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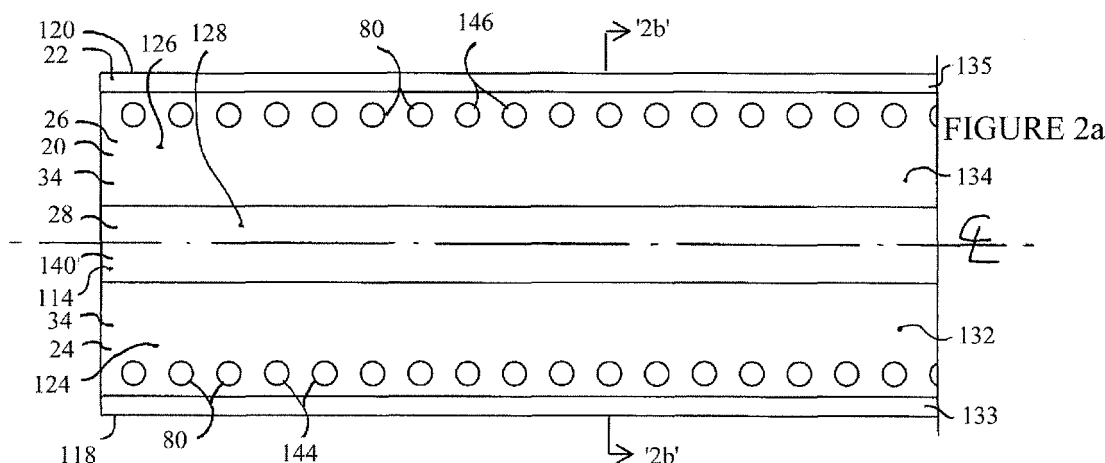
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(54) **Expansion joint and method**

(57) An expansion joint (20) comprises an elongated flat sheet (22) of flexible and resilient polymeric material having a width and a length; upper and lower surfaces (114, 116) and first and second edges (118, 120). The sheet has selvage edges (24, 26) and a central gland (28). The selvage edges have a pair of parallel elongate first and second scrims (132, 134) which may be formed or embedded on each of the opposite surfaces along the

length of the sheet. The rough strips on each surface flank the elongated strip of bare surface of the gland (28). The sheet (22) has an array of apertures (80) located in at least one of the selvage edges (24, 26). The apertures (80) pass through the sheet and the strips and maybe of various shapes, circular, elongate, curving, and either of closed periphery or open to the edges, e.g. as slots or saw tooth edge configuration.



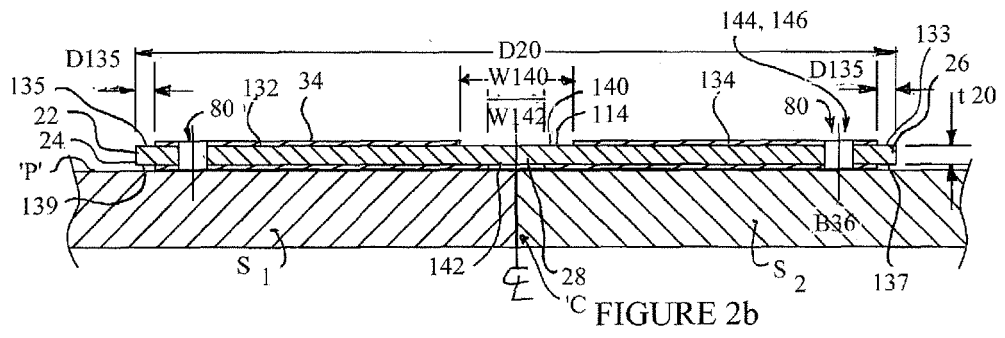


FIGURE 2b

Description

Claim for Priority

[0001] This application claims priority from Canadian Patent Application CA 2,668,073 filed June 2, 2009 by the Applicant Krzysztof Zielonka, the subject matter of the specification, drawings, and claims thereof being incorporated herein by reference.

Field of the Invention

[0002] The invention relates generally to rubber or polymeric waterproof expansion joints.

Background of the Invention

[0003] Rubber expansion joints are often used in construction to help water proof roofs, slabs, and walls, thereby to protect the structure from effluent damage, which may typically be water damage. Traditionally, these expansion joints have included an elongated flat sheet of rubber, vinyl or some other flexible, resilient polymeric material. These expansion joints are usually laid over a joint between two walls or two sheets of waterproofing tiles or fabric. Expansion joints are typically secured to the surface of the joint by adhesive such as tar or the like.

[0004] Rubber expansion joints may be present some challenges or disadvantages. For example, on hot summer days, the tar or adhesive used to bond the joint to the underlying substrate and to hold the joint in place may soften or weaken. This may result in the joint to becoming dislodged and slipping or creeping or migrating away from its desired position. That is, when the bond holding the joint softens, the joint may tend to move, or creep, across the surface of the substrate to which the joint is bonded. This creeping of the joint may result in the failure of the waterproof joint. So far, the only way to ensure that the joint is well adhered is to maximize the surface area of contact between the joint and the adhesive used to bond the joint. This can be done by increasing the surface area dimensions of the sheet, i.e. providing a wider sheet, and or by increasing the surface area of the sheet by roughing up the surface by means of bonding fibrous matting to the surface of the sheet. While these approaches are effective in increasing the adhesion of the joint to the adhesive, increasing the dimensions of the sheet increases its cost; and fibrous matting bonded to the sheets often dislodge from the sheet surface due to poor adhesion of the fibrous matt to the sheet.

Summary of the Invention

[0005] In an aspect of the invention, there is a substantially flat expansion joint. The expansion joint has first and second elastomer based selvage edges and an elastomeric gland located between the selvage edges. The gland is for deployment in a lengthwise direction along

an underlying structural interface. At least a portion of the first selvage edge has a plurality of apertures formed therethrough.

[0006] In a feature of that aspect of the invention the first selvage edge has a total edge length that includes the edge lengths of the apertures. A ratio of the total edge length per unit of running length of the portion in the lengthwise direction is greater than 125%. In another feature the ratio exceeds 200 %. In a further feature, the apertures include an array of slots pitched along the running direction, the slots have a major dimension, and the major dimension is predominantly transverse to the lengthwise direction. In still another feature the apertures are formed in an array of apertures having edges oriented obliquely to the lengthwise direction. In another feature apertures on successive pitches are oriented on alternating left hand and right hand oblique angles. In a yet further feature the apertures have a closed periphery. In an alternate feature the apertures have an at least partially open periphery. In still yet another feature the first selvage edge includes at least a first scrim, and the apertures are formed at least in part through the scrim. In again another feature the first and second selvage edges each have a first surface for placement against structure to which the expansion joint is to be applied, and a second face for orientation facing away from the structure, and both the first and second faces include a scrim.

[0007] In another feature the selvage edges have a transverse width, W. The selvage edges have a most transversely outboard third. The apertures have an extent, L, transverse to the lengthwise direction. The apertures are located in the most transversely outboard third. The extent, L, has a magnitude that is in the range of one eighth to one third of W. In still yet a further feature the first and second selvage edges each have an array of the apertures formed therein, the apertures are circular, closed periphery apertures formed in an outermost one third of each the selvage edge respectively, and the apertures have a diameter to pitch spacing ratio in the range of 1/8 to 3/4.

[0008] In a still yet further feature the joint includes first and second portions meeting at a corner, the first and second portions have respective rubber-based matrices; and the first and second portions are vulcanized together. In another feature the expansion joint has first and second portions, each of the first and second portions having respective first and second selvage edges; the first portion has arrays of the apertures formed in both of the selvage edges, and the second portion has at least one selvage edge that is free of the apertures.

[0009] In another aspect of the invention, there is a method of installing a flat expansion joint on a structure. The structure has first and second portions, and an interface between the first and second portions. The expansion joint has a rubber based matrix. The expansion joint has a lengthwise running gland located between a pair of first and second selvage edges that run along the gland and extend laterally away therefrom. Those sel-

vage edges have apertures formed therethrough. The method includes treating a surface portion of each of the first and second portions of the structure with a resin; placing the first selvage edge in the resin on the first portion of the structure; placing the second selvage edge in the resin on the second portion of the structure; smoothing the expansion joint in place; observing occupation of the apertures with the resin as the expansion joint is smoothed in place; and applying a further amount of resin to cover the selvage edges while leaving the gland uncovered. In a feature of that aspect of the invention, the method further includes applying a mechanical protector over the gland. In another feature the expansion joint has a fibrous scrim mounted to each the selvage edge, and the method includes saturating the fibrous scrim in the resin.

[0010] In another aspect of the invention there is an expansion joint. It has an elongated flat sheet of flexible and resilient polymeric material having a width, opposite upper and lower surfaces, and opposite first and second edges. One of the opposite surfaces is a first surface, and has a fibrous section including a section of the sheet having a plurality of fibers secured to the surface. The fibrous section extends along the first surface adjacent one of the edges. A series of apertures passes through the sheet and is positioned on the fibrous section, with the apertures being positioned adjacent one of the side edges.

[0011] In a feature of that aspect of the invention, each of the upper and lower surfaces have the fibrous section. In another feature each of the fibrous sections comprises a parallel pair of first and second fibrous matts secured to the surface. The fibrous matts are separated by an elongated strip of bare surface. The first and second fibrous matts are located adjacent to the first and second edges of the sheet, respectively, with the apertures forming a parallel pair of first and second rows of apertures positioned adjacent the first and second edges.

[0012] In another aspect of the invention there is an expansion joint. It has an elongated flat sheet of flexible and resilient polymeric material having a width, a length, opposite upper and lower surfaces and opposite first and second edges. The sheet has a parallel pair of fibrous first and second matts secured to each of the opposite surfaces along the length of the sheet. The parallel fibrous matts on each surface are separated by an elongated strip of bare surface. The first and second fibrous matts are located adjacent the first and second edges of the sheet, respectively. Parallel rows of first and second rows of apertures are positioned adjacent to the first and second edges, respectively. Each of the row of apertures passing through the sheet and the fibrous matts. In a feature of that aspect of the invention, each of the apertures have substantially right angled edges. In another feature the apertures are substantially circular.

[0013] In a further aspect of the invention there is an expansion joint. It has an elongated flat sheet of flexible and resilient polymeric material having a width, a length,

opposite upper and lower surfaces and opposite first and second edges. The sheet has a parallel pair of elongated first and second rough strips formed on each of the opposite surfaces along the length of the sheet. The rough strips on each surface are separated by an elongated strip of bare surface. The first and second rough strips are located adjacent the first and second edges of the sheet, respectively. Parallel first and second series of apertures are positioned adjacent to the first and second edges, respectively. Each aperture passes through the sheet and the rough strips.

[0014] In a feature of that aspect of the invention, a portion of each of the rough strips includes fibrous material secured to the sheet. In another feature the rough strips each include a fibrous matt secured to the sheet. In another feature each of the apertures has a substantially right angled edge. In another feature the apertures are substantially circular. In another feature the apertures are substantially polygonal. In a further feature the apertures are substantially triangular. In an alternate feature the apertures are curved. In a further feature the apertures are substantially S-shaped. In another feature the apertures are slots. In another feature the slots have closed peripheries. In another feature the slots are on alternating oblique angles relative to the longitudinal direction to give a wedge arrangement. In an alternate feature, the slots have a closed periphery. In a further feature the slots have a closed and, an open end, and walls that converge from said open end to said closed end.

[0015] These and other aspects and features of the invention may be understood with reference to the description that follows, and with the illustrations of a number of examples.

Description of the Drawings

[0016]

Figure **1a** is an isometric, not-to-scale view of a three-dimensional expansion joint installation such as may incorporate aspects of the present invention;

Figure **1b** is a cross-sectional view of a horizontal portion of an installation such as that of Figure **1a**, in which the thickness of the expansion joint is exaggerated;

Figure **1c** is a cross-sectional view of an application of a roof-to-wall expansion joint portion of an installation such as that of Figure **1a**, in which the thickness of the expansion joint has been exaggerated; Figure **2a** is a plan view of an embodiment of an expansion joint according to an aspect of the present invention;

Figure **2b** is a cross sectional view of the expansion joint of Figure **2a** taken along line section '2b - 2b' of Figure **2a**;

Figure **2c** is an expanded view of a portion of Figure **2b** showing details of the edge of an aperture;

Figure **3a** is a plan view of an alternate embodiment

of expansion joint to that of Figure 2a, in which the expansion joint has a series of open ended slots;
Figure 3b is a plan view of a further alternate embodiment of expansion joint to that of Figure 2a, in which the expansion joint has a series of non-circular slots;

Figure 3c is a plan view of a further alternate embodiment of expansion joint to that of Figure 2a, in which the expansion joint has a series of closed parallel slots;

Figure 3d is a plan view of a further alternate embodiment of expansion joint to that of Figure 2a, in which the expansion joint has a series of angled slots;

Figure 3e is a plan view of a further alternate embodiment of expansion joint to that of Figure 2a, in which the expansion joint has a series of arcuate slots;

Figure 3f is a plan view of a further alternate embodiment of expansion joint to that of Figure 2a, in which the expansion joint has a staggered series of slots; and

Figure 3g is a plan view of a further alternate embodiment of expansion joint to that of Figure 2a, in which the expansion joint has a staggered series of slots having angled edges yielding a serpentine or sawtooth edge.

[0017] In the drawings like characters of reference indicate corresponding parts in the different figures.

Detailed Description of the Invention

[0018] The description that follows, and the embodiments described therein, are provided by way of illustration of examples of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings are generally to scale in plan view. However, in view of the aspect ratios of thickness to width, the thickness has been exaggerated or enlarged in some views for the purposes of clarity of illustration.

[0019] The subject matter herein is intended to include all combinations and permutations of the various individual features shown and described. To the extent that any such feature was subject to a claim in Canadian Patent Application CA 2,668,073 from which this case claims priority, and which is incorporated herein by reference, it will be understood that the subject matter herein includes the combinations of those claimed features had they been written in multiply dependent form rather than in singly dependent form. Furthermore, the subject matter includes the subject matter of all of the independent claims filed in CA 2,668,073 and all of the dependent

claims filed in that case, including all combinations and permutations of those independent claims and the dependent claims therein that could have been made. The Applicant does not disclaim, and reserves the right to claim, any and all such permutations and combinations of claimed features, whether previously combined or separate, as if claims for those combinations had been submitted herewith on the date of filing, whether or not such combinations and permutations were explicitly claimed either separately or in combination. The subject matter is not limited to the particular words used herein, but includes synonyms and alternate forms of expression having substantially the same meaning. The subject matter is not limited to those features described in the written text, but includes that subject matter that can fairly be inferred or otherwise understood by a person of ordinary skill in the art on the basis of the illustrations, whether supported in the written text of the application or not. The Applicant reserves the right to add such written text as may fairly comport with the understanding of a person of ordinary skill in the art of the features shown in the illustrations.

[0020] The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the art in North America. Following from decision of the US Court of Appeals for the Federal Circuit in *Phillips v. A WH Corp.*, the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, to forestall overly broad interpretation under the rule of broadest reasonable interpretation, excludes all interpretations other than those interpretations that are consistent with actual usage in the industry as understood by persons of ordinary skill in the art, or that are expressly supported by this specification. Each of the claims, whether in the form of a sub-combination or combination, is to be interpreted as an whole, and is not to be interpreted as having a first part and a second or "characterizing" part. It is to be understood that the features of any dependent claim herein may be amended or copied to depend from a different independent claim, or string of claims. It is also to be understood that although a claim may include multiple alternate parts, any one or group of those parts may be made the subject matter of another dependent or independent claim.

[0021] In terms of general orientation and directional nomenclature, for expansion joints as described herein a Cartesian frame of reference may be employed in which the longitudinal direction is defined as being coincident with the running direction of the joint, and may be considered to be the x-axis or x-direction. Similarly the width of the joint perpendicular to the running direction may be considered the y-direction. The through thickness may be considered the z-direction. In the context of the joint as an whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the

joint.

[0022] Referring to Figures **1a**, **1b**, **1c**, **2a**, **2b** and **2c**, an expansion joint is shown generally as item **20**. It includes a flat elongated sheet or slab or member **22** of rubber material that may be considered conceptually to be a membrane in which the through thickness is small as compared to the overall width, and, typically, the width is small or very small as compared to the length. That is, the width, D_{20} , may be of an order of magnitude greater than the thickness, t_{20} . For example, t_{20} may be in the range of perhaps 3/32" to 5/32" (1.8 mm, 2mm, 2.2 mm or 3 mm, +/-) thick, whereas the overall width D_{20} of may be in the range of, for example, about 7" to 22" (175 mm to 540 mm), or perhaps more, with mid-range sizes of perhaps about 10" or 10-1/2" (270 mm, +/-), about 13 - 13 1/2 (340 mm, +/-), or about 15" or 16" (400 mm, +/-). Thus the aspect ratio of the material in terms of width to thickness may be of the order of about 80:1 or 100:1 to about 300:1 or 400:1, depending on the installation. The length may be considered potentially to be substantially infinite as compared to the width since, in general, the joint is supplied in a roll that is paid out linearly along the discontinuity to be sealed, which may be 20, 30, 50, or 100 or more feet long.

[0023] In terms of a general overview, expansion joint **20** has the form of a strip having a pair of first and second lengthwise running margins, or portions, called selva edges **24**, **26** and a central portion called a gland **28**. The selva edges include an embedded stiffening element, termed a scrim and indicated as **34**. Scrim **34** may also be fibrous to promote better adhesion on installation, as described below. The scrim may be a partially exposed surface layer, or it may be fully embedded within the matrix of the expansion joint margins.

[0024] In one type of expansion joint, **20**, the waterproofing material of the expansion joint may typically be a continuous material strip compounded from a rubber based elastomer. During the manufacturing process a scrim, i.e., a reinforcement, which may for example be in the form of a polyester fleece, is embedded in the gelling elastomer matrix in the selva edge on both sides of the joint. In some instances, as with a mop applied tar joint, the reinforcing is at least partially external, leaving a roughened or fibrous surface to which the binder, or resin, be it epoxy or tar, or some other material, may be applied. In each case, the reinforcing material does not extend to the expanding or stretching section, namely gland **28**. Another type or embodiment of expansion joint employs a scrim that is embedded as a middle layer in a flame proof rubber matrix, such as may be installed using a flame-heated resin. In a third type or embodiment of expansion joint the scrim is again fully embedded in the rubber matrix, and may be for use with an epoxy resin in installations as a swimming pool or other liquid-containing tank seal, and such as may include potable water containing structures. In each of the second and third instances, the upper and lower surfaces or the selva edges may be roughened, or moulded to have a non-

smooth surface, such as may, for example, have the appearance of being knurled.

[0025] The elastomeric base material may tend to be rubber, and that rubber may tend to be a rubber that is resistant to one or several of UV light, ozone, alkalis, acids, saline solutions, alcohols and ketones. Depending on the circumstances, the joint may be secured in place with a resin, such as may be chosen from the set of resins that includes roofing tars and asphalts; asphaltic saturants; built-up-roof materials (BUR); coal tar pitch (CTP); modified bitumen (SBS / APP); hot rubberized asphalt (HRA); cold adhesives (CAA); spray polyurethane foam (SPF); liquid applied membranes (LAM); Epoxy Resin (ER); EPDM Tie-in or PVC/TPO tie-in. One type of rubber based material typically has an initial Durometer A hardness of approximately 45 +/- 5 according to ASTM D2240. The gland will have an elongation to breaking under ASTM D412 of greater than 500 %, and a tear resistance under ASTM D624 of at least 220 lbf/in, (approx. 40 N/mm).

[0026] Installation may include the use of a resin such as one of the resins noted above. For example, an asphalt or bitumen tar, may be mopped onto the substrate. The substrate may be some type of base ply roofing layer. The expansion joint is then laid over the joint to be sealed, and then further resin is applied to cover at least the selva edges. Further materials, such as pea gravel in the case of a built-up roof, may overlay the selva edges. A protective mechanical layer may in turn bridge across the gland and overlap the inner portions of the selva edges to provide mechanical protection to the gland, without being attached to, or interfering with the operation of, the gland.

[0027] Although expansion joints of this nature may typically be applied across a substantially flat joint, i.e., where, at least initially, the substrates on either side of the joint are substantially co-planar, this need not necessarily be so. For example, an expansion joint may be applied between a substantially horizontal planar portion and a substantially vertical planar portion, as where a building addition of one height meets a taller existing structure, or where the joint lies closely adjacent an up-standing feature, such as a skylight surround. In these cases one selva edge may lie in the plane of the roof, and adhere to an underlying roof substrate, while the other selva edge may bear against, and by the use of a suitable resin may adhere to, a flashing or other like element.

[0028] The geometry of the expansion joint, and its orientation may vary along its length. Expansion joints such as those described herein need not merely run in a single straight line. In Figure **1a**, which is not to scale, seal **20** has many portions. There is a first portion **36**, which is an end portion, that runs across a flat roof **50**, and has a combined length of $L_1 + L_2$. First portion **36** is intersected by a second portion **38** that runs perpendicularly away from portion **36** (it need not be perpendicular) a distance L_3 . Second portion **38** ends at a corner, **40**, whence an-

other portion **42** runs distance L_2 back toward a wall **44**. There is another corner **46**, and a portion **48** that runs a distance L_4 along the junction between wall **44** and roof **50**. Portion **48** ends at a further corner **52** where wall **44** and roof **50** meet another vertical wall **54** (which need not be vertical). A further portion **56** runs a distance L_5 up the junction between walls **44** and **54** to reach the intermediate level roof **60**, where there is another corner, **58**, and a portion **62** that runs a distance L_6 across roof **60** to another wall **64**, at which there is a corner **66**, which is the opposite hand to corner **46**. Portion **66** of joint **20** runs a distance L_7 along the junction of roof **60** and wall **64**. At another corner **66** portion **72** ascends wall **64** a distance L_8 to reach roof **70**. A portion **74** runs across the width L_9 of roof **70**, and then a final, end portion **76** runs down rear wall **78** a distance L_{10} to its end.

[0029] As can be seen in this example, expansion joint **20** does not necessarily run merely in a straight line. It may have planar portions, such as **36**, **38**, **42**, **62**, and **74** that each run in a flat, substantially horizontal plane or planar portions that run in an inclined plane such as the plane of a sloped roof. It may have substantially planar sections, such as **72**, that run along or across a substantially or predominantly up-and-down (i.e., vertical) wall. It may have portions such as **48** and **66** in which one leg lies in, and is adhered to, a substantially horizontal plane of an underlying substrate, and one leg to a vertical or inclined plane. It may have portions such as **56** in which each leg lies in a different inclined or vertical plane, as in a valley, or at the meeting of two walls or partitions. In each case it is held in place by mechanical adhesion to the underlying substrate with the aid of a resin, such as noted above.

[0030] As may be noted, joint **20** as shown in the layout of Figure **1a** has a T-junction, and various corners **40**, **46**, **52**, **58**, **66**. These corners are factory fabricated by vulcanising. Vulcanised curved joints and multilevel joints can be made in this way. These joints or seams may be made under factory controlled conditions, and provide consistent flexibility. It may tend to eliminate the use of glue, tape or caulking. The entire pre-sized assembly is then packaged and delivered to the installation site. Joint **20** is intended to be what is termed a "flat profile expansion joint", and is to be contrasted with current existing expansion joints such as bellows type joints, prefabricated metal joints, bunched-up membranes, or membranes mounted over a backer rod. Joint **20** is substantially flat, or, in the context of folded joints such as **48** or **66**, each selvage edge is substantially flat and has a small or very small effective through thickness, either as compared to its own width, or as compared to those previous joint types. As compared to previous types of expansion joint, a flat, or substantially flat, roughly zero profile waterproof joint may tend not unduly to obstruct the flow of water thereacross, and may tend to reduce the tendency of water to pool behind the joint, as if the joint were a dam.

[0031] In looking at the various portions of joint **20**, we

see, for example that various portions have arrays of apertures **80** formed in their outboard marginal edge regions. These arrays of apertures **80** are intended to be generic. That is, they could be any of the forms of apertures shown in the various embodiments described in Figures **2a**, **3a**, **3b**, **3c**, **3d**, **3e**, **3f**, and **3g** herein, or combinations or variations of them. Figure **1a** is intended to illustrate that arrays of marginal apertures **80** may be formed in both margins, as in portions **38**, **72** and **74**, or only one margin as in portion **68**. They may be used throughout the entire running length of joint **20**, or only portions thereof. The apertures may be used on a vertical face, whether gravity is acting predominantly along joint **20** as in portion **72**, or across joint **20** as in portion **68**. Alternatively there may be portions, such as **36** and **42** in which apertures **80** are not employed at all.

[0032] Figures **1b** and **1c** show cross-sections of typical installations. In each case the through-thickness of the various layers has been greatly exaggerated in proportion to the width of the joint for the purpose of conceptual illustration.

[0033] Figure **1b** shows a flat roof installation at a joint or gap in a roof **B20**, where a concrete structure **B22** meets a fabricated steel structure **B24**. The joint is packed with compressible batt insulation as at **B26**, and a vapour barrier or retarder **B28** is provided. An appropriate substrate may include a layer of compatible insulation material, **B30**, **B32** respectively. A base sheet substrate layer **B34** overlays the joint. Layer **B34** may be of any suitable material, of which one example is a modified bitumen membrane layer. A slit **B36** is made in the base sheet, i.e., layer **B34**, along the joint. The lower portion of an encapsulating layer is applied to base sheet substrate layer **B34** on either side of joint **B36** to a width comfortably greater than the width of seal **20**. This encapsulating layer **B38** may be a suitable resin such as may be selected from those listed above, and in one example may be an asphalt or bitumen encapsulating layer applied with a mop or other suitable spreading device.

[0034] Joint **20** is then placed atop the layer of resin, and pressed down to seat well. This may be done by hand, or, alternatively, a platen or roller may be used as an aid. One indication of good application may be shown by the visible presence of resin squishing up inside apertures **80**. Once joint **20** has been applied and smoothed down, an overlay of the encapsulating resin is applied, e.g., by mop, or other suitable means to complete encapsulating layer **B38**. The overlay is not mopped onto the gland. Left and right hand cap sheets **B40**, **B42**, which may be of the same material as the base sheet, are then placed to cover and adhere to the upper surface of the encapsulating resin. An optional layer in the nature of a shield, or mechanical protector **B44** may be placed overtop of the margins of sheets **B40** and **B42**. Protector **B44** may be secured on one side and substantially free to move on the other, and may overspan gland **28**. Protector **B44** may add, for example, a further layer of puncture resistance.

[0035] Figure 1c shows a flat roof installation at a joint or gap in a structure **C20**, where a roof structure **C22** meets a predominantly vertical wall structure **C24**. The joint is packed with compressible batt insulation as at **C26**, and a vapour barrier or retarder **C28** is provided. An appropriate substrate may include a layer of compatible insulation material, **C30**, applied to roof structure **C22**. A base sheet substrate layer **C34** overlays insulation material **C30** and terminates at a margin running along and adjacent to the joint. Layer **C34** may be of any suitable material, of which one example is a modified bitumen membrane layer. On the other side of the gap, or joint, a base layer, such as may be a flashing **C32** is mounted to wall structure **C24**. Flashing **C32** may be a two ply flashing, which may be a modified bitumen membrane flashing, and which may include a termination bar. The first portion of an encapsulating layer is applied to base sheet substrate layer **C34** on one side of the joint to a width comfortably greater than the width of seal **20**. This encapsulating layer **B38** may be a suitable resin such as may be selected from those listed above, and in one example may be an asphalt or bitumen encapsulating layer applied with a mop or other suitable spreading device.

[0036] One leg or side, or margin **24** of joint **20** is then placed atop the layer of resin, and pressed down to seat well. This may be done by hand, or, alternatively, a platen or roller may be used as an aid. One indication of good application may be shown by the visible presence of resin oozing, or squishing, or welling up inside apertures **80** such as to fill or partially fill the aperture. Once joint **20** has been applied and smoothed down, an overlay of the encapsulating resin is applied, e.g., by mop, or other suitable means to complete encapsulating layer **B38**. The overlay is not mopped onto the gland. A cap sheet **B40**, which may be of the same material as the base sheet, is then placed to cover and adhere to the upper surface of the encapsulating resin. The other leg or margin **26** of joint **20** is placed to lie against, and run along, the inner layer of the two-ply flashing. The second, or outer, layer of the two ply flashing overlies the upper edge of margin **26** of joint **20**. By observation, gland **28** has been bent out-of-plane to permit the other selvage edge to seat against vertical wall structure **C24**.

[0037] Considering now figures **2a**, **2b** and **2c**, the material forming sheet or slab or member **22** may be made of a synthetic rubber which is both flexible and resilient and which may tend to remain flexible in a wide range of weather conditions. Several suitable polymeric materials are available for forming sheet or slab or member **22**, and several currently available polymeric sheets for use in forming flexible expansion joints may be used.

[0038] Member **22** may have a first or upper surface **114**, and an opposite, second, or bottom, surface **116**. Member **22** has first and second lengthwise extending opposed side edges **118** and **120**. Member **22** has three regions. There may be first and second marginal or edge regions **124**, **126**, and a third or central, or intermediate

region **128** running lengthwise along member **22** between the two edge regions. The central region may have a substantially smooth surface on one or, more typically, both faces. The adjacent edge regions **124**, **126** may have a more roughened surface. One way to obtain this rougher surface is to apply a fibrous element, such as fibrous matting, or scrim, in the form of fibrous strips **132**, **134**, **136**, **138** to those edge regions of the first and second surfaces respectively. One way to do this is to embed one face of a fibrous matt or strip in the rubber during construction, as at curing, or to bond the fibrous sheet to the elastomeric substrate, or to roughen the rubber surface mechanically as by abrasion. The roughened surface, or the dense array of bonded or embedded fibres provides a greater surface area for anchoring in a bonding or resinous material, be it a polymer resin or a more traditional medium such as roofing tar. The roughened marginal edge regions, with, for example, embedded fibrous material may be referred to as, and may define selvage edges **24**, **26**. The width of the selvage edges **D₂₄** is half of the overall width, **D₂₀**, less the mean width of the gland, **D₂₈**, arithmetically $D_{24} = \frac{1}{2}(D_{20} - D_{28})$.

[0039] Selvage edges **24**, **26** are of equal width. While this is typically so, it need not necessarily be so, and the edges may be of unequal widths, particularly if one edge is to lie horizontally, and one edge is to bend upward and bear against a wall or wall flashing.

[0040] Surface **114** has rough strips **132** and **134** and surface **116** has rough strips **136** and **138**. Rough strips **132** and **136** may be arranged parallel to rough strips **134** and **138**. Rough strips **132**, **136** lie adjacent to side edge **118**, while rough strips **134** and **138** lie adjacent to side edge **120**. Rough strips **132**, **134** and **136**, **138** form areas of surface **114** and **116**, respectively, that have been treated to augment or enhance the surface area to which an adhesive resin may bond. Quite thin regions along the very edges of member **22** laterally outboard of roughened strips **132**, **134**, **136**, and **138** respectively may be smooth, as at **133**, **135**, **137**, and **139**. Alternatively, the rough strips may extend fully to the edge of the member **22**. The width of these thin regions is indicated as **D₁₃₅**, and, as noted, may be as small as zero.

[0041] The third, or central region or portion **128** defines central gland **28** of member **22** and may have bare or smooth portions **140** and **142** on surfaces **114** and **116** respectively. These portions are positioned, in this instance generally centrally, between strips **22**, **24** and **26**, **28**, respectively. The selvage edges may be relatively stiffer than the gland in tension and shear. That is, the gland may be "stretchier", or of greater elasticity than the selvage edges. This may be due to a different, i.e., slightly greater, thickness than the gland, and due to the embedded strips of rougher material, those strips tending to be more inelastic than the underlying (typically rubber) matrix. The respective widths **W₁₄₀** and **W₁₄₂** of smooth portions **140**, **142** need not be equal. Where a rough partially external scrim is used, for example, the width of the lower smooth region may be narrower than the upper smooth

region. Expressed differently, to the extent that the scrims stiffen the joint, the unstiffened portion of joint **20** on the underside will be narrower, and the portion on the upper side will be wider. In other embodiments, such as those in which the stiffening scrim is fully encapsulated in the elastomeric matrix, widths W_{140} and W_{142} may be the same. The mean gland width, D_{128} may be taken as the average of widths W_{140} and W_{142} .

[0042] A series, or array, of apertures **144**, **146** is formed in each of the selvage edges, namely regions **124**, and **126**. These apertures are positioned along member **22** adjacent, edges **118** and **120**, respectively, running generally parallel thereto. As seen in Figure **2b**, each aperture passes through sheet **22** and the fibrous matting of the roughened strips, **132**, **134**, **136** and **138**, as may be. As seen in the enlarged detail of Figure **2c**, apertures **144**, **146** may each have a right angled edge portion **148** where the bore of the aperture intersects or meets surfaces **114** and **116**.

[0043] A series of apertures, such as **144**, **146**, may tend to reduce the creep of the finished and installed expansion joint. This may be considered a surprising or counter intuitive view. One might expect that providing apertures along the rough strips would decrease the surface area of contact between the joint and the bonded substrate, **S**, of Figure **2b** to which the joint is bonded. However, the apertures may tend to decrease the amount of creep. It is believed that the right angled edges **38** of the apertures may act in a conceptually similar manner to the treads of a car tire, increasing the amount of "traction" between the sheet and the bonding agent, be it tar or some other resin applied to bond the expansion joint to the substrate. Ridges or creases in the sheet may act in a similar way, however, forming a resilient sheet with ridges and the like is quite awkward and expensive compared to simply punching a series of apertures through the sheet.

[0044] That is to say, the premise of expansion joint **20** is that it overlies an underlying structure, such as mating roof panels, or substrates, S_1 and S_2 , that meet along a crack or joint '**C**', and that are susceptible to a measure of relative movement at that crack or joint '**C**', such that a flexible expansion joint member of some kind is required. The interface between the substantially planar face of member **22** and the underlying substrate portions, S_1 and S_2 , is substantially planar, as symbolized by interface plane, **P**. Even when applied generously, the bonding agent will form a relatively thin layer between member **22** and substrate **S**. In the illustrations of Figures **2c** member **22** is shown slightly away from the substrate members, by a small gap. This is intended to be representative of the space occupied by the resin. The size of the gap and the vertical relative thickness of the parts is exaggerated for the purposes of illustration. That bonding layer may tend to be cycled in shear during contraction, expansion or shifting of the adjacent underlying roof panels.

[0045] The bonding agent apertures permit the sealing

resin to flow and accumulate in the out-of-plane direction away from plane **P**. The bonding agent may then gain a mechanical grip on the non-planar edge or face of the aperture that stands away from, e.g., typically some distance perpendicular to, interface plane, **P**. Furthermore, to the extent that the resin forms a semi-solid plug in the aperture, the aperture edges may tend to act somewhat analogous to fillet welds in shear. Another feature of an aperture that penetrates through the thickness of the material is that it permits relatively easy visual inspection of the presence of the bonding resin at the bonding interface, and in the apertures.

[0046] In the embodiment of Figures **2a**, **2b** and **2c**, the apertures have closed perimeters, being circular, straight through bores penetrating through the selvage margins. The Apertures need not be circular, and they need not necessarily have closed peripheries. For example, in the embodiment of Figure **3a**, an expansion joint **200** has an array of apertures **202** each of which has the form of an open-ended slot that extends inboard from the respective edge **204**. The inboard end of the slot, or the head of the slot, may have a bulbous enlargement as at **206**. To the extent that joint **200** may be taken to be symmetrical, another similar array of slots may be understood to be formed in the opposite selvage edge.

[0047] In the embodiment of Figure **3b** an expansion joint **220** employs arrays of apertures **222** that are not circular, but have the form of a polygon, in this instance a triangle. The triangles of the array are alternating as at **224**, **226**, such as to leave alternatingly angled intermediate strut portions **228**, **230** that may tend to yield a wedge-like resistance to shear force application in the plane of joint **228**.

[0048] In the embodiment of Figure **3c**, an expansion joint **240** has a series of ovate slots **242** having closed peripheries (as compared to slots **202** that each have an open ended periphery) Slots **242** have a long axis that is substantially perpendicular to the running direction or x-axis, of joint **240** more generally. Although only an half view is shown, the other half may be taken to be symmetrical. The pitch between the slot centers in the x-direction may be greater than $\frac{3}{4}$ of the lateral length L_{242} of the slots, and may tend to be in the range of $\frac{3}{4}$ to $\frac{3}{2}$ times the length L_{242} .

[0049] In the embodiment of Figure **3d**, an expansion joint **260** has a series of slots **262**, not unlike slots **242**, except that slots **262** include left hand and right hand angled slots **264**, **266** that have a mutually wedging orientation, and that leave alternating wedge-like tab areas **268**, **270**. Again, joint **260** may be symmetrical, in which case matching apertures are also formed in the opposite selvage edge. The angles of the slots relative to the x-axis are indicated as alpha and beta. Although it is convenient that these angles be the same, they need not be. The angles may tend to be greater than 45 degrees and may lie in the range of 60 to 75 degrees. The pitch spacing of apertures **262** is similar to that of apertures **242**.

[0050] In the embodiment of Figure **3e**, an expansion

joint **280** has an array of apertures **282**, in which the apertures have a generally curved shape. In this instance the curve is gently S-shaped. The pitch spacing of apertures **282** is similar to that of apertures **242**. Again, as with all of Figures **3a**, **3b**, **3c**, **3d**, **3e** and **3f**, although only half the item is shown, the other half may be taken as being substantially symmetrical, and may be a mirror image.

[0051] In the embodiment of Figure **3f**, and expansion joint **300** has an array of apertures **302** in which the array has an alternating inboard and outboard stagger, the inboard apertures being indicated as **304**, and the outboard apertures as **306**. While apertures **304** and **306** are round circular apertures, any of the oval, triangular or curved apertures of the other embodiments of Figures **3a**, **3b**, **3c**, **3d**, and **3e** could also have an inboard-outboard alternating stagger. The pitch spacing of apertures **302** is similar to that of apertures **242**.

[0052] In the embodiment of Figure **3g**, and expansion joint **320** has an array of marginal fingers **322** and corresponding apertures **324** defined between those fingers, the edges of fingers **322** and corresponding wedge-shaped apertures **324** being alternately angled at angles phi and theta. These angles are comparatively sharp, and may be greater than 60 degrees relative to the running direction of the joint. Expressed in the context of the lateral direction, the tangent portion of the edge, or the average angle if the edge is not straight, may be in the range of perhaps 10 - 30 degrees. Again, while these angles may be equal, and repeating, they need not necessarily be so. The resultant feathered edge may be termed undulating, serpentine, saw toothed, deviating, and so on. A deviating edge as shown will necessarily have a longer edge length than the straight line running distance of the joint. While apertures **324** are of the same size, they could also have an inboard-outboard alternating stagger. A serpentine or deviating edge may also be used in combination with closed periphery apertures such as shown in others of the embodiments presented herein.

[0053] In each of the embodiments described, the various apertures are located in the laterally outermost third or quarter of the respective selvage edges. The lateral extent of each aperture is less than 1/3 of the lateral extent of the selvage edge, and may be in the range of 1/8 to 1/4 of that width. In absolute terms the length of the aperture may be in the range of 3/4" to 2 1/2", depending on the size of the joint.

[0054] In the case of non-circular apertures, it may be that the major axis of the aperture, or major portions of the edge of the aperture, tend not to be parallel to the x-direction, or to the nominal direction of edges **118**, **120**. Rather they have a component that is perpendicular, or predominantly away from those edges, even if obliquely so.

[0055] The resistance of the selvage edge to creep may to some extent then be a function of the arc length of the sum of the perimeters of the apertures. That is, the

resistance to creep may be enhanced where the effective length of the selvage edge is greater than the nominal straightline length of that edge. One proxy for the effective length of that shear edge is the sum of the length of the edge itself plus the lengths of the apertures, divided by the nominal straightline length of the edge, expressed as a ratio or as a percent. In all of the illustrated embodiments that ratio is greater than 100 %. It may be greater than 150 %, and may be in the range of 180 - 250 % of the corresponding straight line running length.

[0056] Specific embodiments of the present invention have been disclosed; however, several variations of the disclosed embodiments could be envisioned as within the scope of this invention. It is to be understood that the present invention is not limited to the embodiments described above, but encompasses any and all embodiments within the scope of the following claims.

Claims

1. A substantially flat expansion joint, said expansion joint having first and second elastomer based selvage edges and an elastomeric gland located between the selvage edges, the gland being for deployment in a lengthwise direction along an underlying structural interface, at least a portion of said first selvage edge having a plurality of apertures formed therethrough.
2. The expansion joint of claim 1 wherein said first selvage edge has a total edge length that includes edge lengths of said apertures; and a ratio of said total edge length per unit of running length of said portion in said lengthwise direction is greater than 125%.
3. The expansion joint of any one of claims 1 and 2 wherein at least one of:
 - (a) said apertures include an array of slots pitched along said running direction, said slots have a major dimension, and said major dimension is predominantly transverse to said lengthwise direction;
 - (b) said apertures are formed in an array of apertures having at least one of:
 - (i) edges oriented obliquely to said lengthwise direction;
 - (ii) apertures that on successive pitches are oriented on alternating left hand and right hand oblique angles; and
 - (iii) apertures having a closed periphery;
 - (c) said first selvage edge including at least a first scrim, and said apertures being formed at least in part through said scrim;
 - (d) said first and second selvage edges each

- having a first surface for placement against structure to which the expansion joint is to be applied, and a second face for orientation facing away from the structure, and both said first and second faces including a scrim;
- (e) said selvage edges having a transverse width, W;
- said selvage edges having a most transversely outboard third;
- said apertures having an extent, L, transverse to said lengthwise direction; and said apertures being located in said most transversely outboard third; and
- said extent, L, has a magnitude that is in the range of one eighth to one third of W;
- (f) said first and second selvage edges each having an array of said apertures formed therein, said apertures being circular, closed periphery apertures formed in an outermost one third of each said selvage edge respectively, and said apertures having a diameter to pitch spacing ratio in the range of 1/8 to 3/4;
- (g) said joint includes first and second portions meeting at a corner, said first and second portions have respective rubber-based matrices; and said first and second portions are vulcanized together.
- (h) said expansion joint has first and second portions, each of said first and second portions having respective first and second selvage edges; said first portion has arrays of said apertures formed in both of said selvage edges, and said second portion has at least one selvage edge that is free of said apertures.
4. The expansion joint of any one of claims 1 and 2 wherein said apertures have an at least partially open periphery.
5. A method of installing a flat expansion joint on a structure; the structure having first and second portions, and an interface between said first and second portions; the expansion joint having a rubber based matrix; the expansion joint having a lengthwise running gland located between a pair of first and second selvage edges that run along said gland and extend laterally away therefrom, those selvage edges having apertures formed therethrough; said method comprising:
- treating a surface portion of each of said first and second portions of said structure with a resin;
- placing said first selvage edge in said resin on said first portion of said structure;
- placing said second selvage edge in said resin on said second portion of said
- structure;
- smoothing said expansion joint in place;
- observing occupation of said apertures with said resin as said expansion joint is smoothed in place; and
- applying a further amount of resin to cover said selvage edges while leaving said gland uncovered.
6. The method of claim 5 wherein said method further includes applying a mechanical protector over said gland.
7. The method of claim 5 wherein the expansion joint has a fibrous scrim mounted to each said selvage edge, and the method includes saturating said fibrous scrim in said resin.
8. An expansion joint comprising:
- an elongated flat sheet of flexible and resilient polymeric material having a width, opposite upper and lower surfaces, and opposite first and second edges;
- one of said opposite surfaces being a first surface, and having a fibrous section including a section of the sheet having a plurality of fibers secured to the surface, the fibrous section extending along said first surface adjacent one of the edges; and
- a series of apertures passing through the sheet and positioned on the fibrous section, the apertures positioned adjacent one of the side edges.
9. The expansion joint of claim 8 wherein each of the upper and lower surfaces have a fibrous section.
10. The expansion joint of any one of claims 8 and 9 wherein each of the fibrous sections comprises a parallel pair of first and second fibrous matts secured to the surface, the fibrous matts being separated by an elongated strip of bare surface, the first and second fibrous matts being located adjacent the first and second edges of the sheet, respectively, the apertures forming a parallel pair of first and second row of apertures positioned adjacent the first and second edges, respectively.
11. An expansion joint comprising:
- an elongated flat sheet of flexible and resilient polymeric material having a width, a length, opposite upper and lower surfaces and opposite first and second edges;
- a parallel pair of fibrous first and second matts secured to each of the opposite surfaces along the length of the sheet, the par-

allel fibrous matts on each surface being separated by an elongated strip of bare surface; the first and second fibrous matts being located adjacent the first and second edges of the sheet, respectively; and
 a parallel pair of first and second row of apertures positioned adjacent the first and second edges, respectively, each of the row of apertures passing through the sheet and the fibrous matts.

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12. An expansion joint comprising:

an elongated flat sheet of flexible and resilient polymeric material having a width, a length, opposite upper and lower surfaces and opposite first and second edges;
 a parallel pair of elongated first and second rough strips formed on each of the opposite surfaces along the length of the sheet, the rough strips on each surface being separated by an elongated strip of bare surface; the first and second rough strips being located adjacent the first and second edges of the sheet, respectively; and
 a parallel pair of first and second series of apertures positioned adjacent the first and second edges, respectively, each of the apertures passing through the sheet and the rough strips.

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13. The expansion joint of claim 12 wherein the rough strips each comprise one of:

- (a) a portion of the sheet having a fibrous material secured thereto; and
- (b) a fibrous matt secured to the sheet.

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14. The expansion joint of any one of claims 1 - 4 and 8 - 13 wherein each of the apertures have substantially right angled edges.

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15. The expansion joint of any one of claims 1 - 4 and 8 - 14 wherein the apertures are substantially circular.

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FIGURE 1a

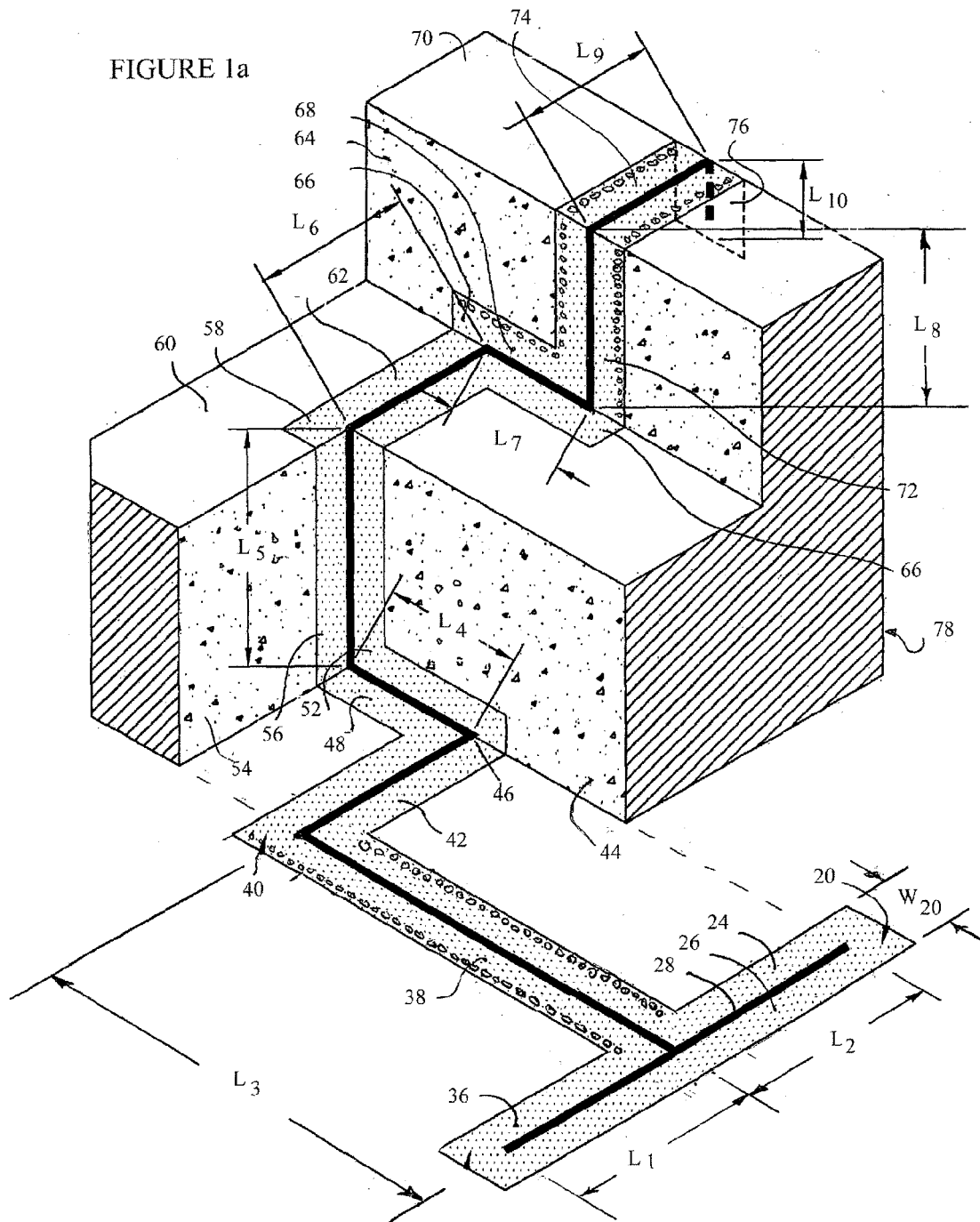


FIGURE 1c

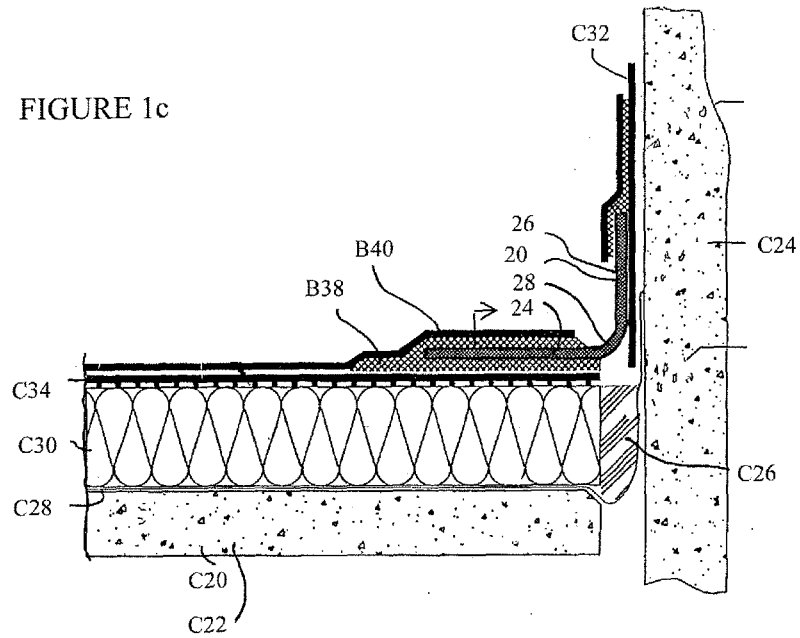
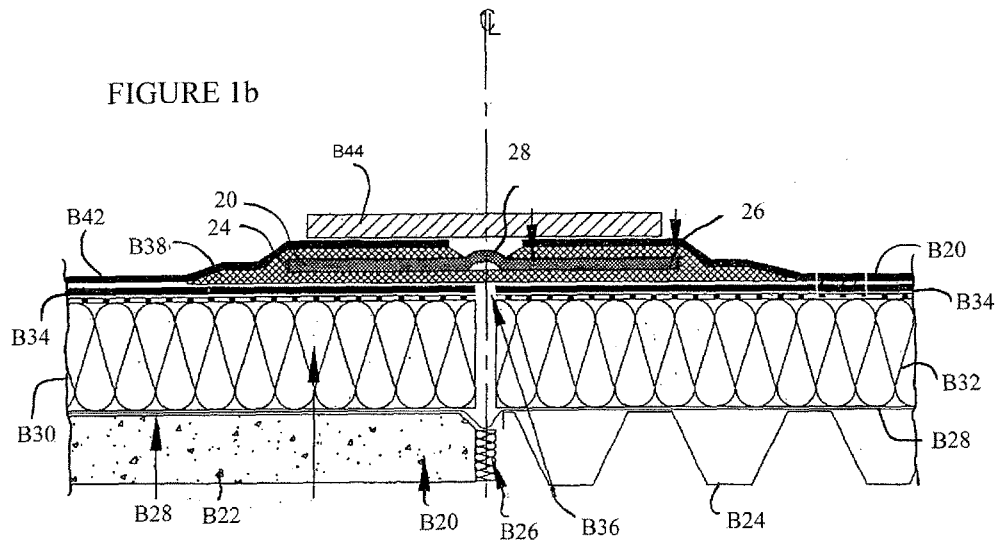
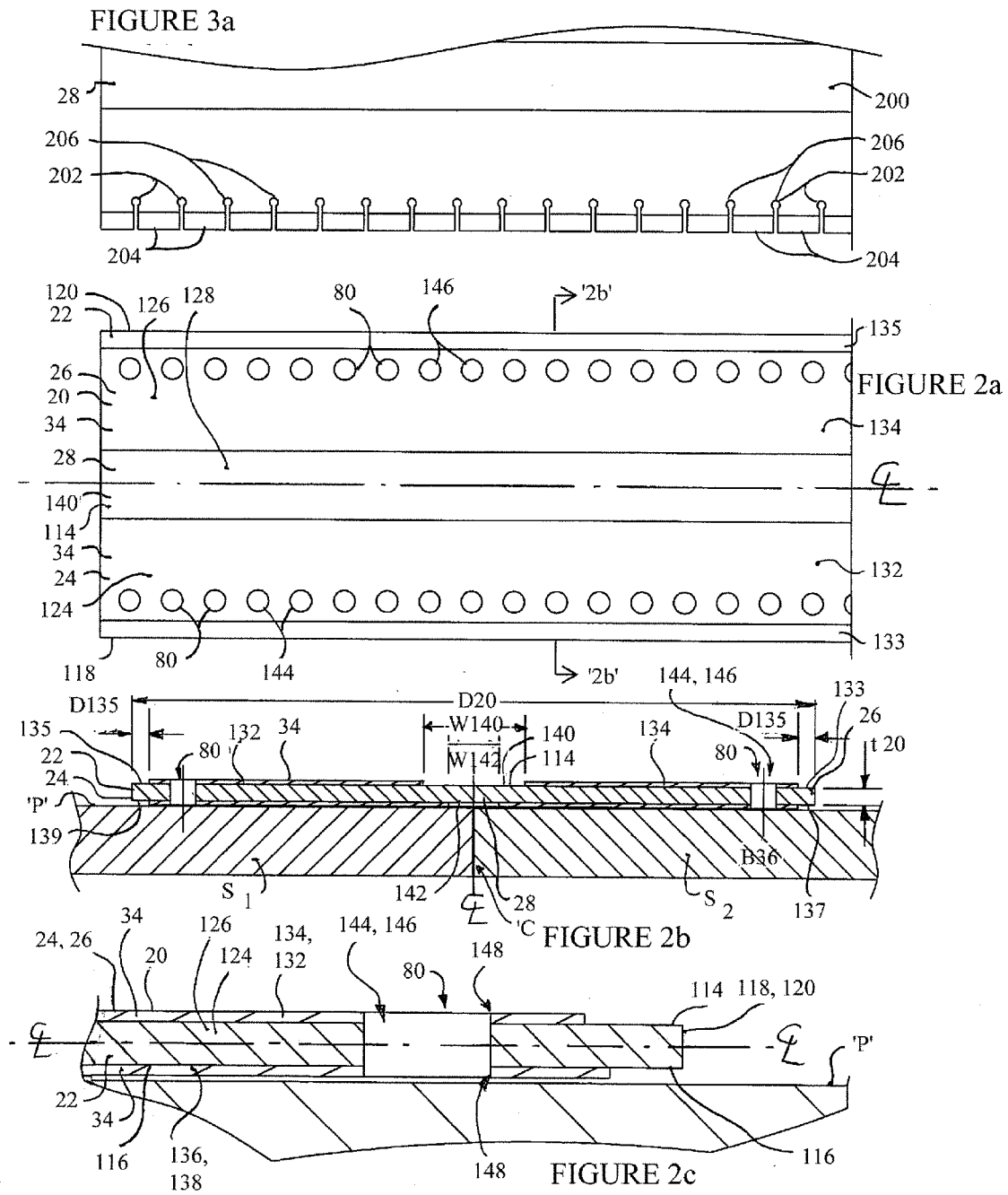
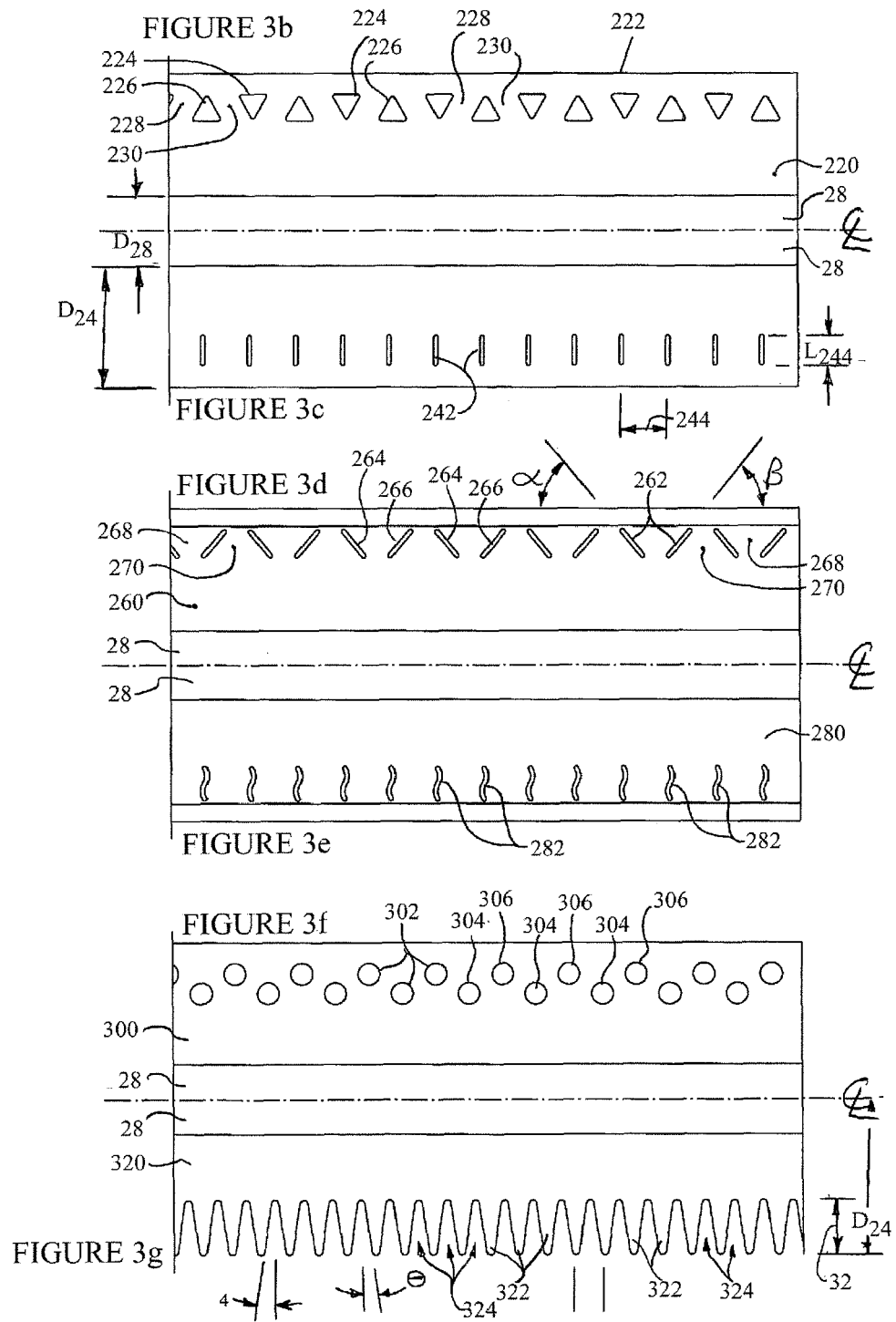


FIGURE 1b







REFERENCES CITED IN THE DESCRIPTION

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