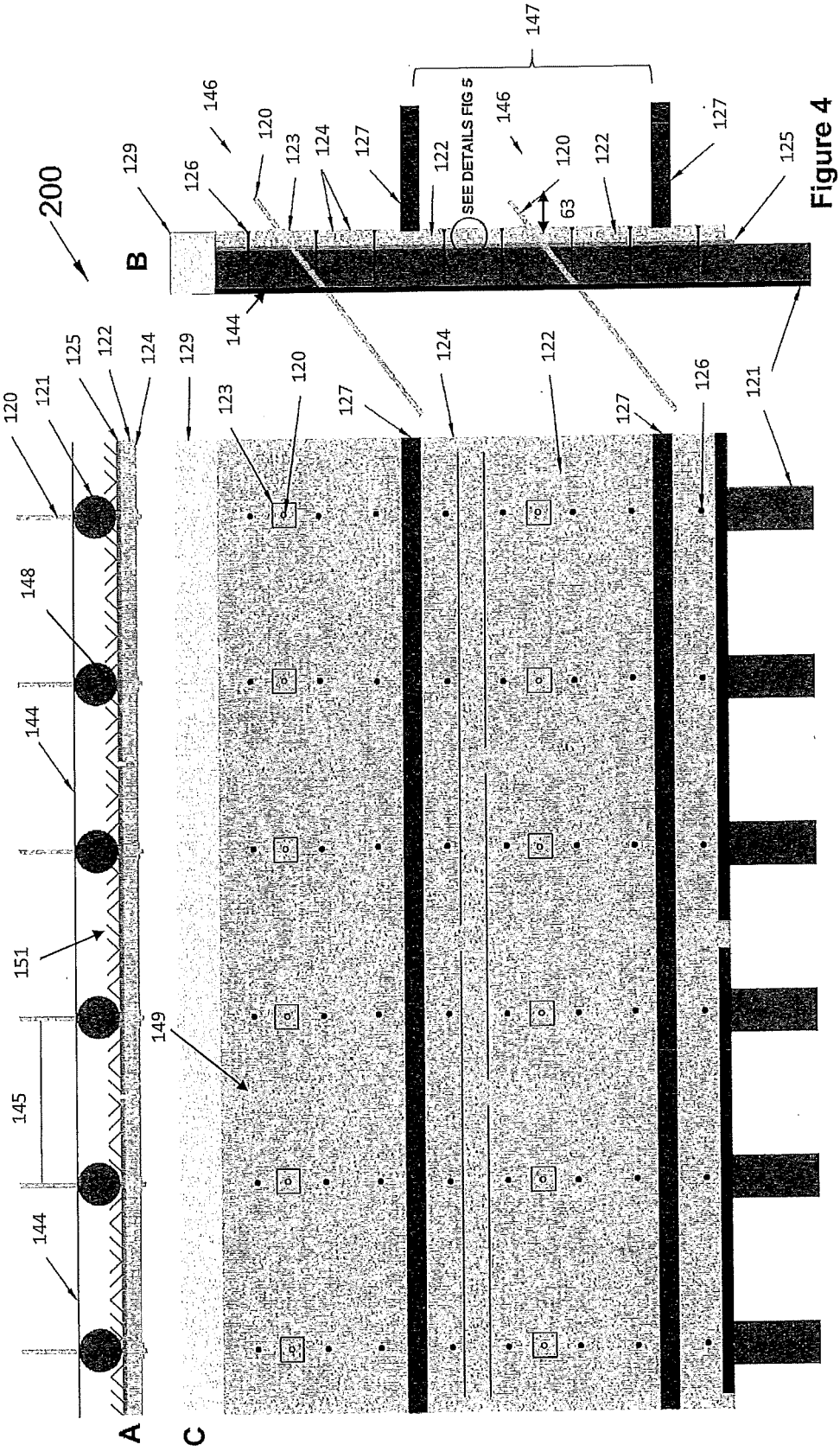
200
A
B
C
SEE DETAILS FIG 5
63
120
121
122
123
124
125
126
127
129
144
145
146
147
148
149
151

Figure 4

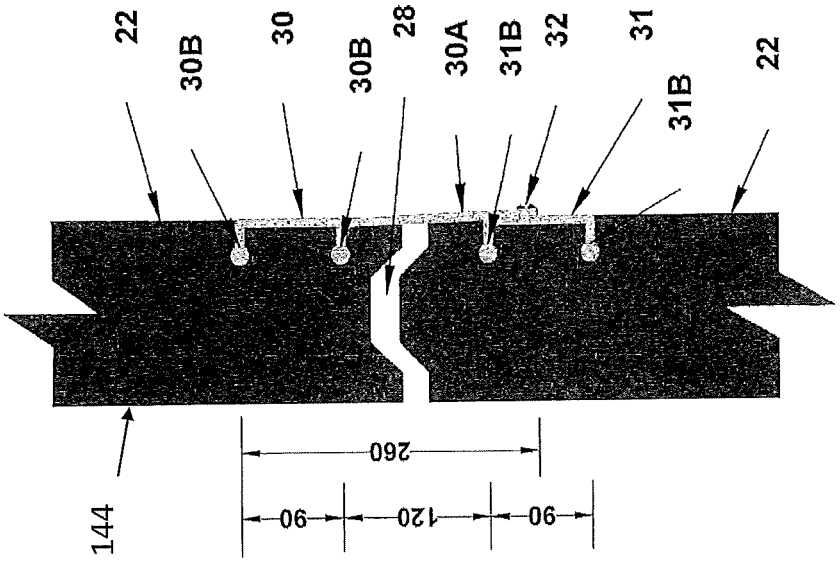

Figure 5

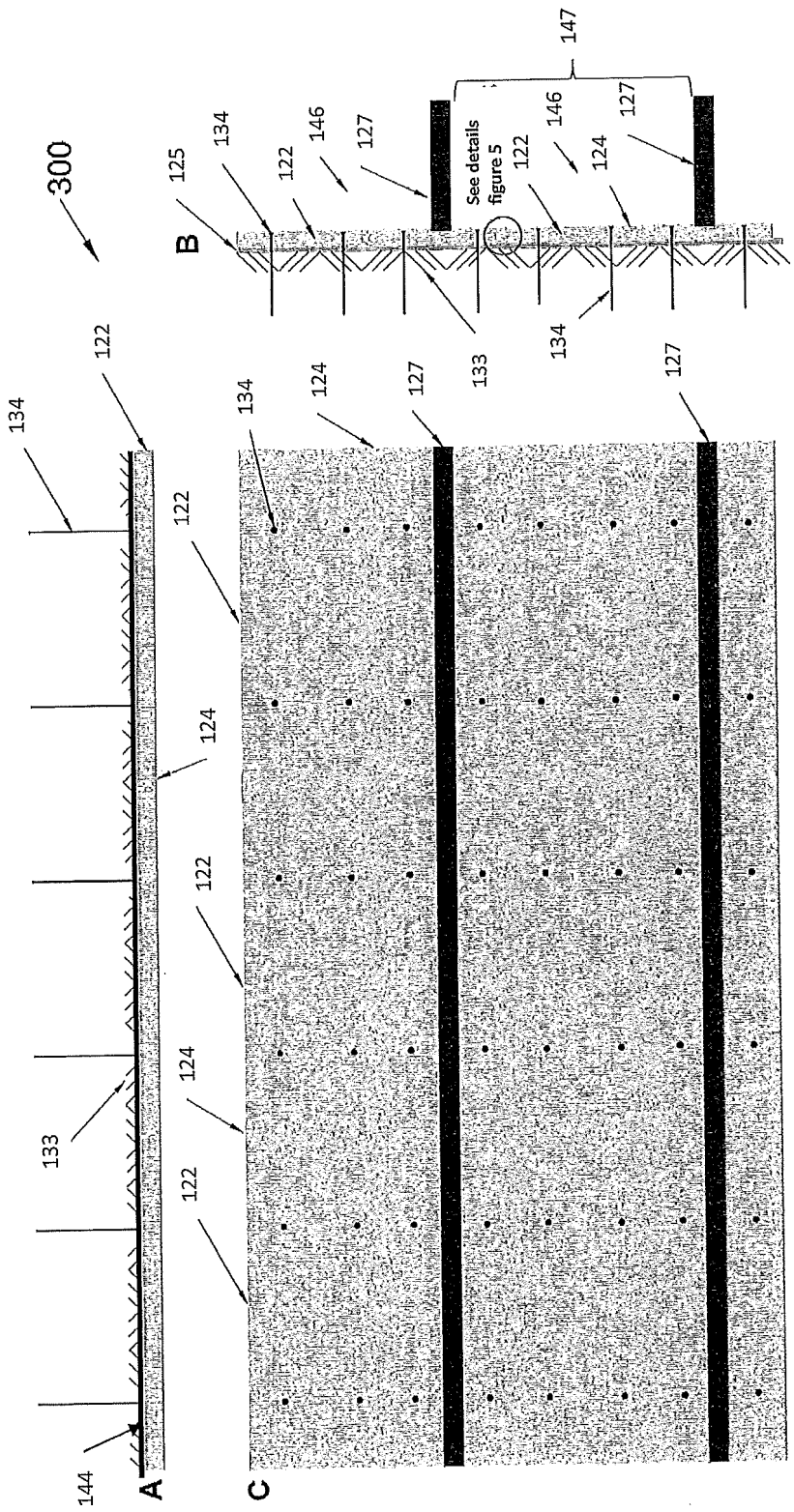
300
A
B
C
See details figure 5
122
124
127
133
134
144
146
147
125

Figure 6

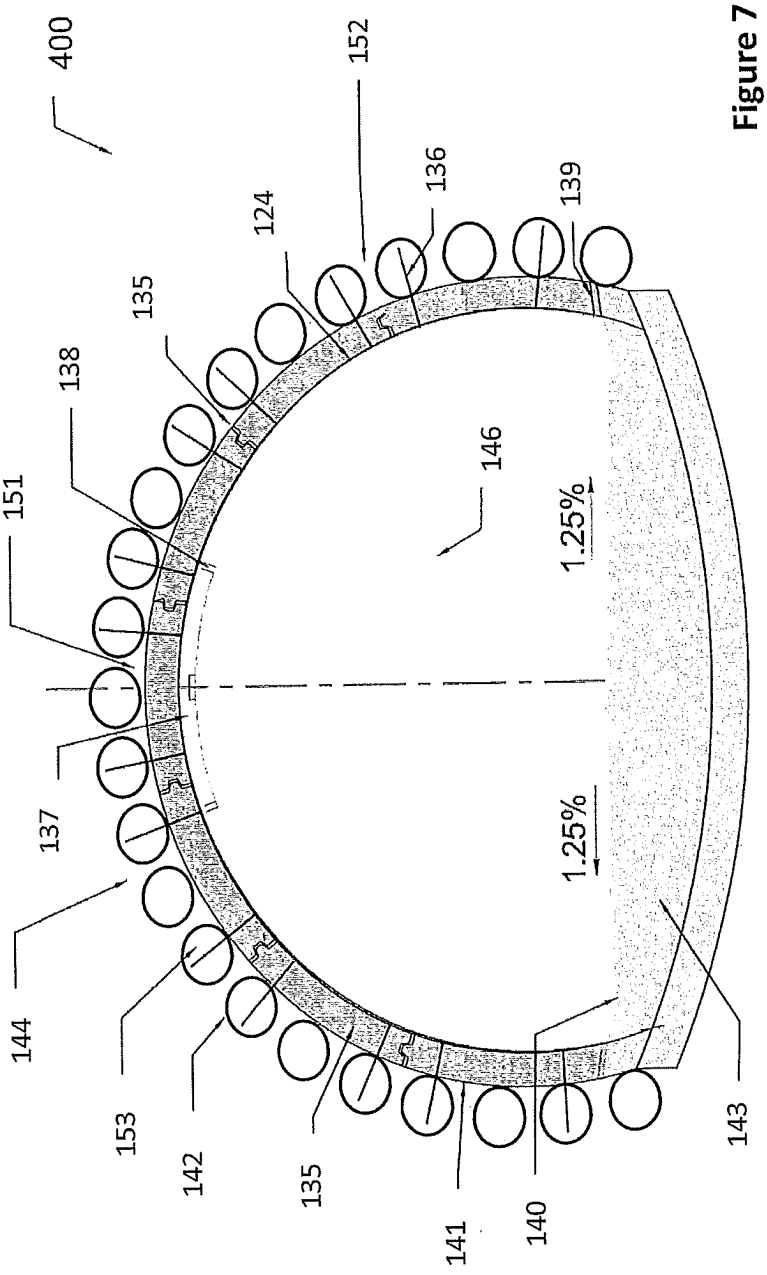
400
152
136
139
124
135
138
151
146
1.25%
1.25%
137
144
153
142
135
141
140
143

Figure 7

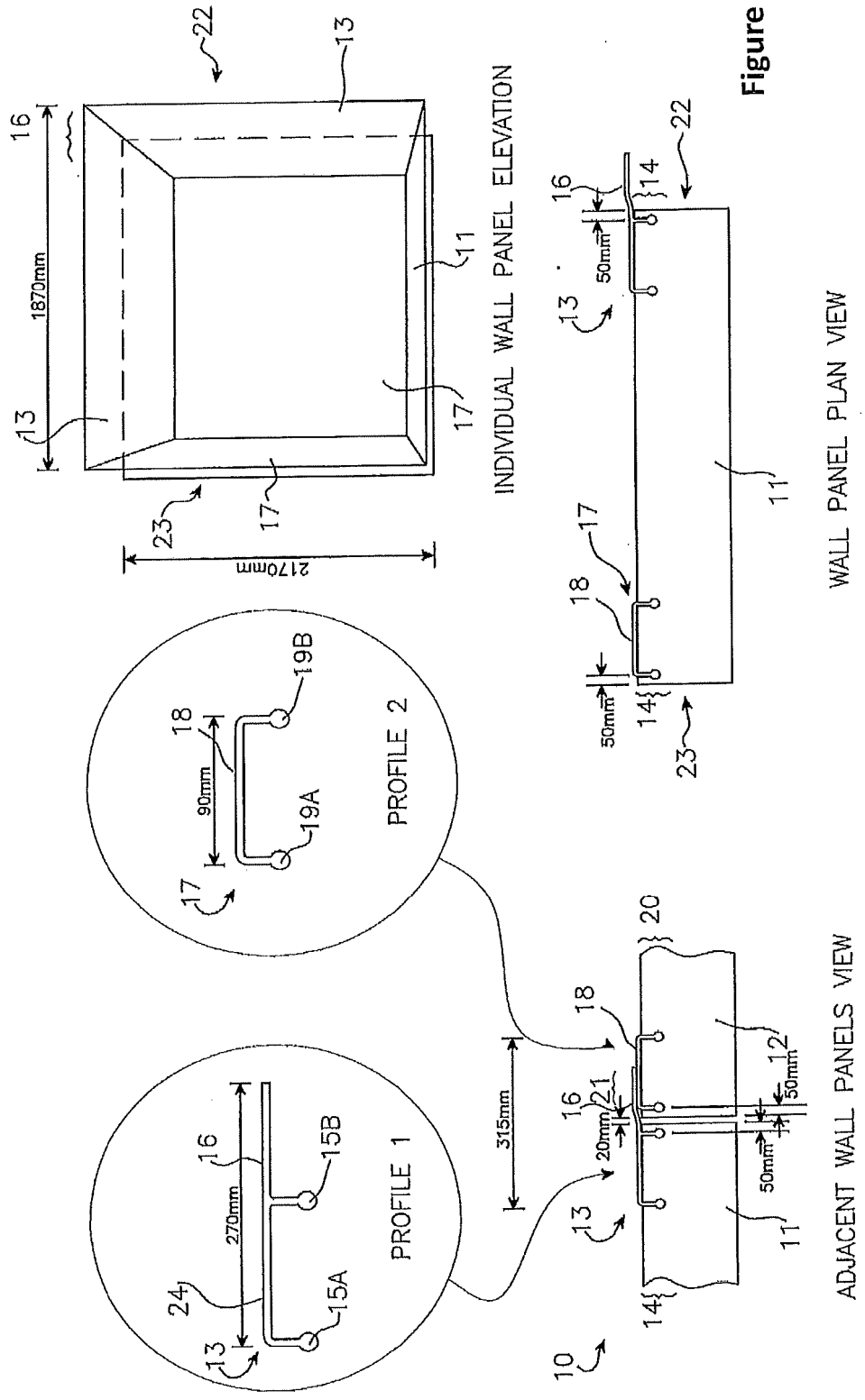
INDIVIDUAL WALL PANEL ELEVATION
WALL PANEL PLAN VIEW
ADJACENT WALL PANELS VIEW
PROFILE 1
PROFILE 2
1870mm
2170mm
270mm
90mm
315mm
20mm
50mm
10
11
12
13
14
15A
15B
16
17
18
19A
19B
20
21
22
23
24

Figure 8

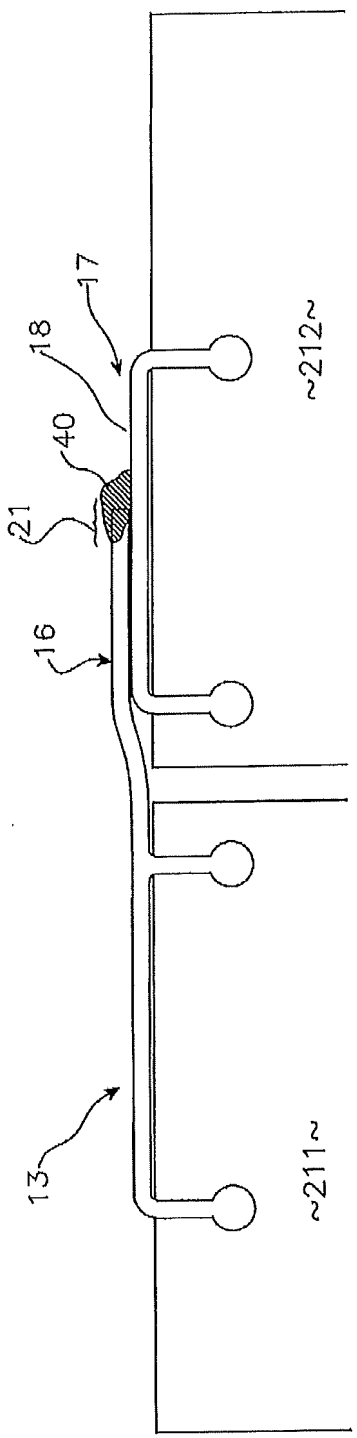

Figure 9A

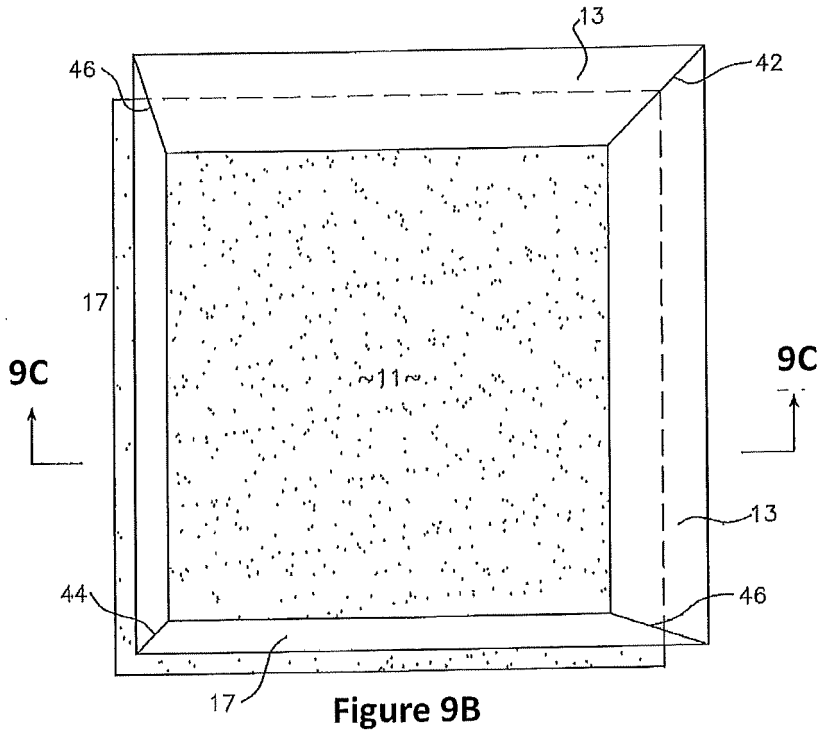

Figure 9B

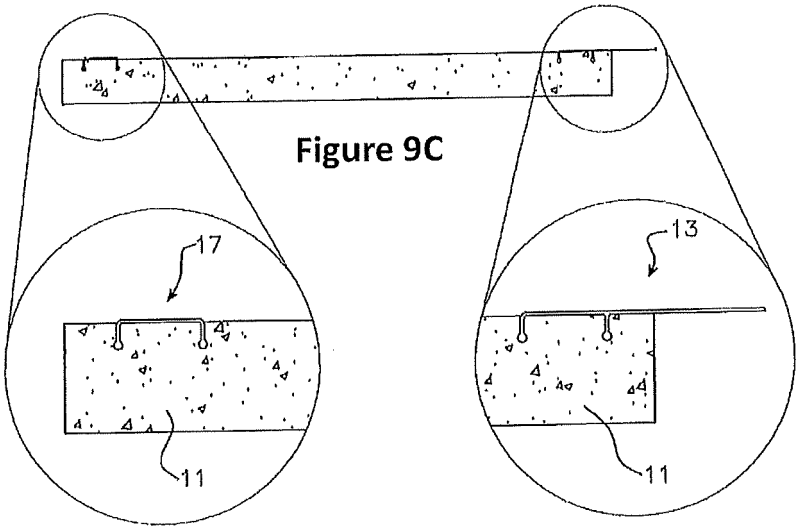

Figure 9C

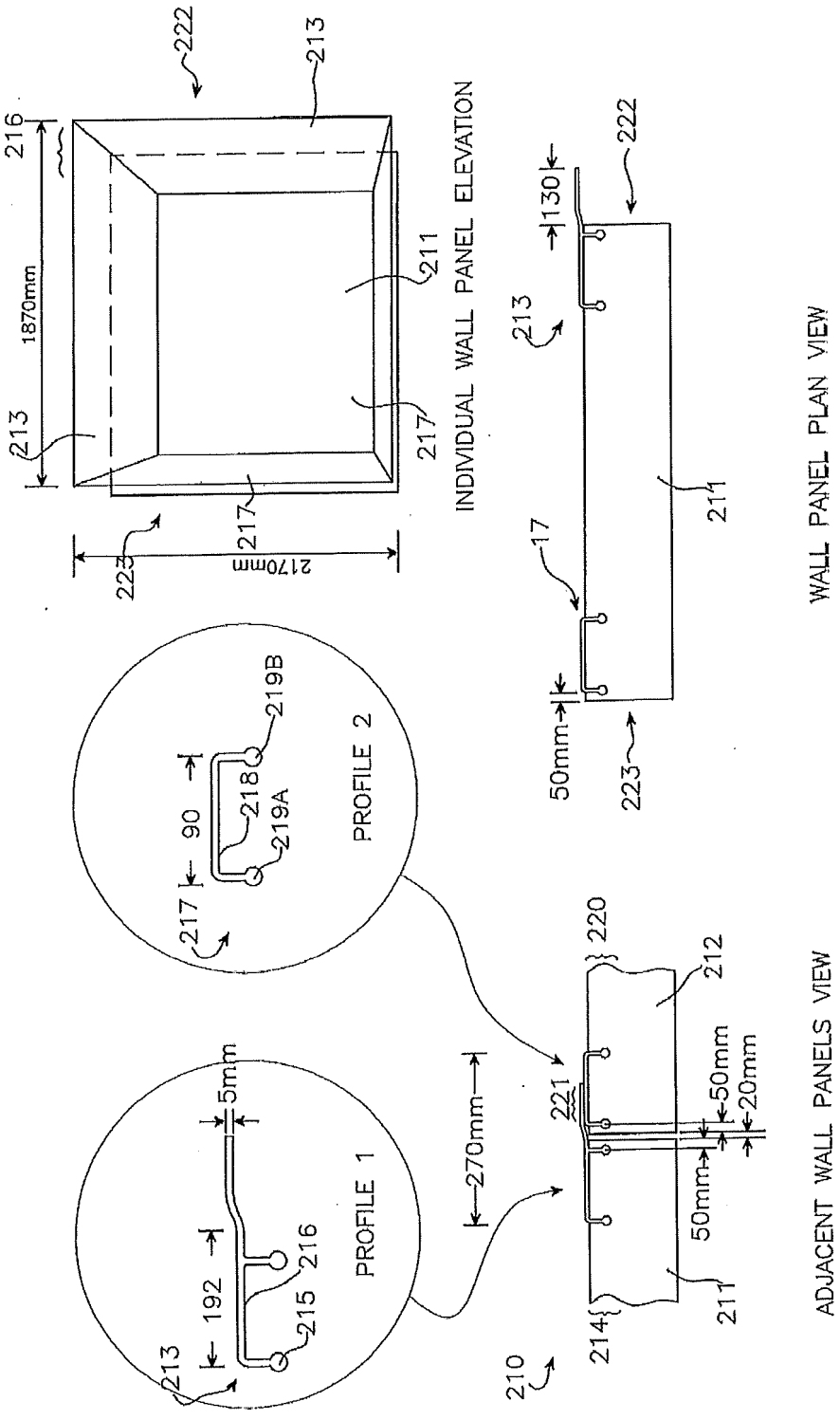
222
213
216
1870mm
213
211
217
217
223
2170mm
INDIVIDUAL WALL PANEL ELEVATION
PROFILE 2
219B
218
219A
90
217
PROFILE 1
5mm
192
216
215
213
270mm
210
221
220
212
50mm
20mm
50mm
214
211
ADJACENT WALL PANELS VIEW
130
222
213
17
211
50mm
223
WALL PANEL PLAN VIEW

Figure 10

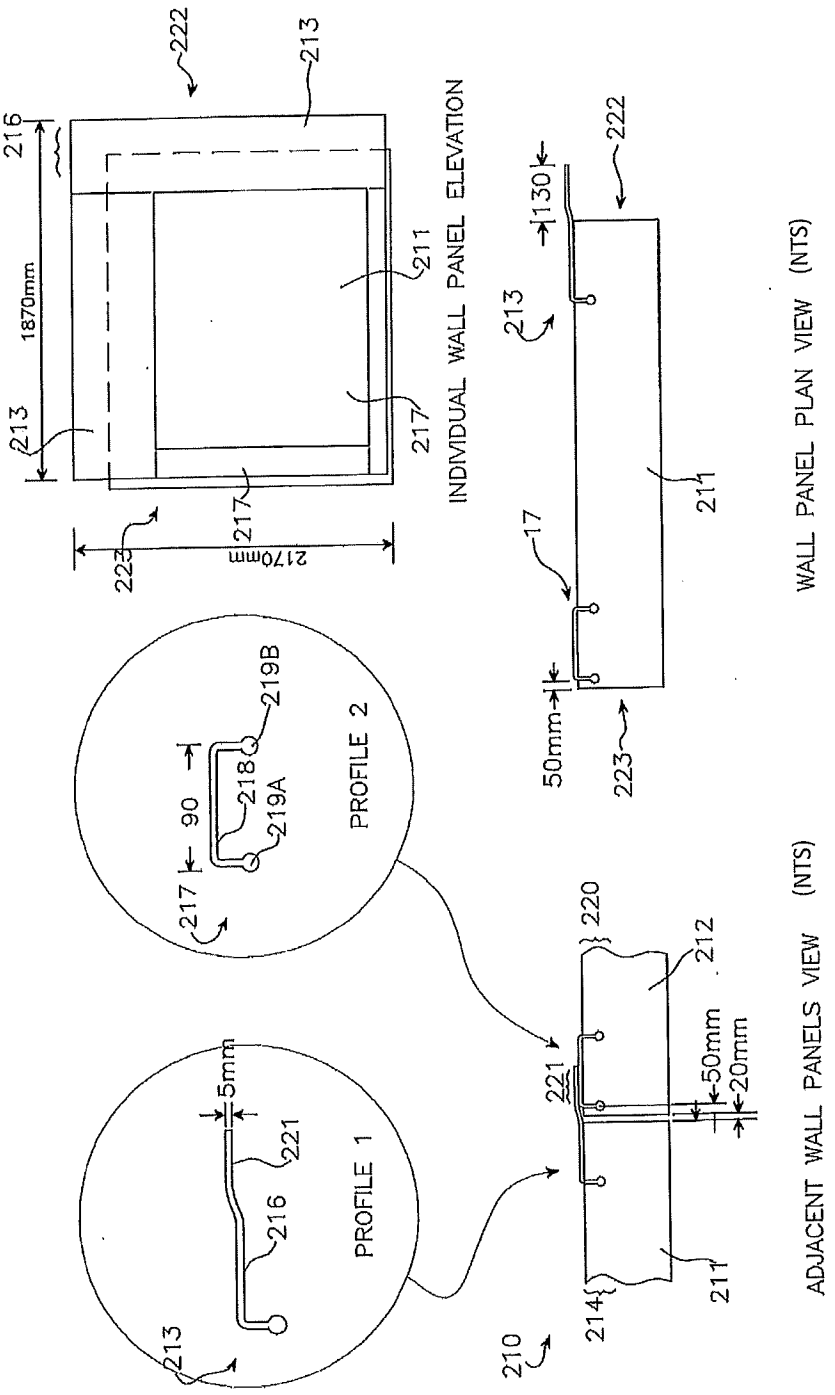
222
213
216
1870mm
213
211
217
223
2170mm
217
INDIVIDUAL WALL PANEL ELEVATION
PROFILE 2
219B
218
219A
90
217
PROFILE 1
5mm
221
216
213
210
220
212
221
50mm
20mm
214
211
ADJACENT WALL PANELS VIEW (NTS)
130
222
213
17
211
50mm
223
WALL PANEL PLAN VIEW (NTS)

Figure 10A

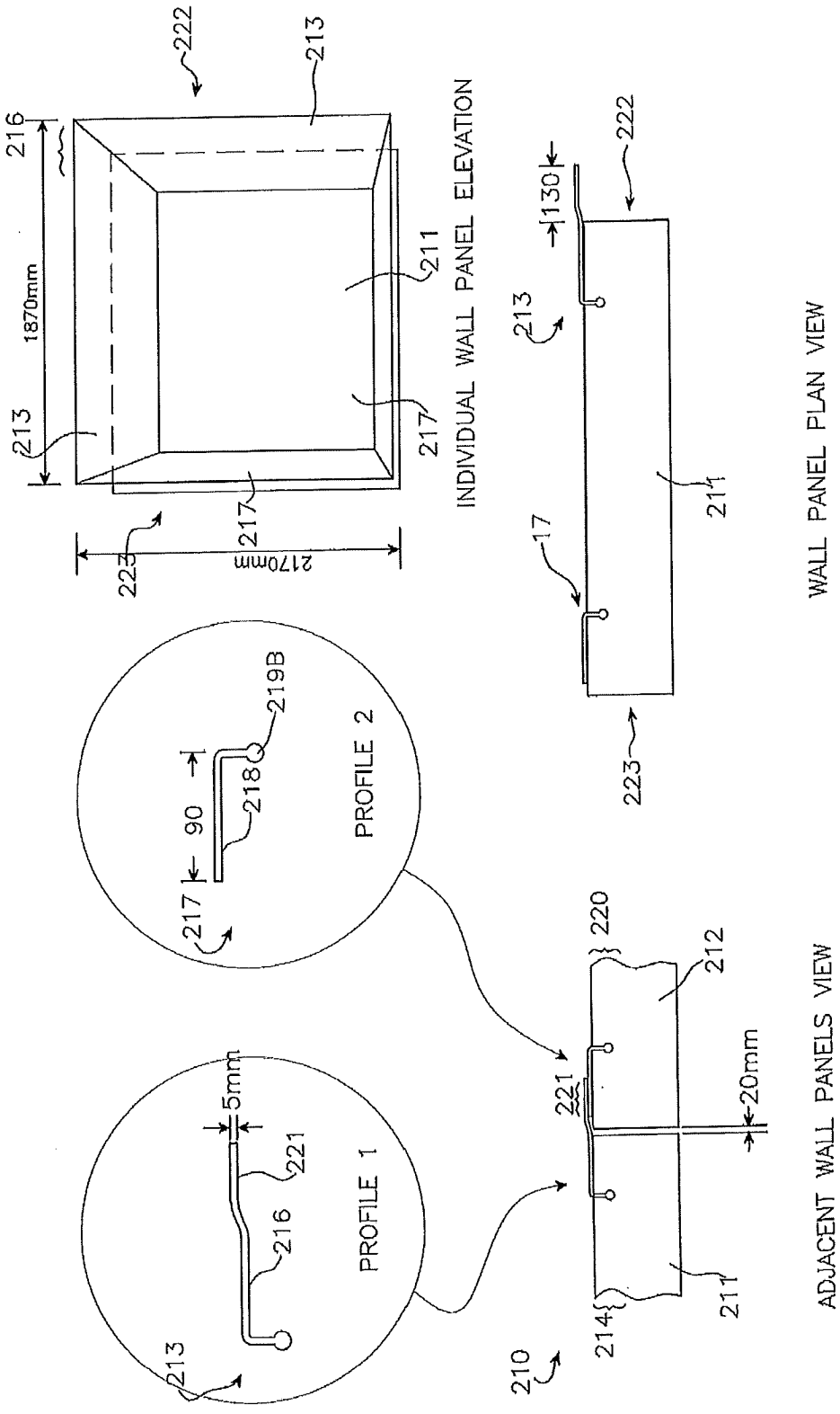
222
213
216
1870mm
213
211
217
217
223
2170mm
INDIVIDUAL WALL PANEL ELEVATION
130
222
213
17
211
223
WALL PANEL PLAN VIEW
PROFILE 2
219B
218
90
217
PROFILE 1
5mm
221
216
213
220
212
221
20mm
214
211
210
ADJACENT WALL PANELS VIEW

Figure 10B

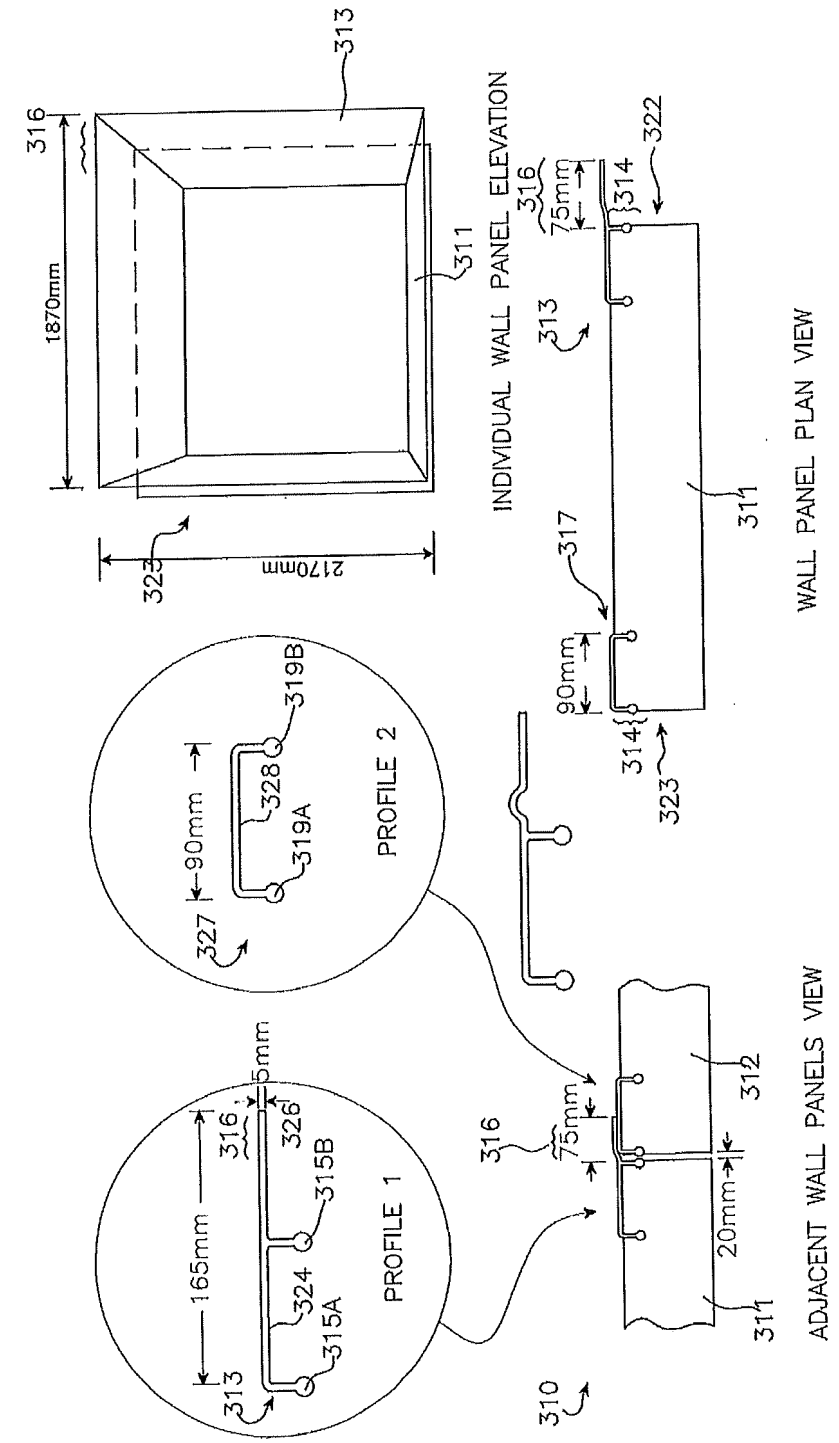
316
1870mm
313
311
323
2170mm
INDIVIDUAL WALL PANEL ELEVATION
316
75mm
314
322
313
317
311
90mm
314
323
WALL PANEL PLAN VIEW
PROFILE 2
319B
328
319A
90mm
327
PROFILE 1
5mm
316
326
315B
165mm
324
315A
313
316
75mm
312
20mm
311
310
ADJACENT WALL PANELS VIEW

Figure 11

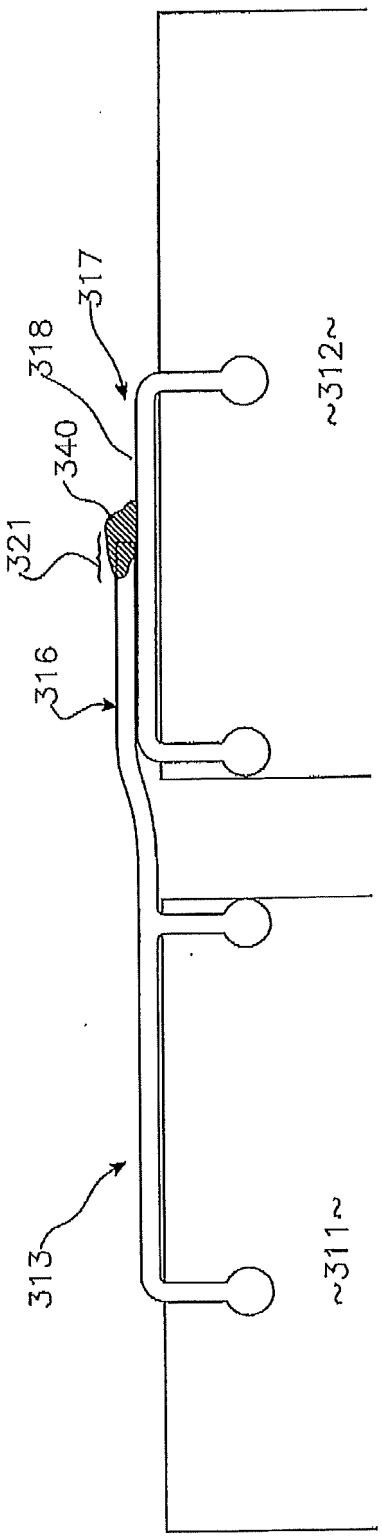

Figure 11A

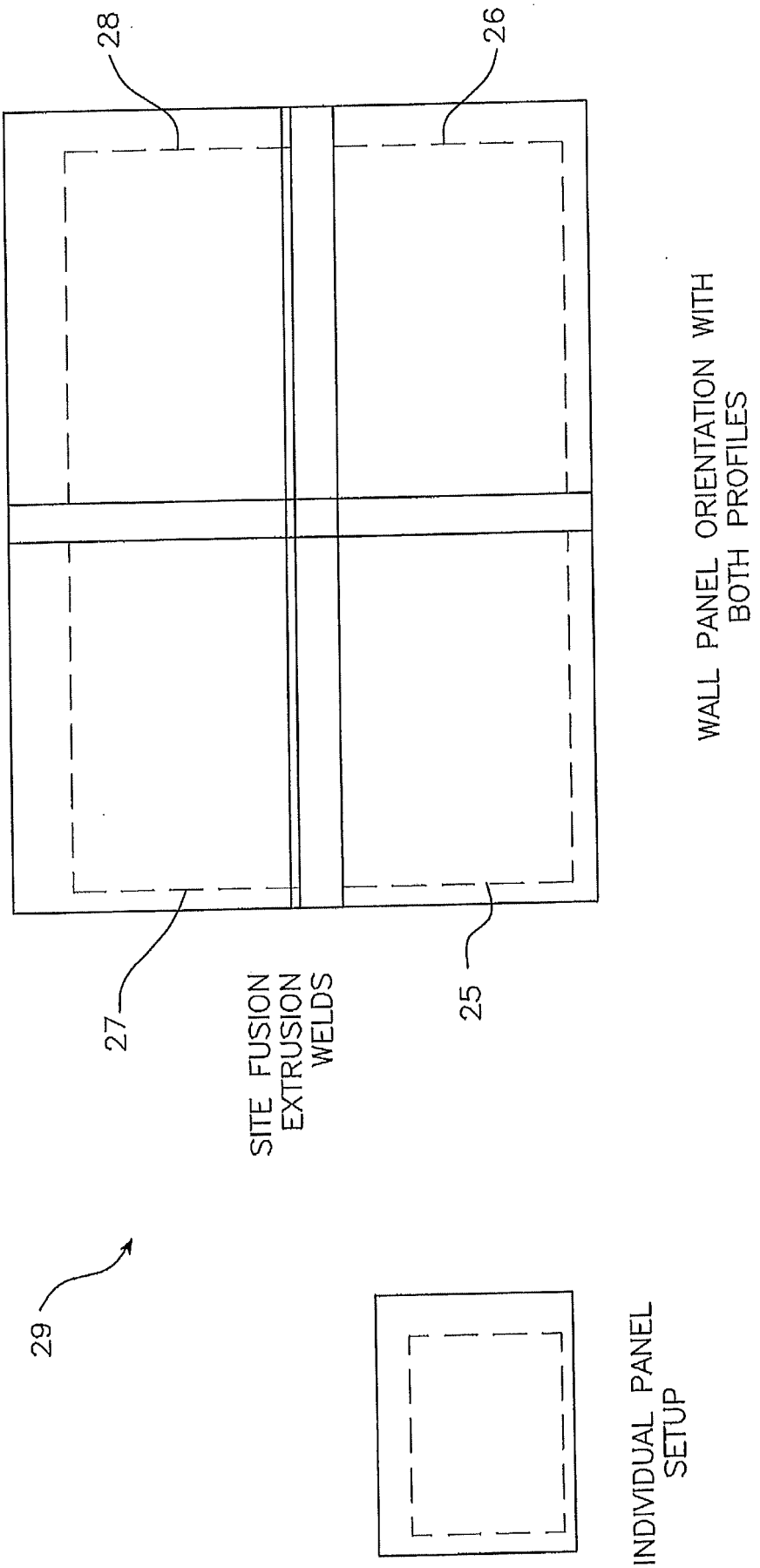
28
26
27
25
SITE FUSION EXTRUSION WELDS
WALL PANEL ORIENTATION WITH BOTH PROFILES
29
INDIVIDUAL PANEL SETUP

Figure 12

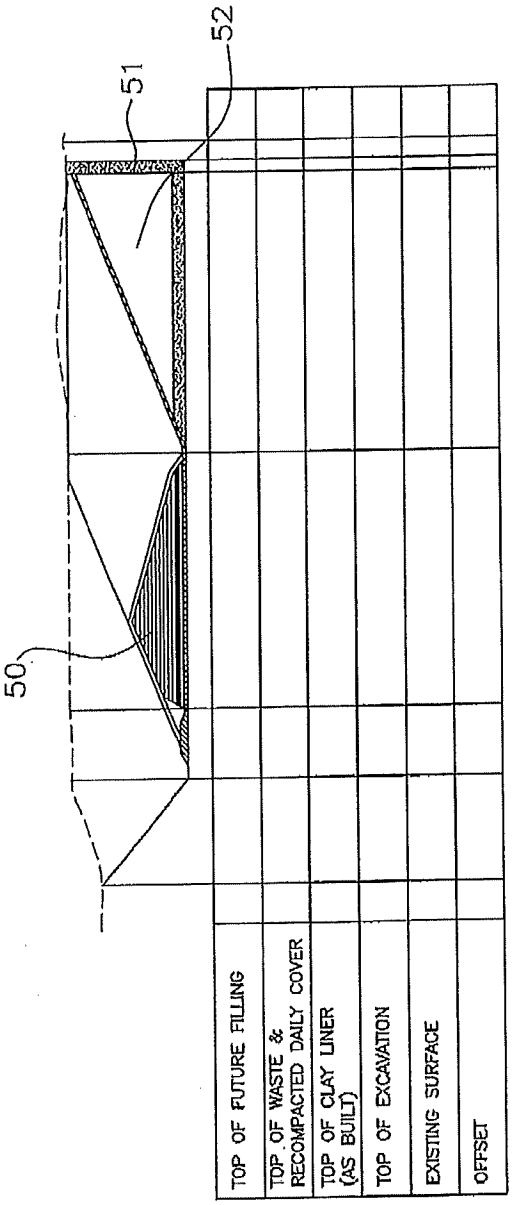
50
51
52
TOP OF FUTURE FILLING
TOP OF WASTE & RECOMPACTED DAILY COVER
TOP OF CLAY LINER (AS BUILT)
TOP OF EXCAVATION
EXISTING SURFACE
OFFSET

Figure 13

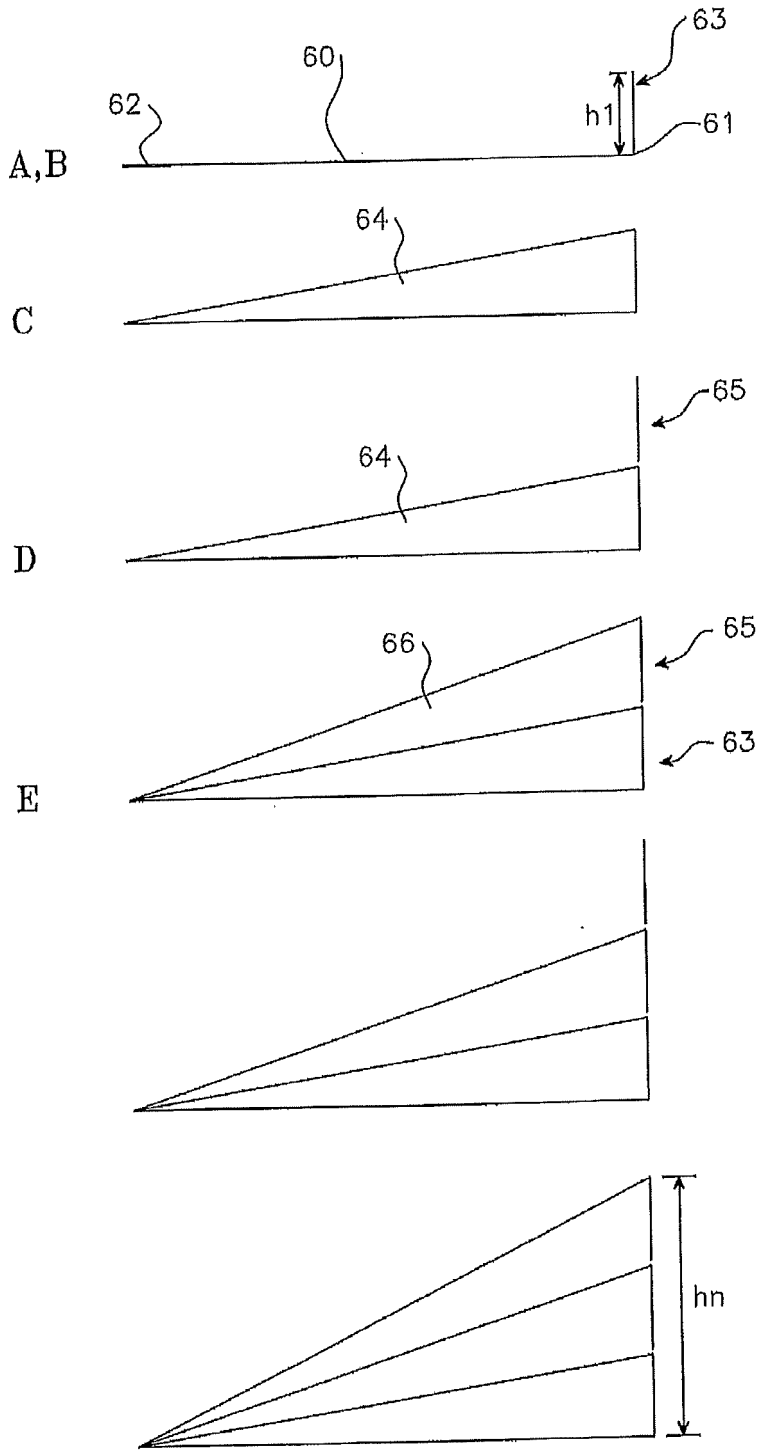

Figure 14

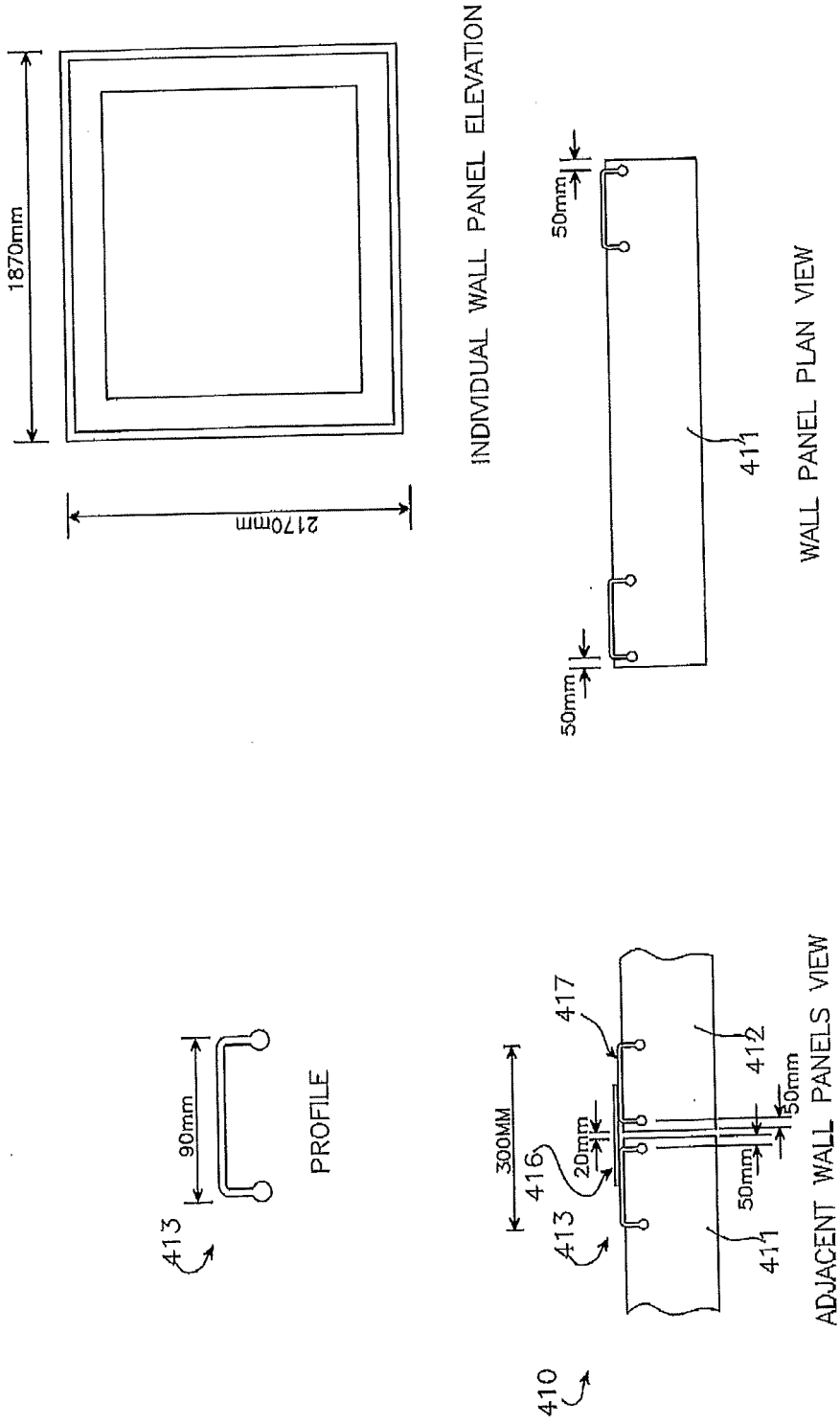
1870mm
2170mm
INDIVIDUAL WALL PANEL ELEVATION
50mm
50mm
411
WALL PANEL PLAN VIEW
90mm
413
PROFILE
300MM
416
20mm
413
417
412
50mm
50mm
411
410
ADJACENT WALL PANELS VIEW

Figure 15

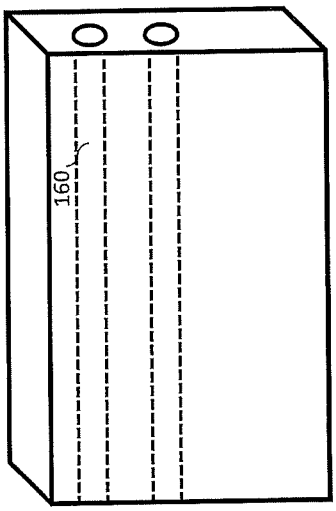

Figure 17

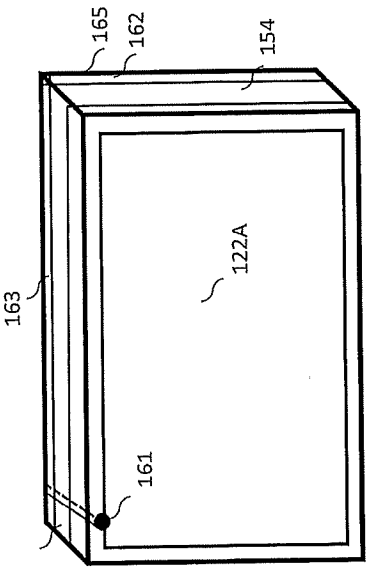

Figure 16

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2011009219 A1, Alfonso Gonzalez **[0004]**
- US 6220789 B1, Richard White **[0005]**
- DE 19723554 A1 **[0006]**
- US 4913594 A **[0007]**
- FR 2415693, Bachy **[0098]**