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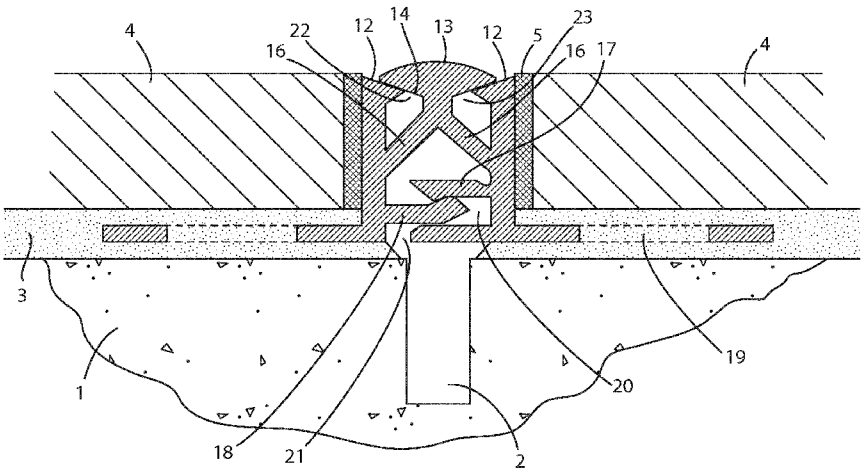


Figure 8

(57) Abstract: An improved control joint for sealing movement gaps in the floors and walls of buildings has a pair of spaced-apart plate-like members for mounting against the faces defining the gap, a resilient structure connecting and bridging the plate-like members, and a central member with a cap extending upwardly between the plate-like members. The plate-like member on a first side of the gap bears against the underside of the cap on the first side and the plate-like member on the second side of the gap bears against the underside of the cap on the second side. The device can have a latch holding it partially compressed for fitting into a gap so that both expansion and contraction of the gap are catered for while maintaining a good seal and secure anchoring to the building components on either side of the gap throughout the movement cycle.

WO 2017/017052 A1

Improved Movement Control Joint

FIELD OF THE INVENTION

The present invention relates to a movement joint for tiles and coatings.

BACKGROUND OF THE INVENTION

Buildings generally employ wet components such as concrete and mortar in their construction and, over time these dry, the components shrink and this can cause surface cracking of both the component and any finishes applied to it. Similarly buildings are subjected to expansion and contraction forces arising from thermal gain and loss of construction components. Thermal gains and losses can arise from external factors such as winter/summer and day/night cycling or from imposed heating and/or cooling from underfloor heating and cooling systems. Other factors such as wind loading, settlement and service loads all conspire to expose the structure to a rather complex, stochastic, often three-dimensional movement pattern of overlapping shear and extension/compression movements.

To cater for these complex movements it is common practice to either leave a gap between adjoining building components to accommodate movement. Gaps are often formed in walls and floors by sawing through the material to create a weak point in the substrate to thereby induce movement cracking in predictable locations. These gaps and saw cuts are commonly referred to as movement joints or control joints.

Gaps and saw cuts have to be sealed afterwards to prevent the ingress of water and other contaminants and the materials used to seal them must be flexible enough to open and close in response to the contraction and expansion of buildings components. Factory-formed jointing systems comprising rigid side members affixed to a flexible core are often used to span these gaps.

Walls and floors may covered with decorative finishes and movement joints in the underlying substrates must be carried through these finishes in order to prevent them becoming damaged as the underlying substrate deflects in response to the forces applied. Factory-formed joint systems are also inserted between decorative finishes to accommodate movement.

As factory-formed joints are made in a factory this to a large extent eliminates the impact of workmanship and site conditions and similarly these systems are fully cured before they leave the factory and are not affected by environmental conditions during the cure period such as is the case with sealants and caulk.

They do however have a number of severe limitations in that, unlike sealants and caulking they require mechanical connection to the substrate to function. This connection is normally formed through the attachment of a central flexible material to preferentially rigid side members which are then keyed into an adhesive or a bedding mortar. These generally rigid members are designed to stretch and compress the central flexible material of the joint system, said flexible material generally being manufactured from thermoplastic plastics such as Polyvinylchloride and Polyurethane or synthetic rubbers such as Polychloroprene, Ethylene Propylene Diene Monomer, Santoprene and Silicone.

The integrity of this bond between the rigid members and the adhesive or mortar bed has a direct influence on the performance of the factory-formed joint in that the adhesive or mortar bed must be strong enough grip the rigid members such that they stretch the flexible portion of the joint and open the joint when building elements begin to contract through drying shrinkage and thermal loss.

The tensile strength of most cementitious adhesives and mortars varies between 0.5N/mm^2 and 1.0N/mm^2 and rarely exceeds 2.5N/mm^2. As a consequence the tensile strength of the flexible section of factory-formed joints must be significantly less than this value otherwise the mechanical bond between cementitious adhesive/mortar and the factory-formed joint will fail. Table 1 below shows a list of the most common materials used to form the flexible portion of a factory-formed movement joint.

Table 1: Common Materials used as the Flexible Component of a Movement Joint

Material	Type	Minimum Tensile Strength N/mm2
Polyvinylchloride (PVC)	Flexible extruded	6.9
Polyurethane	Flexible extruded	5.8
Polychloroprene (Neoprene)	Flexible extruded	10.2
Ethylene Propylene Diene Monomer (EPDM)	Flexible extruded	9.4
Santoprene	Flexible extruded	8.8
Silicone	Flexible extruded	6.2

As can be seen the minimum tensile strength of these materials is significantly greater than the maximum tensile strength of the adhesive and mortar used to mechanically fix these movement joints in place. The result is that, when building elements begin to contract through drying shrinkage and thermal loss the bond between the adhesive, mortar and factory-formed joint will fail before the joint can open to accommodate the movement. The factory-formed joint will fail to open under tensile strain resulting in be delamination of the rigid side members from the adhesive or mortar thus compromising the seal and allowing the passage of water and other contaminants into the gap or saw cut.

There is a design of factory-formed control joint which will open up in response to movement and which is not mechanically fixed by bonding, shown in US Patent Number 6,574,933 'Movement Joint'. This joint comprises compressible filler held within a rigid envelope which is compressed and installed into a preformed gap or saw cut of predetermined width. As the joint is pre-compressed it will open up when the substrates either side of it shrink due to drying and thermal contraction. One limitation of this type of joint is that it is only suitable for narrow gaps less than 5mm wide. When used in gaps wider than 5mm the flexible core material protrudes beyond the joint surface when the joint comes under compression as the surrounding substrates expand due to thermal gain. This is a limitation in the use of this type of factory-formed joint as the ejection of the flexible material under compression can cause a trip hazard if joints wider than 5mm are used in floors.

One further limitation of the type of factory formed joint shown in US Patent Number 6,574,933 derives directly from gap and saw cut width limitations. Like sealants the opening and closing capacity of the flexible core of a given material and hardness of this type of joint is determined by the width of the gap. The wider the gap; the greater the movement capacity of the joint. The

width of the gaps for this type of joint is limited to 5mm maximum and as a consequence the magnitude of movement that these joint systems can accommodate is limited.

The invention disclosed offers an improved device which solves the problem presented by factory formed jointing systems as disclosed above.

SUMMARY OF THE INVENTION

The invention provides a control joint device for sealing a movement gap defined between adjacent opposed faces of two building components, the device comprising:

a pair of spaced-apart plate-like members adapted to be mounted against said opposed adjacent faces such that the plate-like members are generally parallel to one another and are mounted on either side of the gap;

a resilient structure connecting and bridging the plate-like members;

a central member extending upwardly from said resilient structure between the plate-like members, the central member having a cap, the cap having an underside facing the resilient structure and a top side facing away from the resilient structure;

the resilient structure and central member being dimensioned such that in use the plate-like member on a first side of the gap bears against the underside of the cap on the first side and the plate-like member on the second side of the gap bears against the underside of the cap on the second side.

The present invention thus allows a factory-formed movement joint to be provided which is designed to span gaps and saw cuts left or formed between elements of construction to allow for differential movement of these components. The device, being resiliently inserted in the gap, will open to compensate for the drying shrinkage and thermal contraction of building elements. Similarly the device will close in response to expansion of buildings elements due to thermal gain, wind loading and other similar factors.

The present invention allows a device to be produced in a controlled environment in a factory so as to limit the negative impact of workmanship and site conditions which regularly affect the installation and performance of sealants and caulking which are also used for this type of application. One improvement of the invention is that it is fully cured before it is installed and

doesn't suffer from the cure or width-to-depth ratio problems often associated with caulk and sealants.

Unlike sealants, the device may be substantially manufactured from plastic polymers the ageing characteristics of which are well understood. More than 2,000 accelerated ageing testing protocols have been accepted by the American Society for Testing and Materials (ASTM) and, depending on product application, the polymer employed will be matched to the environment to maximise service life.

Unlike sealants and caulk the device is not subject to 'slump' therefore the width of the gap is not a limiting factor in the design of the proposed device as there are few limitations beyond the extrusion width limits of existing thermoplastic and synthetic rubber extrusion technology. Similarly the movement capacity of the invention is only limited by existing extrusion technology.

The device is trafficable by pedestrians and vehicles and resists penetration and damage by such traffic. Similarly, throughout the movement cycle accommodated by the device, it has been designed to support and prevent damage to the arris of brittle finishes such as concrete, ceramic tiles and natural stone by the aforementioned pedestrians and vehicles. Caulk and sealant provide little or no lateral support to the arris of the brittle finish with the result that attrition from pedestrian and wheeled traffic cause cracking and failure at the unsupported edge.

Preferably, each plate-like member has an angled surface at an upper end thereof, the angled surface sloping downwardly and inwardly away from the respective face against which the plate-like member is mounted in use, and the cap has an underside with a pair of angled surfaces, one at either side of the central member, each angled surface sloping upwardly and outwardly away towards the first or second side respectively, the plate-like members and cap being dimensioned such that in use the angled surface of the plate-like member on a first side of the gap bears against the respective angled surface of the underside of the cap on the first side, and the angled surface of the plate-like member on the second side of the gap bears against the respective angled surface of the underside of the cap on the second side.

The device is designed to prevent the ingress of debris, water and other contaminants throughout both opening and closing movement cycles, with the angled surfaces of the plate-like members

bearing against the underside of the cap and the plate-like members themselves being mounted against the walls of the gap.

The upward and outward sloping bases on either side of the cap can thus be designed to lie parallel, directly above and in contact with the angled surfaces at the respective tops of the plate-like members which provide substantially inward and downward sloping angled returns. When installed in a movement gap the underside of the cap touches the inward sloping angled returns of the plate-like members. The inward sloping angled returns serve to offer support to the upward sloping underside of the cap when said cap comes under loading from pedestrian and vehicular traffic or other such forces. The result of the angled slope design is that a load applied to the cap translates into an outward force transferred through the plate-like members and to the walls of the gap or saw cut such the vertical load imposed is largely transferred outwards towards the abutting substrate. It can be shown that as the load applied on the mushroom cap is transferred through angled planes in such a way that the force applied acts in two directions; at an angle along the Y-axis at 90° to the plane of the slope and along the corresponding X axis down the plane of the slope. Using as an example of a force (F_g) of 100N applied through a 30° slope it can be shown that the resultant components of this force comprising (F_x) applied down the plane of the slope and (F_y) applied at 90° to the plane of the slope are:

$F_X = F_g Sin30^{\circ} = 100 \times 0.5 = 50N$ down the plane of the slope

$F_y = F_g Cos30^{\circ} = 100 \times 0.866 = 86.6N$ applied at an angle of 30° to the plane of the slope

The result of the angled slope design is thus that a significant portion of the load applied to the cap translates into an outward force transferred through the plate-like members of the device and to the walls of the gap or saw cut such that the friction between these members and the walls increases, with the result that under loading the joint becomes increasingly resistant to being pressed into the gap or saw cut.

Preferably, the central member is carried on the resilient structure such that the central member moves vertically upwards as the resilient structure is compressed and downwards with relaxation of the resilient structure, said movement tending to maintain the contact between said cap and said plate-like members under different compressive states

Preferably, said resilient structure forms an inverted V-shape between the plates, with the central member being mounted on the apex thereof

Preferably, the central member is formed integrally with and emerges from the resilient structure

Preferably, each plate-like member is provided with a mounting attachment for mounting the plate-like member to its building component

More preferably, the mounting attachment is an anchoring plate extending perpendicularly from the plate-like member to provide an L-shaped arrangement, whereby the anchoring plate may be mounted below or within the building component on whose face the plate-like member is thereby mounted

The anchoring plates of the substantially L-shaped arrangements are designed to locate the preformed joint in position and to anchor it to the substrate either side of the gap by means of adhesive or mortar.

The device preferably further comprises a latch mechanism for holding the resilient structure in a state of partial compression and preventing the plates from moving away from one another in a normal latched state

Preferably, the latch mechanism permits increased compression of the resilient structure as the plates are moved closer to one another from the normal latched state

Further, preferably, the latch is designed to unlatch and to permit the plates to move apart from one another under a tension force applied across the device, wherein the tension force required to unlatch is less than 2.5N/mm^2, more preferably less than 1.0N/mm^2, most preferably less than 0.5N/mm^2, whereby when the plates are mounted to the components with cementitious or adhesive materials the plates will move apart under tension force from the normal latch position before the cementitious or adhesive mounting fails

Preferably, the latch comprises a pair of co-operating members having angled surfaces which engage with one another as the plates are compressed together to form a latch

Preferably, the co-operating members are resilient and the angled surfaces are shaped to permit unlatching when a predetermined tensile force is applied to the plates

Preferably, the central member further comprises a stem connected at one end to said resilient structure and at said other end to said cap. While preferred devices show such a stem-and-cap structure, having a mushroom-like shape, the cap can also be mounted directly on the resilient structure, transitioning outward from that structure to define the underside against which the plate-like members bear.

Preferably, the gap across the plates defines a first horizontal axis when the device is mounted in use and the plates are elongated along a second, orthogonal, horizontal axis to form an extended strip to be mounted against the faces of the building components

Preferably, the cap is an elongate member extending along the second horizontal axis

Preferably, the stem is a resilient planar member extending along the second horizontal axis

Preferably, the cap has an upper surface which presents a rounded surface across the gap, bridging the components of the building structure

Preferably, the cap is resiliently deformable

Preferably, the central member further comprises a stem connected at one end to said resilient structure and at said other end to said cap, and the cap is wider than the stem when viewed in a plane transverse to the plate-like members, such that on either side of the stem, below the cap, a respective space is defined

Preferably, upon compression or contraction of a gap in which the device is fitted, said spaces accommodate said plate-like members being compressed inwardly

Preferably, the respective angled surfaces of the plate-like members and cap are designed to match one another when the device is inserted into said gap

Preferably, said angled surfaces assume an angle from the horizontal of between 10 and 80 degrees in normal use, preferably between 20 and 60 degrees, more preferably between 25 and 45 degrees

Preferably, the plate-like members, resilient structure and central member are integrally extruded from an extrudable thermoplastic material such as PVC, Polyethylene, Polyurethane, or Polypropylene or a synthetic rubber such as Silicone, Neoprene, or EPDM

Preferably, said device has a relaxed state, and a range of operating compressed states ranging from said relaxed state to a maximally compressed state in which the plate-like members and cap remain in contact without damage to the device, the device being dimensioned such that said relaxed and maximally compressed states lie outside the expected maximum and minimum ranges of width achieved under a normal expected range of environmental conditions, for an expansion gap to which the device is to be fitted

There is also provided a method of filling an expansion gap defined between building components, comprising the steps of: determining maximum and minimum ranges of width for said expansion gap under a normal expected range of environmental conditions; selecting a control joint device as defined above such that said relaxed and maximally compressed states of said device lie outside the determined maximum and minimum ranges of width for said expansion gap; and fitting said control joint device to said building components under compression

Preferably, said building components are finishing components mounted on a substrate or on a pair of adjacent substrate members, said finishing components defining a pair of opposed, adjacent faces; and the method further comprises mounting the control joint device by anchoring each plate-like member of the device into a space between the respective building component and the underlying substrate, whereby under ambient conditions the device is compressed to a state intermediate between the relaxed and maximally compressed states.

The preferred form of the device is preferably extruded from plastic polymers in an open position and upon curing has been designed to be factory pre-compressed prior to shipping such that male and female parts of the latch engage one another and hold the device in a partially compressed position. During installation the device is then mechanically connected to the substrates either side of the gap by use of either adhesives or mortar and from this partially compressed position

the device may be compressed further to accommodate expansive movement by surrounding substrates. Alternatively should these substrates contract for any reason with the gap thereby expanding the device can open and the male and female parts of the latch disengage to facilitate such movement.

The invention in its partially compressed form is installed over gaps or saw cuts and from this partially compressed position the joint can open and close in response to movement from the expansion and contraction of abutting building elements. The resilient structure, which preferably has arms in an inverted V-shape, will close and the central cap will rise slightly when the gap or saw cut closes and the joint comes under increased compression from the expansion of abutting building elements. The arms of the inverted V-shape will open and the central mushroom cap will drop slightly when the partially compressed joint is released as the gap or saw cut opens due to contraction of abutting building elements.

The present invention also provides smooth transit for pedestrian and vehicles and only exhibits slight vertical displacement when the movement joint is fully closed, said displacement being significantly less than the 6.35mm advised as the maximum permissible by Americans with Disabilities Act (ADA) legislation.

The magnitude of pre-compression may be calculated such that the compression set characteristics of the thermoplastic or synthetic rubber material have been accounted for whilst permitting the Inverted T-Shaped device to open up and close by predetermined magnitudes in response to movement between the elements of construction hence the device is superior to other factory-formed joints which cannot open in response to structural deflection.

When the joint is partially compressed and installed above a gap or saw cut the gap dimension is termed ‘the installation width’ and wider joints will accommodate greater movement than narrower ones. Those experienced in the field will be able to select an appropriate width of joint for a given anticipated magnitude of movement.

One further feature of the design of the device and the flexibility of the materials from which it may be manufactured is that the joint can be supplied in coil form which, unlike factory-formed joints which have joins every two to three metres, means that butt joints are avoided and thus a continuous seal is formed.

As noted previously factory preformed joint systems that rely upon the strength of the bond between rigid side members and adhesive or mortar to open and close have a major drawback in that the tensile strength of the adhesive or mortar is less than the strength required to stretch the flexible central core that these joints employ, hence the joint's adhesion to the substrate will fail before the joint can open. The proposed device however does not require the rigid members to stretch a central flexible material to function; as the joint has been pre-compressed prior to installation it is already primed to open under forces substantially less than 0.5N/mm^2 which is the minimum tensile strength of the adhesive or mortar likely to be employed to bond the joint in place.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a sectional detail of a conventional factory formed movement joint designed to be installed over a gap formed in a substrate.

Figure 2 shown a plan view of the movement joint detail shown in Figure 1

Figure 3 shows an enlarged sectional view of the joint detail shown in Figure 1 after the substrate has contracted through either drying shrinkage, thermal loss or other such force.

Figure 4 shows a sectional detail of a device according to the invention as extruded and before it has been pre-compressed.

Figure 5 shows a sectional detail of the device shown in Figure 4 after it has been pre-compressed and latched prior to installation.

Figure 6 shows a plan detail of the device of Figure 5.

Figure 7 is a force diagram showing how a vertical force applied to the central mushroom cap of the device is partially transferred outwards into the abutting substrates.

Figure 8 shows the device of Fig. 4 pre-compressed at installation width and installed above a gap formed in a substrate to accommodate movement.

Figure 9 shows the device of Figure 8 after the substrate has expanded and the gap contracted due to forces arising from thermal gain, wind loading or other similar causes.

Figure 10 shows the device of Figure 8 after the substrate has contracted and the gap opened due to forces arising from drying shrinkage, thermal loss, wind loading or other similar causes.

Figure 11 shows a further embodiment of device wherein the sides of the extrusion are reinforced by metal to improve the impact resistance at the exposed outer edges of the device.

DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 shows a rebate which has been formed by leaving a gap 2 between two elements 1 of a building. Alternatively the gap may comprise a saw cut which divides an element into smaller components. Such gaps are left or formed at regular intervals as part of the normal process of construction to accommodate deflections arising from a number of factors including the drying shrinkage of wet components as well as expansion and contraction of said components as their temperature increases and decreases.

Figure 1 also shows a device termed a movement joint or control joint comprising L-shaped plates 6 comprising vertically oriented side plates and horizontally oriented foot plates to which is bonded or co-extruded a central flexible core 7. This type of joint is representative of current control joint technology wherein the plates 6 are perforated with holes 8 and the control joint is embedded in an adhesive or mortar bed 3. The adhesive or mortar bed 3 lies both below and above the footplates 6 while passing through the perforated holes 8 and providing a fixative for the finishes 4. Gaps between the edges of the finishes 4 and the L-shaped side plates 6 are typically filled with a cementitious or other material, generally termed grout.

Figure 2 shows a plan view of the same device wherein the perforations 8 in the L-shaped plates can be clearly seen. These perforations serve to locate the joint firmly within the adhesive or mortar layer and permit the adhesive or mortar layers above and below the foot plates to cross-link to further secure the control joint in place.

Figure 3 shows an enlarged view of a portion of the control joint shown in Figures 1 and 2. In this instance the substrate 1 has contracted due to either thermal loss or drying shrinkage and a crack 11 is shown at the base of the rebate 2. This crack arises where the substrate 1 has been deliberately weakened by the formation of said rebate 2 by either sawing a slot in the substrate or by other means such as leaving a gap between two differing sections of substrate. As the substrate contracts it begins to apply tensile stress via the adhesive or mortar bed 3 to the L-shaped side plates 6 of the joint.

As has been discussed above the tensile strength of the adhesive or mortar bed is generally insufficient to stretch the flexible core 7 of the control joint with the result that the seam of grout 5 begins to exhibit a fracture line 9. This fracture line 9 often progresses until one of the L-shaped plates 6 of the control joint is completely delaminated from the adhesive or mortar layer 3. The delamination of the control joint from the adhesive bed also has implications for the finishes 4 lying above the control joint foot plate 6 in that said delamination means that these finishes are no longer fully bonded to the substrate 1 by means of the adhesive 3. In such cases traffic moving over the finishes in these areas sometimes cause cracking 10 in the finishes where the cracks run parallel to and contiguous with the end of the control joint footplate 6.

Figure 4 is a sectional representation of a device according to the invention following its extrusion. The device has the general form of an inverted T-shape and may be extruded from thermoplastic or synthetic rubber material. It is extruded in an open position to accommodate the clearances required by the manufacturing process.

In this form of the device a central structure, comprising a mushroom shaped cap 13 and a stem 26, is attached to a resilient structure 16, so that the cap 13 is mounted on the resilient structure 16 via the stem 26. The resilient structure has the form of an inverted V-shape whose arms are connected to outer plate-like members 12. The plate-like members form part of an L-shaped body (also referred to herein as L-shaped arms), with an anchoring portion 25 extending horizontally outwardly away from the bottom of each plate-like member 12 to accommodate anchoring in the building structure. The top surfaces 15 of the plate-like members 12 are angled inwards and downwards towards the centre of the joint while the underside 14 of the mushroom-shaped cap 13 slopes outwards and upwards on either side such that when the device is closed the faces 14 of the underside of the cap are parallel to and in contact with the faces of the upper surfaces 15 of the L-shaped arms.

The device also comprises a latch having a male member 18 designed to engage with a corresponding female slot 31 formed between an upper arm 17 and an inward extension of the anchoring member 25 at the base of the plate-like member 12. As the device is closed the tapered end of the male section 18 forces the upper arm 17 to deflect upwards said arm 17 having a hinge 30 where it joins the main upright of the plate-like member 12. The anchoring portions 25 are formed or punched with perforations 19 which aid in affixing the device to a substrate by means of adhesive or mortar.

Figure 5 shows the device of Figure 4 after it has been compressed and closed to a condition termed its 'nominal width'. This nominal width is the state of the joint at the point at which it is installed above a movement gap and from which nominal width it can open and close to reflect movements arising in the substrate. The compression of the joint causes the male member 18 to engage with the female slot 31 such that the device is held latched in a partially closed position. In such position the joint has the capacity to open by disengagement of the male arm from the female slot. The design of the tapered ends of both the male member 18 and the upper arm 17 and its hinge 30 are such that the force required to disengage the male arm from the female slot is less than the tensile strength of the adhesive or mortar in which the device will be embedded. Conversely the device can be closed further wherein the male arm is pressed further into the female slot such that the gaps 20, 22, 23 and 24 close in response to movement from the substrate.

As the invention is closed to its nominal position the inverted V-shaped arms of the resilient structure 16 linked to the mushroom cap 13 also close and in doing so cause the mushroom cap to lift. As the mushroom cap lifts the corresponding sloping tops 15 of the plate-like members slide beneath the sloping bases of the mushroom cap 14 such that as the device is closed further the tops 15 of these members 12 slide progressively beneath and remain in contact with the sloping bases 14 of the central mushroom cap 13.

The device is designed such that contact is maintained between the bases of the mushroom-shaped cap and the tops of the arms 12 throughout the entire movement cycle of the product such that it offers support when mushroom shaped cap 13 comes under load. This fact is important in that the shape of both the bases of the mushroom caps and the tops of the L-shaped arms serve to ensure that a significant component of the load applied is transferred outwards

into the abutting finishes thereby supporting the vulnerable edges of and brittle materials from which the finishes may have been made.

Figure 6 shows a plan detail of the device as described in Figure 5 wherein the mushroom shaped cap 13 rests on tops 15 of the L-shaped arms 15. The holes 19 in the anchoring portions 25 of the L-shaped arms are formed to allow the adhesive or mortar to penetrate said joint footplate and ensure that the device is anshored within the adhesive or mortar layer.

Figure 7 shows the impact of a load F_g applied at point A on the sloping top of one of the outer arms of the O-shaped device. The angle of the slope is θ and depending upon the gradient of this slope the total load is translated into two forces F_x and F_y, where F_x is applied along the plane of the slope and where the value of $F_x = F_g Sin\theta$ and $F_y = F_g Cos\theta$.

Vertical imposed loading applied to the mushroom shaped cap is transferred from the upward sloping bases of the cap through the inward sloping angled returns 15 of the plate-like members 12 of the device and out to the walls 1 of the gap or saw cut. It can be shown that as the load applied on the mushroom cap 13 is transferred through angled planes 14 and 15 in such a way that the force applied acts in two directions; at an angle along the Y-axis at 90° to the plane of the slope and along the corresponding X axis down the plane of the slope. Using an example of a force (F_g) of 100N applied through a 30° slope angle, the resultant components of this force comprising (F_x) applied down the plane of the slope and (F_y) applied at 90° to the plane of the slope:

$F_X = F_g Sin30^\circ = 100 \times 0.5 = 50N$ down the plane of the slope

$F_y = F_g Cos30^\circ = 100 \times 0.866 = 86.6N$ applied at an angle of 30° to the plane of the slope

Figure 8 shows a cross sectional view of the device when it is installed at 'nominal width' as described in Figure 5. The invention spans a saw cut 2 formed between two sections of a substrate 1 or a gap left between two separate substrates said saw cut or gap being left to weaken the substrate such that when the structure deflects that the substrate 1 cracks at this weakened location. The device is embedded within a layer of adhesive or mortar 3 on top of which finishes 4 such as tiles or coatings are applied. The holes 19 formed in the anchoring portions 25 of the L-shaped arms serve to further secure the device within the adhesive or mortar bed 3. Typically a layer of cementitious or epoxy material called grout 5 is applied between the

finishes and the upright outer faces of the plate-like members 12. In the 'normal width' state the joint is capable of opening and closing in response to structural deflection. The gaps 20,21,22,and 23 serve to allow the joint to close in the event that the substrate 1 expands. Similarly, the male member 18 disengages from the female slot 31 when the perforated anchoring members 19 come under tension as the substrate 1 contracts said tension being transferred from the substrate 1 to the L-shaped members through the adhesive or mortar layer 3.

Figure 9 shows the device in its fully closed position following compression which can arise from the expansion of the substrate 1 and/or abutting materials 4 and 5 due to expansion arising from thermal gain in which case the gaps 20 and 21 will close. Under this compression of the device the gaps 22 and 23 have been further reduced due to the two plate-like members 12 being pressed increasingly inwards. As they are pressed inwards they slide progressively beneath the central mushroom cap 13 which lifts in response to both the closure of the plates 12 and the compression of the arms 35 and 36 of the resilient inverted V-shape structure from which the stem 26 of the mushroom shaped cap 13 rises. In Fig. 9, the stem is no longer clearly distinguishable due to the elastic deformation of the resilient structure and central member so that the arms 35, 36 and stem are stretched into a continuous shape. The device has been designed such that the uplift of the mushroom cap 1 by the action of the arms 35 and 36 being closed together is matched by the plate-like members moving inwards and offering continuous contact and support via the sloping bases 14 of the mushroom cap 13 and the inward sloping tops of the plate-like members. This ensures that these members 12 offer support when a load is applied to the mushroom-shaped cap 13 and transfer said loading to the abutting finishes 4 and 5 throughout the device's entire movement cycle.

Figure 10 shows the device in its fully open position following tension which can arise from contraction of the substrate 1 and/or abutting materials 4 and 5 due the forces arising from factors such as thermal loss, drying shrinkage and wind loading. These forces act on the substrate 1 and/or abutting materials 4 and 5 causing the saw cut or gap to widen and crack 11 and apply tension to the device through the adhesive or mortar layer 3 in which the device is embedded. When this happens the gaps 20 and 21 open and the gaps 22 and 23 beneath the mushroom-shaped cap 13 open due to the two plate-like members 12 being drawn increasingly outwards. As they are drawn outwards they slide progressively beneath the central mushroom cap 13 which drops in response to both the opening of the members 12 and the extension of the arms 35 and 36 of the inverted V-shape upon which the stem supporting the mushroom shaped cap 13 is

mounted. The device has been designed such that the descent of the mushroom cap 1 by the action of the arms 35 and 36 being opened is matched by the plate-like members moving outwards, thereby remaining in contact with one another and offering continuous contact and support via the sloping bases 14 of the mushroom cap 13 and the inward sloping tops of the tops 15 of the plate-like members 12. This ensures that these members 12 offer support when a load is applied to the mushroom-shaped cap 13 and transfer said loading to the abutting finishes 4 and 5 throughout the device's entire movement cycle.

Figure 11 shows a cross section of a further embodiment, generally similar to that of Figs. 4-10, designed for applications where it is required that the outer edges of control joints are reinforced with metal. This device is shown with the outer thermoplastic L-shaped arms 12 reinforced by metal arms 30 which a co-extruded with the thermoplastic material.

CLAIMS

1. A control joint device for sealing a movement gap defined between adjacent opposed faces of two building components, the device comprising:

a pair of spaced-apart plate-like members adapted to be mounted against said opposed adjacent faces such that the plate-like members are generally parallel to one another and are mounted on either side of the gap;

a resilient structure connecting and bridging the plate-like members;

a central member extending upwardly from said resilient structure between the plate-like members, the central member having a cap, the cap having an underside facing the resilient structure and a top side facing away from the resilient structure;

the resilient structure, and central member being dimensioned such that in use the plate-like member on a first side of the gap bears against the underside of the cap on the first side and the plate-like member on the second side of the gap bears against the underside of the cap on the second side.

2. The control joint device of claim 1, wherein each plate-like member having an angled surface at an upper end thereof, the angled surface sloping downwardly and inwardly away from the respective face against which the plate-like member is mounted in use, and wherein the cap has an underside with a pair of angled surfaces, one at either side of the central member, each angled surface sloping upwardly and outwardly away towards the first or second side respectively, the plate-like members and cap being dimensioned such that in use the angled surface of the plate-like member on a first side of the gap bears against the respective angled surface of the underside of the cap on the first side, and the angled surface of the plate-like member on the second side of the gap bears against the respective angled surface of the underside of the cap on the second side.

3. The control joint device of claim 1 or 2, wherein the central member is carried on the resilient structure such that the central member moves vertically upwards as the resilient structure is compressed and downwards with relaxation of the resilient structure, said movement tending to maintain the contact between said cap and said plate-like members under different compressive states.

4. The control joint device of any preceding claim, wherein said resilient structure forms an inverted V-shape between the plates, with the central member being mounted on the apex thereof.

5. The control joint device of claim 4, wherein the central member is formed integrally with and emerges from the resilient structure.

6. The control joint device of any preceding claim, wherein each plate-like member is provided with a mounting attachment for mounting the plate-like member to its building component.

7. The control joint device of claim 6, wherein the mounting attachment is an anchoring plate extending perpendicularly from the plate-like member to provide an L-shaped arrangement, whereby the anchoring plate may be mounted below or within the building component on whose face the plate-like member is thereby mounted.

8. The control joint device of any preceding claim, further comprising a latch mechanism for holding the resilient structure in a state of partial compression and preventing the plates from moving away from one another in a normal latched state.

9. The control joint device of claim 8, wherein the latch mechanism permits increased compression of the resilient structure as the plates are moved closer to one another from the normal latched state.

10. The control joint device of claim 8 or 9, wherein the latch is designed to unlatch and to permit the plates to move apart from one another under a tension force applied across the device, wherein the tension force required to unlatch is less than 2.5N/mm^2, more preferably less than 1.0N/mm^2, most preferably less than 0.5N/mm^2, whereby when the plates are mounted to the components with cementitious or adhesive materials the plates will move apart under tension force from the normal latch position before the cementitious or adhesive mounting fails.

11. The control joint device of any of claims 8-10, wherein the latch comprises a pair of co-operating members having angled surfaces which engage with one another as the plates are compressed together to form a latch.

12. The control joint device of claim 11, wherein the co-operating members are resilient and the angled surfaces are shaped to permit unlatching when a predetermined tensile force is applied to the plates.

13. The control joint device of any preceding claim, wherein the central member further comprises a stem connected at one end to said resilient structure and at said other end to said cap.

14. The control joint device of any preceding claim, wherein the gap across the plates defines a first horizontal axis when the device is mounted in use and wherein the plates are elongated along a second, orthogonal horizontal axis to form an extended strip to be mounted against the faces of the building components.

15. The control joint device of claim 14, wherein the cap is an elongate member extending along the second horizontal axis.

16. The control joint device of claim 14 or 15 when dependent on claim 13, wherein the stem is a resilient planar member extending along the second horizontal axis.

17. The control joint device of any preceding claim, wherein the cap has an upper surface which presents a rounded surface across the gap, bridging the components of the building structure.

18. The control joint device of any preceding claim, wherein the cap is resiliently deformable.

19. The control joint device of any preceding claim, wherein the central member further comprises a stem connected at one end to said resilient structure and at said other end to said cap, and wherein the cap is wider than the stem when viewed in a plane transverse to the plate-like members, such that on either side of the stem, below the cap, a respective space is defined.

20. The control joint device of claim 19, wherein upon compression of a gap in which the device is fitted, said spaces accommodate said plate-like members being compressed inwardly.

21. The control joint device of claim 2 or any claim dependent thereon, wherein the respective angled surfaces of the plate-like members and cap are designed to match one another when the device is inserted into said gap.

22. The control joint device of claim 21, wherein said angled surfaces assume an angle from the horizontal of between 10 and 80 degrees in normal use, preferably between 20 and 60 degrees, more preferably between 25 and 45 degrees.

23. The control joint device of any preceding claim, wherein the plate-like members, resilient structure and central member are integrally extruded from an extrudable thermoplastic material such as PVC, Polyethylene, Polyurethane, or Polypropylene or a synthetic rubber such as Silicone, Neoprene, or EPDM.

24. The control joint device of any preceding claim, wherein said device has a relaxed state, and a range of operating compressed states ranging from said relaxed state to a maximally compressed state in which the plate-like members and cap remain in contact without damage to the device, the device being dimensioned such that said relaxed and maximally compressed states lie outside the expected maximum and minimum ranges of width achieved under a normal expected range of environmental conditions, for an expansion gap to which the device is to be fitted.

25. A method of filling an expansion gap defined between building components, comprising the steps of: determining maximum and minimum ranges of width for said expansion gap under a normal expected range of environmental conditions; selecting a control joint device according to claim 23 such that said relaxed and maximally compressed states of said device lie outside the determined maximum and minimum ranges of width for said expansion gap; and fitting said control joint device to said building components under compression.

26. A method of filling an expansion gap according to claim 25, wherein said building components are finishing components mounted on a substrate or on a pair of adjacent substrate members, said finishing components defining a pair of opposed, adjacent faces; and mounting the control joint device by anchoring each plate-like member of the device into a space between the respective building component and the underlying substrate, whereby under ambient conditions the device is compressed to a state intermediate between the relaxed and maximally compressed states.

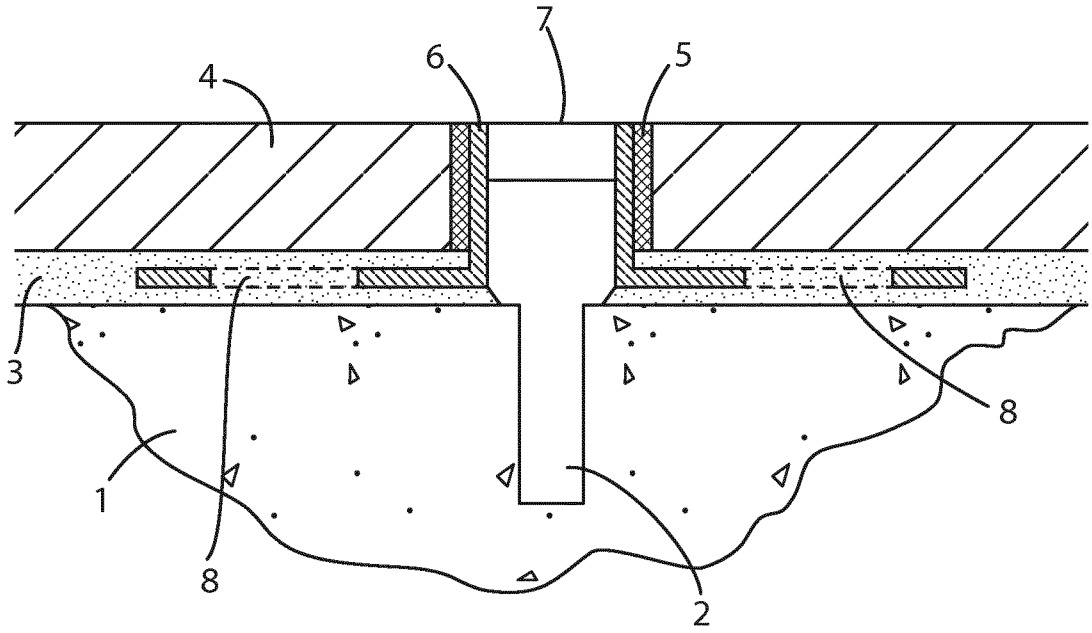


Figure 1

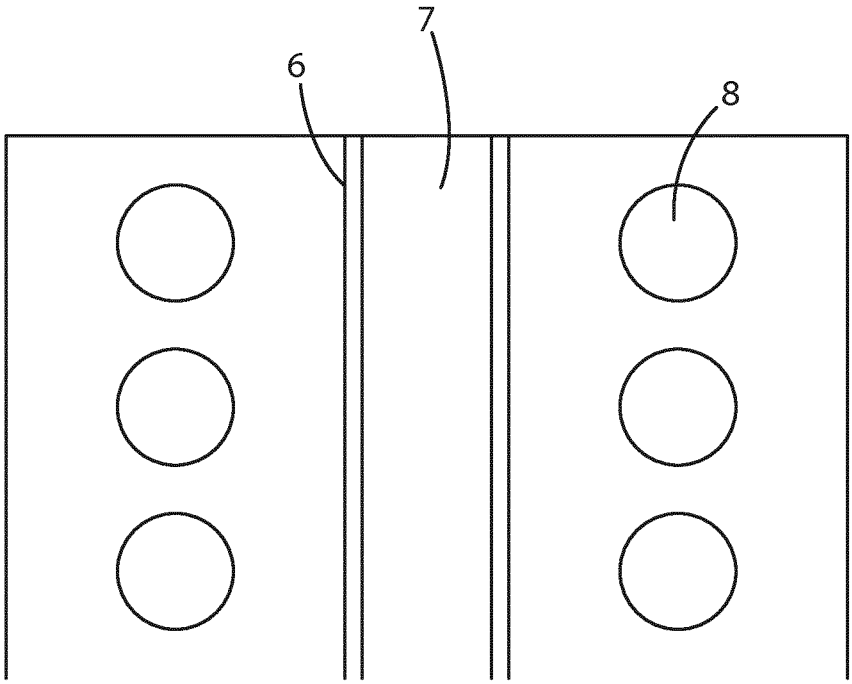


Figure 2

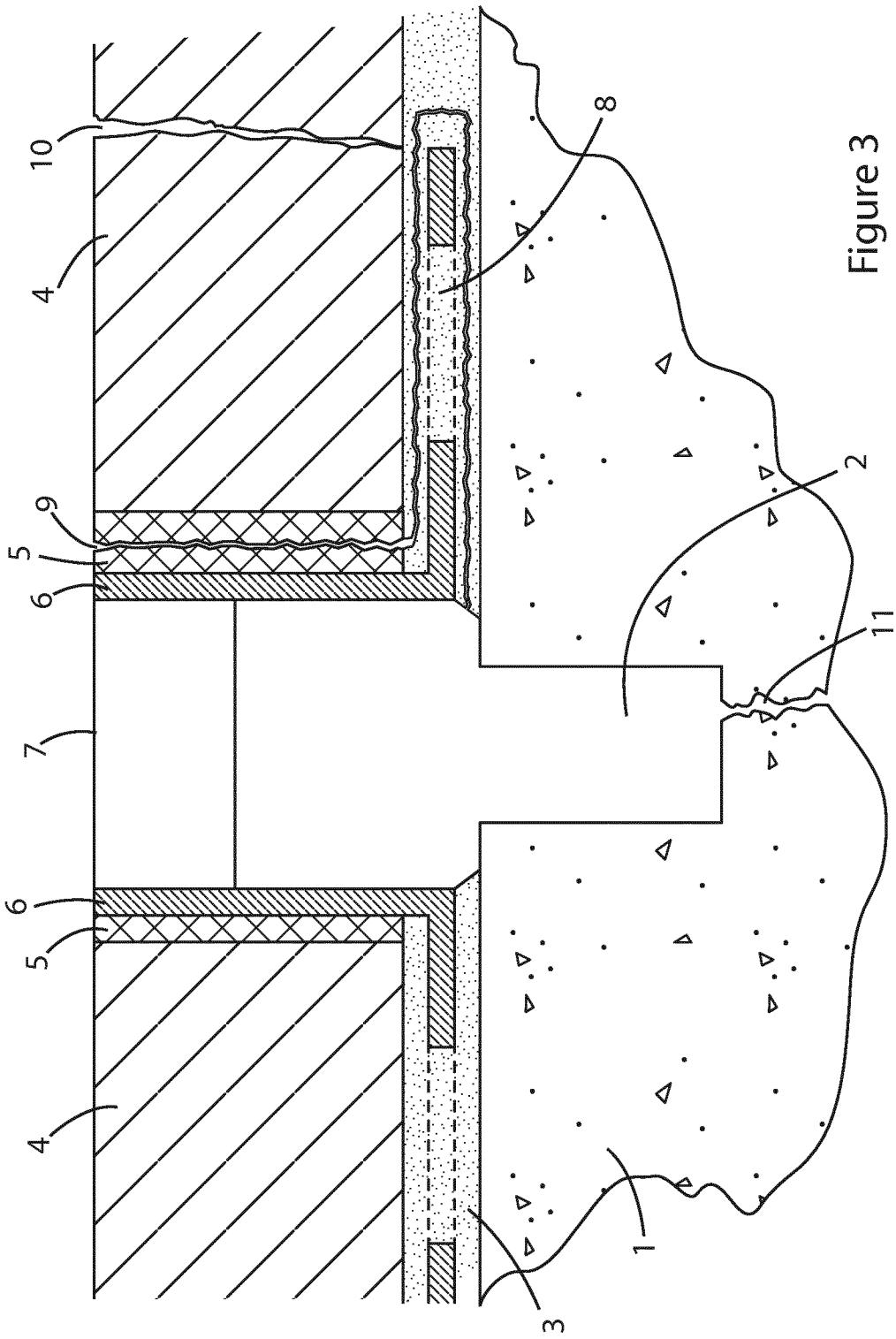


Figure 3

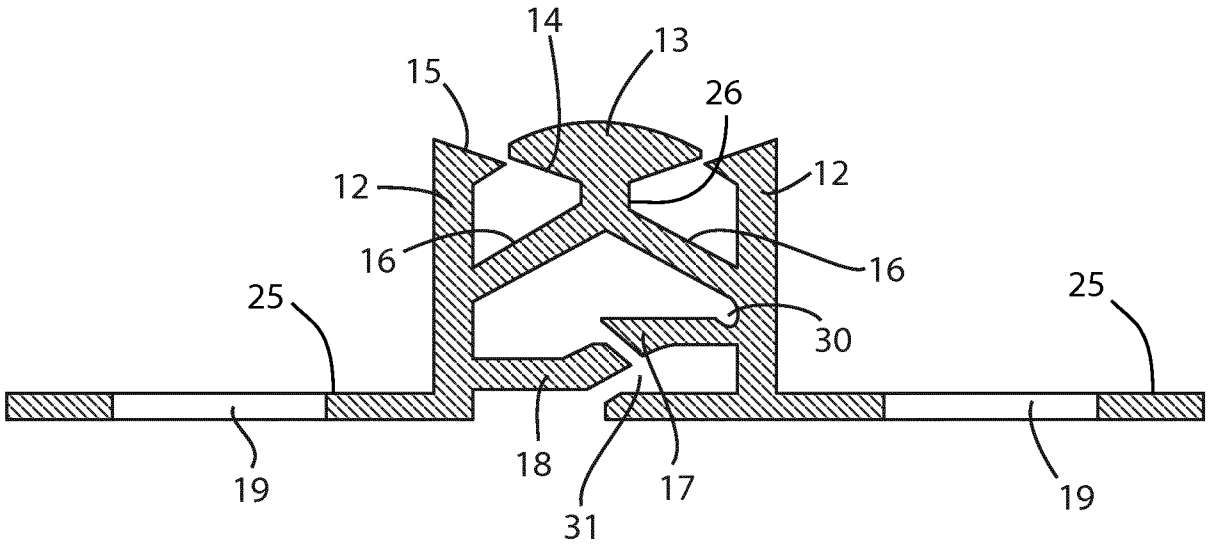


Figure 4

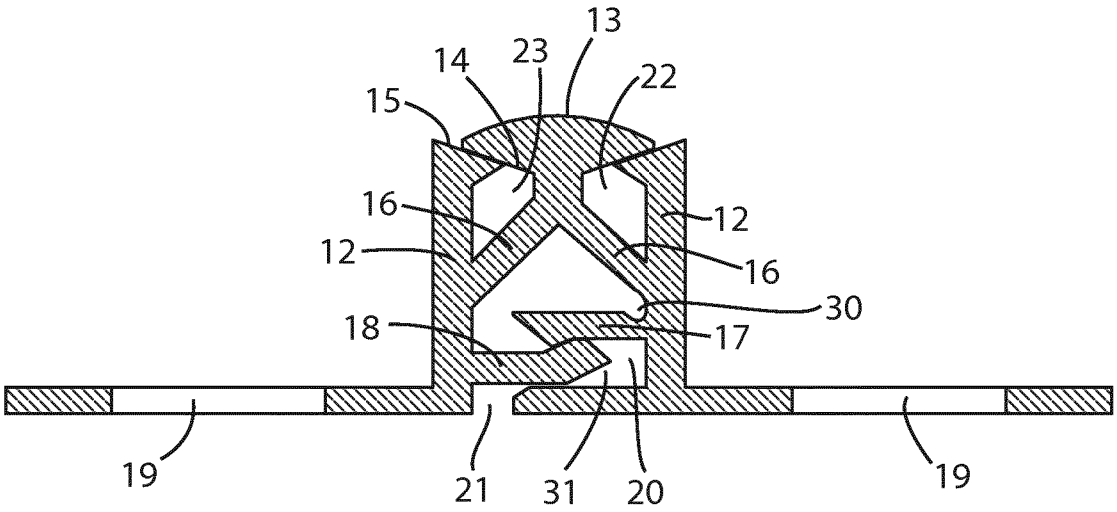


Figure 5

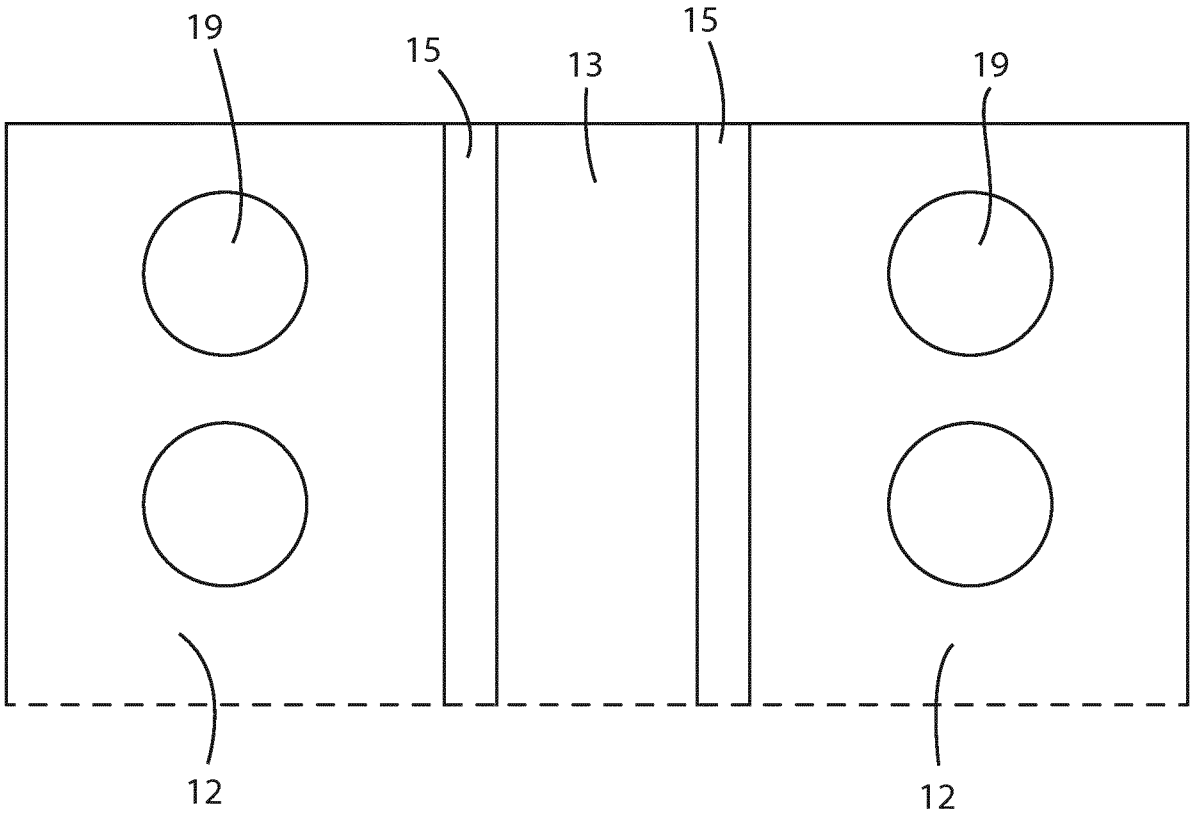


Figure 6

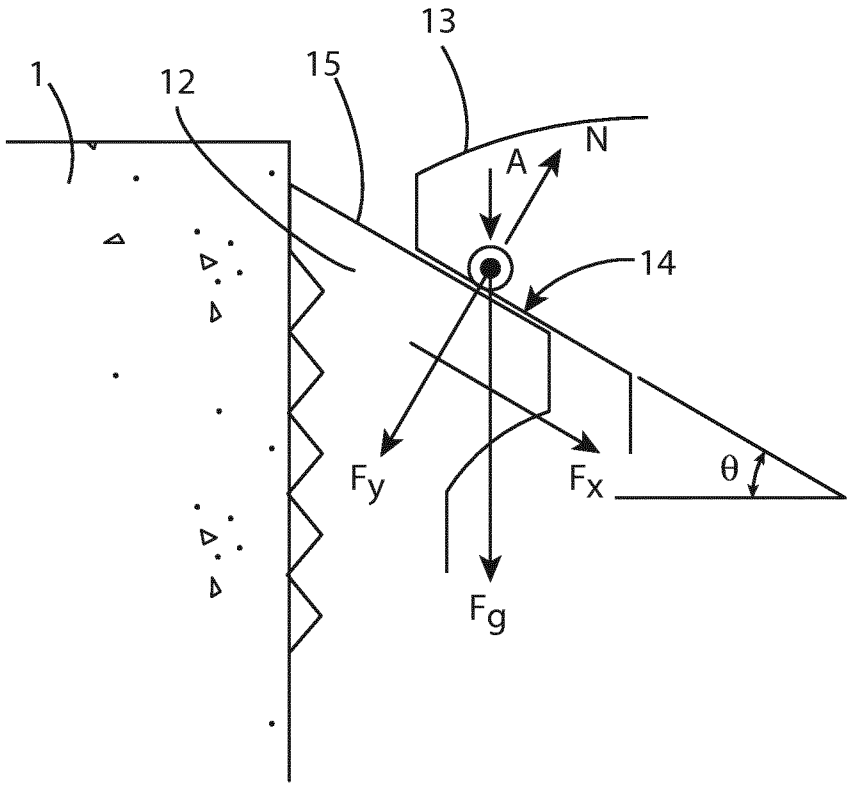


Figure 7

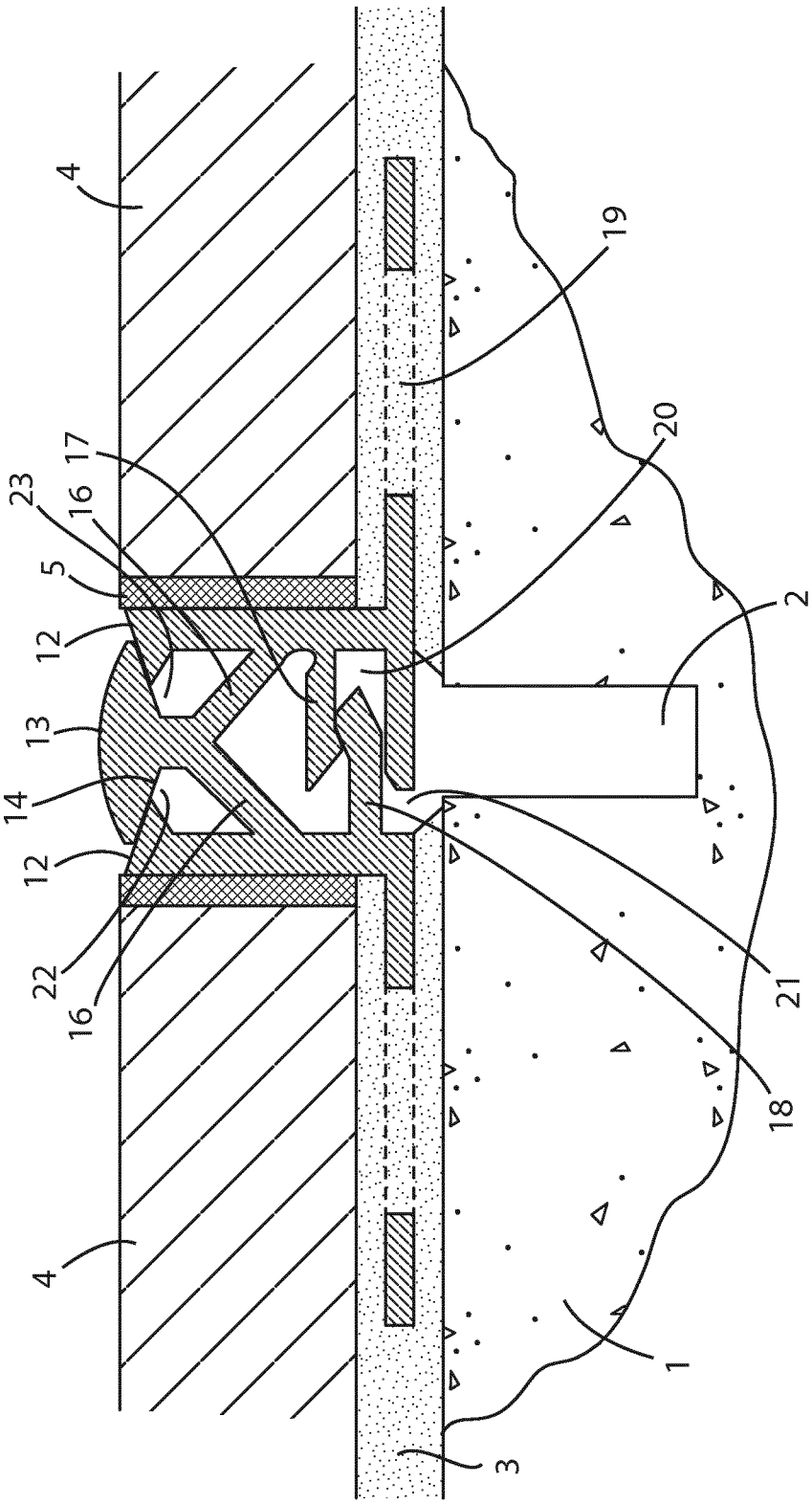


Figure 8

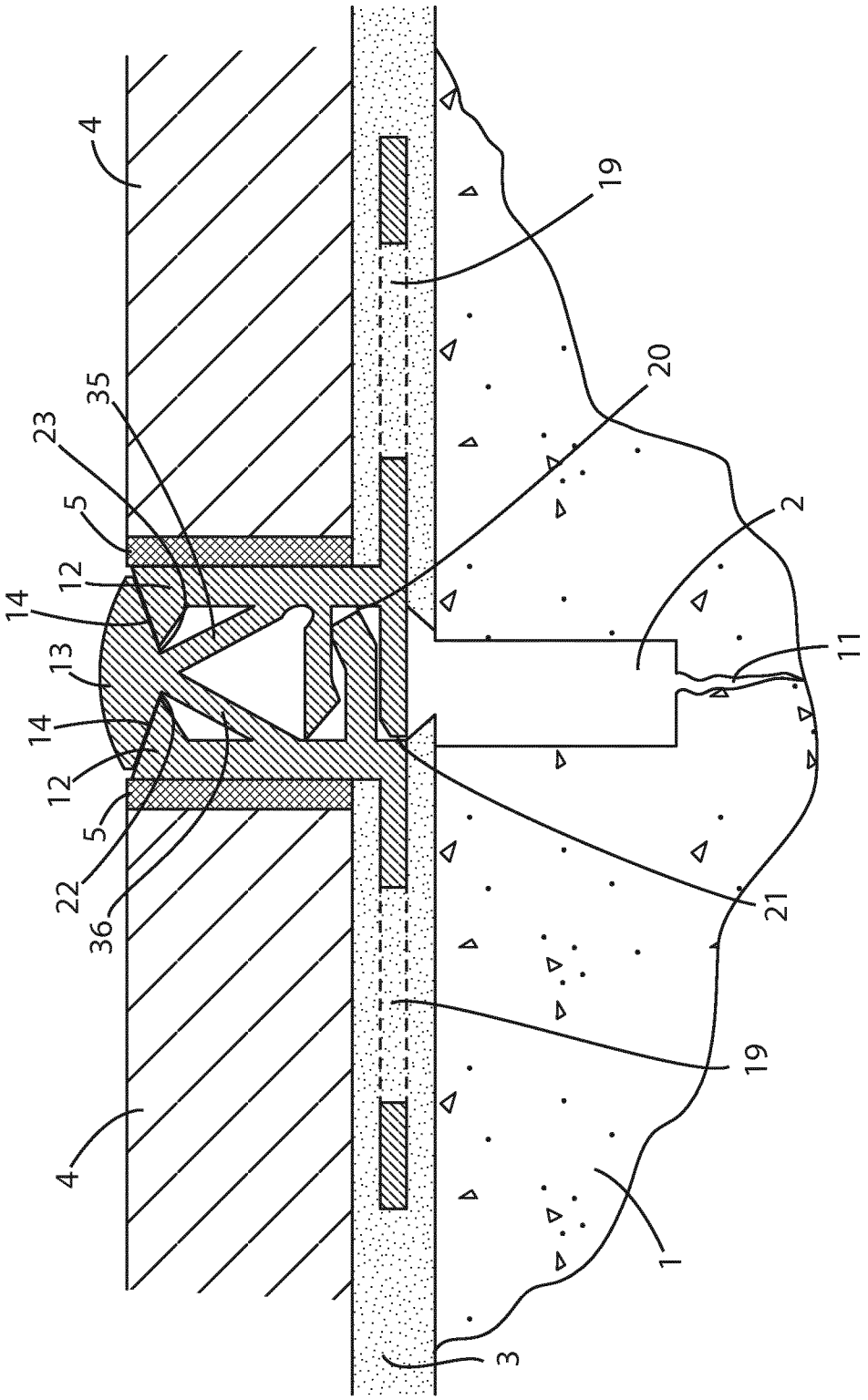


Figure 9

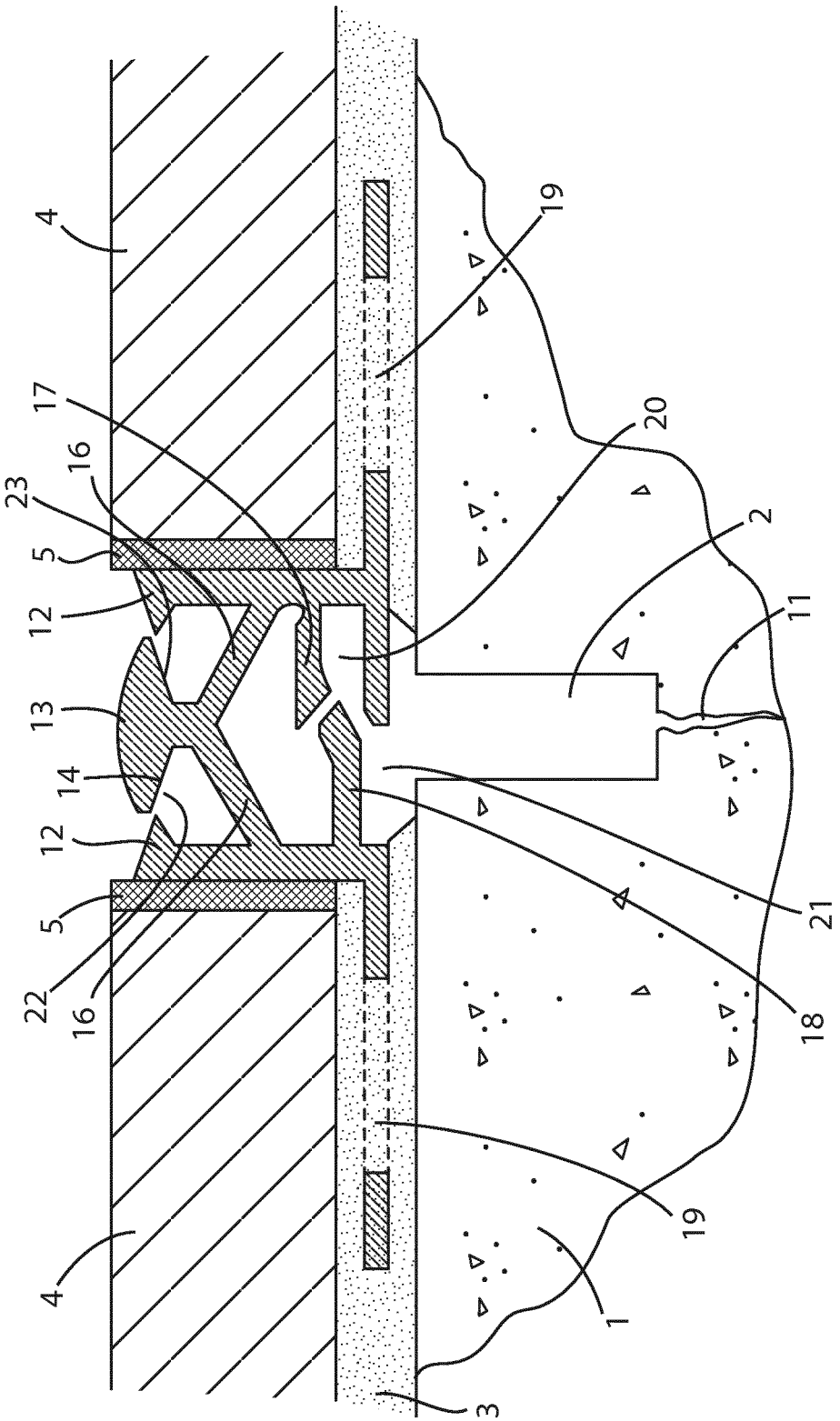


Figure 10

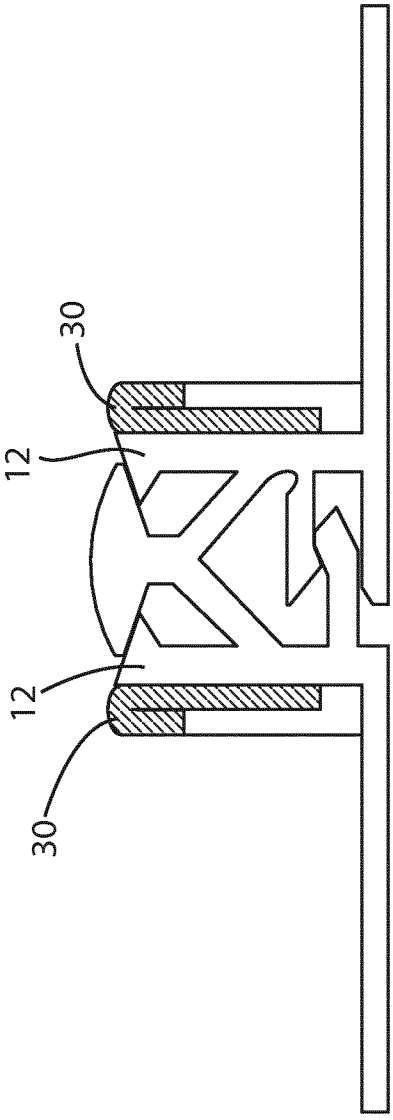


Figure 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/067634

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04B1/68 E01C11/10 E04F15/14 E04F19/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04B E01C E04F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 38 26 514 C1 (MIGUA HAMMERSCHMIDT) 7 December 1989 (1989-12-07) column 4, line 30 - column 5, line 40 figure 1 -----	1-7, 13-15, 18-26
X	WO 92/01843 A1 (VEXCOLT UK LTD [GB]) 6 February 1992 (1992-02-06) page 4, line 31 - page 6, line 28 figure 1 -----	1-3, 6-21, 24-26
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2016	27/09/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	López-García, G

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/067634

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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