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Brown

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[54] **EXPANSION JOINT AND BRIDGE JOINT SEALS**

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[52] **U.S. Cl.** **404/65**
[51] **Int. Cl.** **E01c 11/10**
[58] **Field of Search** 94/18, 18.2, 51

[56] **References Cited**

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[57] **ABSTRACT**

Invertible, elongated, elastomer joint sealing strips having substantialy flat side walls, longitudinally corrugated or pleated top and bottom walls preferably of the same general configuration, an internal web structure with one or two pairs of crossed webs connected to the top and bottom walls and additional diagonal webs extending diagonally across the four corners to provide two or three side-by-side diamond openings in internal structure of seals, and a longitudinal rib or bead on each side wall to aid symmetrical lateral collapse of the seal and also to impede inward bending or rolling of its corners.

6 Claims, 4 Drawing Figures

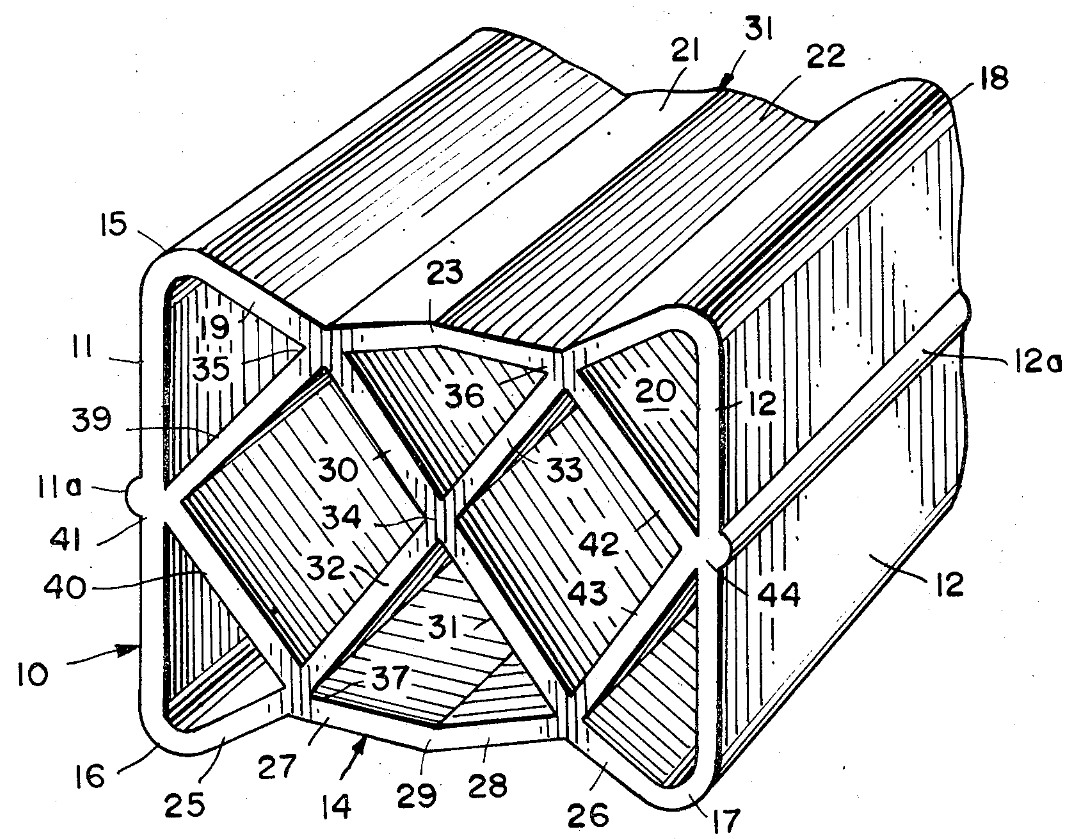

FIG. 1

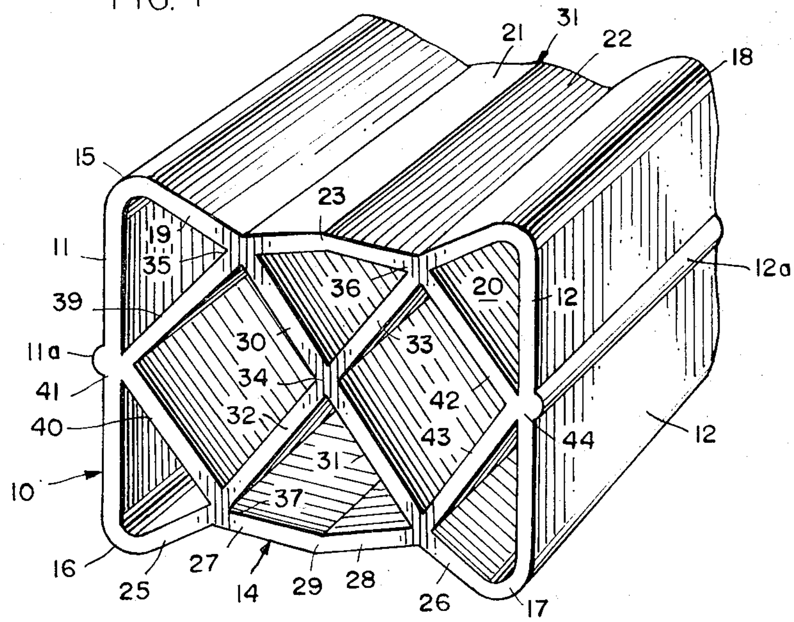

FIG. 2

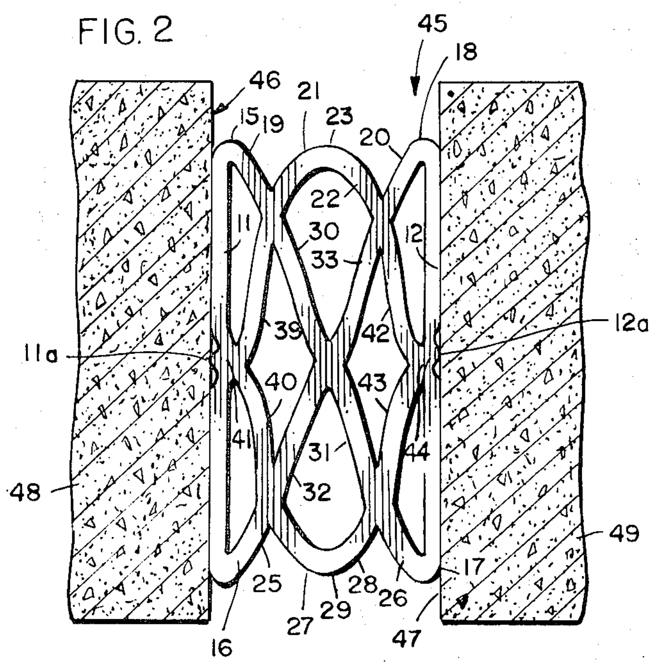

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FIG. 3

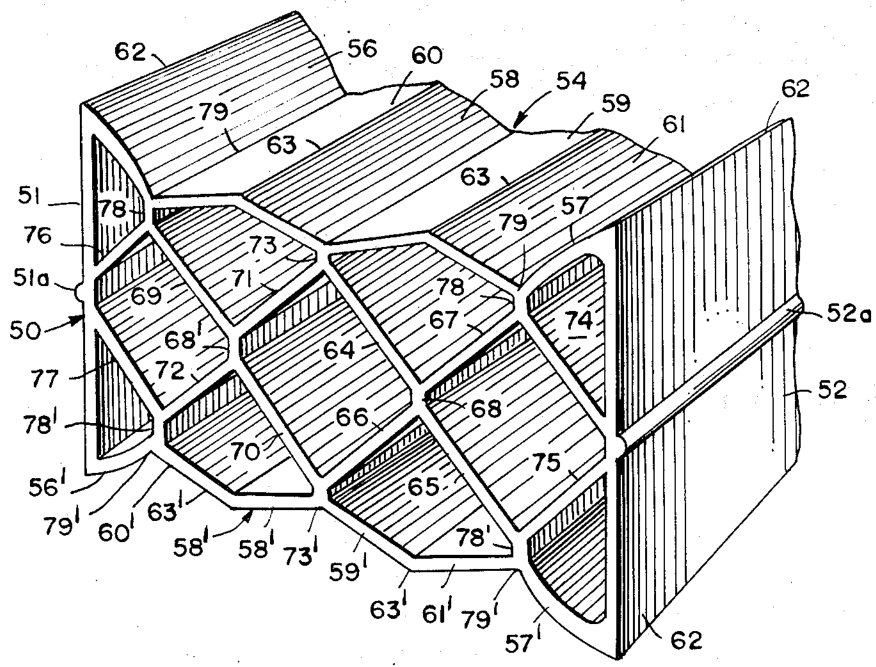
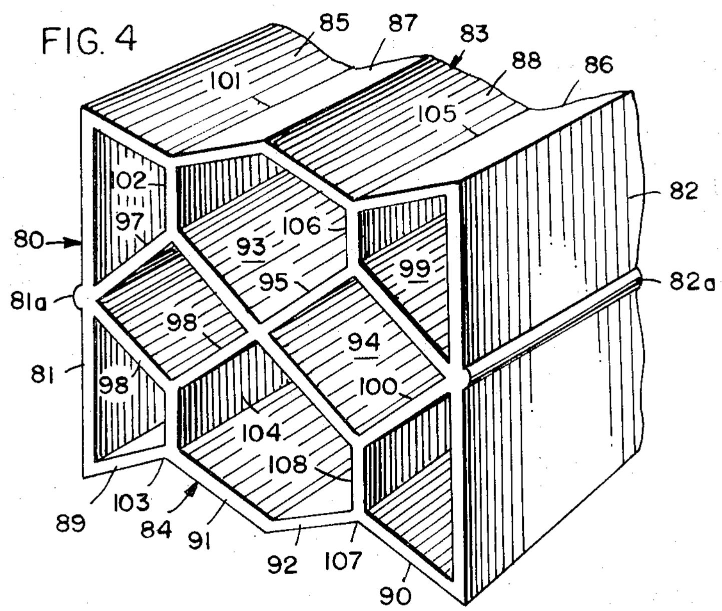


FIG. 4



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EXPANSION JOINT AND BRIDGE JOINT SEALS

BACKGROUND OF THE INVENTION

The sealing strips of the subject invention are designed primarily for use in joints having a relatively large width dimension and a substantial amount of joint movement. Expansion joints and bridge joints are the two better known types of such joints. Expansion joints are formed transversely or crosswise in a pavement or highway the full depth of the slab. They are provided to allow the concrete to expand as it becomes heated under the warmer climate conditions and/or sun radiation. The temperature of concrete in highways or other pavements such as airport runways, concrete drainage ditches, and the like may vary from temperatures in the order of −20° or −30°F. in the winter months up to temperatures in the range of 130° to 140°F. in the summer months. Over such temperature range, the concrete has considerable amount of contraction and expansion.

To allow for such expansion or contraction, transverse joints or spaces are provided at defined intervals. These joints or spaces must be sealed in order to prevent accumulation of undesired particles such as sand, gravel or other incompressibles in an amount whereby such accumulation prevents the joint from closing by expansion of the concrete in warm weather. Joints are also sealed in order to prevent infiltration of water, the freezing of which in cold weather can cause damage to the joint. In supported joints, e.g., joints having a dowel-type supporting structure across the joint, infiltration of water can cause rusting or other damage to the dowl structure. Also, water entering the joint can also cause, in some instances, washing away and erosion of the subgrade in the area of the joint.

The joints of bridges with which the subject invention is primarily concerned are joints on the decks or floors of bridges. The filling of such joints with incompressibles is undesirable for the reasons aforesaid. Additionally, water, particularly water carrying dissolved deicing chemicals such as calcium chloride or sodium chloride, can be damaging to concrete and/or steel understructures of the bridge if it is allowed to flow through the deck or floor joints of the bridge.

In some highway designs, expansion joints are used in combination with contraction joints, e.g., in an arrangement of relatively widely spaced expansion joints and a plurality of contraction joints therebetween. Contraction joints allow pavement slabs to expand only to their original length. They do not accommodate relatively high orders of expansion of the concrete sections between the contraction joints with the result that some highways are designed to include expansion joints periodically in addition to the contraction joints to take up expansion of pavement which cannot be accommodated by the contraction joints between two expansion joints.

It has been proposed heretofore by others to seal expansion joints and/or bridge joints with elongated, elastomer joint sealing strips having an internal web truss structure which, in the laterally collapsed or compressed state of the sealing strips, urges the side walls of such strips against the side walls of the joints to provide the requisite sealing of such joints. Illustrative thereof are the sealing strips illustrated in U.S. Pat. Nos. 3,358,568 and 3,276,336.

BRIEF DESCRIPTION OF THE INVENTION

Briefly, the present invention concerns elongated, elastomer joint seals which are particularly adapted for use in relatively wide joints having substantial amounts of joint movement. These sealing strips are characterized by longitudinally corrugated or pleated top and bottom walls which fold into pleats when the strip is laterally compressed. These top and bottom walls are substantially symmetric and preferably of substantially identical configuration, one being the substantial mirror image of the other. This provides an invertible sealing strip wherein either of said walls can constitute the upper or top wall. Thus, should one of these walls be damaged during installation or after the seal has been in service, the seal may be removed and inverted so that the undamaged wall serves as the top wall of the seal

The seals of the subject invention are further characterized by an internal web structure of elastomer webs which allow a great range of lateral collapse of the seal between the minimum width dimension of the seal where the internal webs are pressed tightly against each other and the maximum width dimension of the seal, i.e., one in which the seal is compressed to a width of about 80 to 85 percent of the uncompressed width of the seal.

The internal web structure comprises a set of diagonal webs which provide one or two X's substantially at the center portion of the seal and which connect at their respective longitudinal edges either directly or via narrow vertical connecting strips with the top and bottom walls at longitudinal juncture lines which are laterally inwardly of the respective corners of the seal. The internal web structure further has additional webs extending diagonally across the four corners from the respective longitudinal juncture lines at the top and bottom walls or from the narrow connecting strips to respective intersections with the midportions of the side walls.

The top and bottom walls, respectively, may have the shape of a shallow W and a shallow M to provide the aforesaid pleated shape. With one type seal, the midpart of the top wall is a shallow M, the edges of the latter being connected to the side walls by more steeply diagonal top wall segments. The bottom wall is the same shape in mirror image. The side walls preferably are substantially flat or planar. The side walls and top and bottom walls may be joined at the four corners of the seal by rounded corners, the purpose of which is set forth in more detail below.

Seals of the type herein contemplated are described in application Ser. No. 826,311, filed May 21, 1969, by Delmont D. Brown and Donald R. Boney.

The improvement herein resides in provision of a rib extending longitudinally along the midportion of each side wall. These ribs solve a problem unexpectedly experienced in seals of the structures aforesaid, i.e., irregular collapse of the web structures upon lateral compression of the seal and inward bending or rolling of the corners of the seal. A secondary advantage is that these ribs form a ledge which retains liquid adhesive placed between the contacting faces of the joint and the seal.

DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the invention is illustrated in the drawing wherein:

FIG. 1 is a perspective view of a fragmentary end section of the embodiment;

FIG. 2 is an end elevation of an expansion joint with the seal of FIG. 1 mounted therein in the laterally compressed state;

FIG. 3 is a perspective view of another embodiment of an elastomer joint sealing strip; and

FIG. 4 is a perspective view of a third embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, the elongated, hollow elastomer seal **10** comprises side walls **11** and **12** which are preferably substantially parallel, elongated, substantially flat or planar, elastomer walls, the longitudinal edges of the side walls **11** and **12** are joined with the top wall **13** and bottom wall **14** by integrally formed rounded corners **15, 16, 17** and **18.** Though less preferred, such corners may be sharp corners.

The top wall **13** has a shallow W shape formed by longitudinally elongated, tranversely diagonally downwardly extending side segments **19** and **20** and longitudinally elongated, transversely diagonally upwardly extending center segments **21** and **22** which meet at a central apex **23.**

The bottom wall **14** is a shallow M-shaped wall made up of longitudinally elongated, transversely upwardly extending side segments **25** and **26** and longitudinally elongated, transversely diagonally downwardly extending center segments **27** and **28** which meet at a central nadir **29.**

When the seal is laterally collapsed, the side segments **19,20** and **25,26** fold downwardly and inwardly (FIG. **2**) while the center segments **21,22** and **27,28** assume respective sharp inclinations. Such orientation raises and lowers the respective apex **23** and nadir **29** relative to the rounded corners **15-18.**

The internal web structure comprises a set of diagonal webs **30–33** which join and are integral at the juncture **34** in the center of the seal. The web pairs **30,31** and **32,33** form an X configuration with the respective longitudinal edges of the X integral and joined with the nadirs and apices **35–38** of the respective outer and center segments of the top and bottom wall.

The remainder of the internal web structure comprises longitudinally elongated, transversely diagonal webs **39, 40, 42** and **43** which cut diagonally across the four corners of the seal. The diagonal web **39** is joined with and is integral with the nadir **35** at one longitudinal edge and with the midportion **41** of the side wall **11** at the other longitudinal edge. The diagonal web **40** is joined with and integral with the midportion **41** and the apex **37.** The diagonal web **42** is joined with and integral with the nadir **36** and the longitudinal midportion **44** of the side wall **12,** while the diagonal web **43** is joined with and integral with the longitudinal midportion **44** and the apex **38.** It is not essential for purposes of the invention that the diagonal web pairs **39,40** and **42,43** meet at a common juncture as illustrated. If desired, these webs may meet the respective side walls **11** and **12** at spaced intersections rather than at the longitudinal midportions **41** and **44.**

As shown in FIG. **2,** the internal webs do not form sharp bends or folds when the seal is laterally compressed, This is a distinct advantage in that sharp ends or folds, particularly those approaching 180°, impart high stresses to the web structure. Such bends or folds would form when the seal is in its maximum state of compression, i.e., a state of compression when the joint is most closed. This state occurs in the hot summer months when the concrete reaches temperatures over 100°F. The higher temperatures are more detrimental to aging of the elastomer whereby it loses its resilient properties. Experience indicates that elastomer seals in field use can be expected to lose up to 50 percent of their initial resilient characteristics in a period of one to three years. High stresses in any of the elastomer webs or walls materially accelerate the aging degradation of the elastomer and hence it is of considerable advantage to avoid sharp bends.

As shown in FIG. **2,** the crossed webs **30–33** substantially retain their X configuration when the seal is laterally collapsed. This characteristic is the result of the overall geometry of the seal whereby the side walls **11** and **12** in effect become somewhat longer upon lateral compression of the seal while the outer segments of the top and bottom walls **19,20** and **25,26** become somewhat shorter through a rolling action of the rounded corners **15–18.**

Because of the aforesaid characteristics of the seal, it is preferred that the central apex **23** and nadir **29** in the uncompressed seal be respectively lower and higher than the upper corners **15** and **18** and the lower corners **16** and **17.** In such arrangement the apex **23** and nadir **29** rise and drop, respectively, to positions which do not extend appreciably above or below the respective corners of the seal when the latter is laterally collapsed (see FIG. **2**).

The exterior faces of side walls **11** and **12** each has a single, integral, elastomer, longitudinal narrow, semi-cylindrical rib or bead **11*a*** and **12*a*** opposite the junctures of diagonal web pairs **39,40** and **42,43** at respective longitudinal midportions **41** and **44.** These ribs or beads prevent the corners of the seal from bending or rolling inwardly when the seal is collapsed in a joint as shown in FIG. **2** — thereby keeping the edges of the outer faces of side walls **11** and **12** substantially completely in tight, flush contact with respective faces **46** and **47** of joint **45.** Also, the ribs or beads aid in attainment of a substantially symmetrical collapse of the internal webs, i.e., a symmetry similar to that shown in FIG. **2,** upon lateral compression of the seal.

As the width dimension of the subject seals increases, it is desirable to keep the angle of the diagonal internal members from becoming too flat with respect to the horizontal. Preferably such angles should never be less than about 30° and most optimally they are in the order of 40° to 50°. Therefore, the diagonal rib members may be connected to the top and bottom walls and/or to each other by means of narrow, vertical, integral, elastomer strips such as shown in FIGS. **3** and **4.**

Referring first to FIG. **3,** this hollow, elongated, elastomer seal **50** of the subject invention includes a pair of side walls **51** and **52** which are preferably substantially planar and substantially vertically disposed. Each side wall has narrow, semi-cylindrical ribs or beads **51*a*** and **52*a*** located similarly to and serving the same purpose as ribs or beads **11*a*** and **12*a*.** The top and bottom walls **54** and **55** have a projected width greater than the depth of the side walls **51** and **52,** e.g., as in a seal having a depth of 3 ¾ inches and a width of 5 inches.

The top wall **54** comprises two sharply downwardly sloping outer sections or strips **56** and **57** and a shallow-M-shaped mid-part composed of the inner, downwardly converging legs **58** and **59** and outer, downwardly diverging legs **60** and **61.**

The bottom wall **55** is a mirror image of the top wall **54** whereby the sealing strip can be inverted 180°. The bottom wall comprises the outer, sharply upwardly sloping sections or strips **56'** and **57'** and the shallow-W-shaped mid-part composed of the legs **58'–61'**. The respective mid-parts are preferably below the junctures of the side walls and top and bottom walls forming the corners **62** so that their apices **63** and **63'** do not rise above the outer corners of the seal when the seal is collapsed laterally.

The internal web structure of the sealing strip **50** is composed of diagonal webs **64, 65, 66** and **67** in the right-hand portion of the strip and a similar set of diagonal webs **69, 70, 71** and **72** in the left-hand portion of the strip. The right-hand webs **64–67** meet and are joined by a narrow, vertically disposed web segment **68** and the longitudinal edges of the webs **69–72** are similarly joined by a narrow vertical web **68'**. The upper and lower longitudinal edges, respectively, of the webs **64,71** and **66,70** are joined with a nadir and an apex of the top and bottom walls **54** and **55** by similar, vertically disposed, narrow webs **73** and **73'**.

The remainder of the internal structure of the sealing strip **50** comprises diagonal webs or ribs **74, 75, 76** and **77** extending diagonally across the corners **62** of the sealing strip **50.** They are joined respectively with the diagonal ribs or members **67, 65, 69** and **72** by narrow, vertically disposed, webs **78** and **78'**, the latter in turn connecting these diagonal internal members with the top and bottom walls respectively at the nadirs and apices **79** and **79'** formed by the outermost strips or segments and next adjacent segments of the midportions of these walls.

As in the embodiment of FIGS. **1** and **2,** the internal webs do not form sharp bends or folds when the seal is laterally compressed, the advantages of which have been described above. The use of the narrow webs **68, 68', 73, 73', 78** and **78'** allow the diagonal, internal webs **64–67, 69–72** and **74–77** to extend transversely diagonally at the optimum angle with reference to the horizontal, i.e., an angle of about **40°–50°**, to give the maximum lateral thrust effect when they are collapsed or bent as the seal **50** is collapsed laterally. The crossed webs **64–67** and **69–72** substantially retain their approximate X configuration when the seal is laterally collapsed. This characteristic is the result of the overall geometry of the seal, which allows for some vertical flexure in the midportions of the top and bottom walls **54** and **55.** Because of the aforesaid characteristics of the seal, it is preferred that the midportions in the uncompressed seal be respectively lower and higher than the corners **62.** In such arrangement the midportions may rise and drop, respectively, to positions which do not extend appreciably above or below the respective corners of the seal when the latter is laterally collapsed.

The sealing strip **80** of FIG. **4** is similar in some respects and different in other respects from the sealing strips **50.** It has a vertical dimension which is greater than the width dimension. It comprises a pair of vertically disposed, substantially parallel side walls **81** and **82** with top and bottom walls **83** and **84.** The side walls each have a single longitudinal rib or bead **81*a*** and **81*b*** like the earlier described narrow, semi-cylindrical ribs or beads **11*a*, 12*a*, 51*a*** and **52*a*.** The top wall **83** is, in transverse cross section, in the shape of a shallow W, while the bottom wall **84** is substantially a mirror image thereof in the shape of a shallow M in transverse cross section. The top wall **83** comprises downwardly sloping outer segments **85** and **86** and shallow, inverted-V-shaped inner segments **87** and **88.** The bottom wall **84** comprises upwardly sloping outer segments **89** and **90** and shallow V-shaped inner segments **91** and **92.**

The diagonal, inner members of the sealing strip **80** comprise rib members **93** and **94** which are substantially coplanar and rib members **95** and **96,** which are also substantially coplanar. These rib members cross at about the longitudinal axis of the seal and together form an X. The outer edges of the X are connected to diagonally sloping rib members **97** and **98** and **99** and **100,** which respectively intersect in pairs at substantially the midportion of the side walls **81** and **82.** The rib members **93–100** are connected to the nadirs and apices of the top and bottom walls by narrow, vertically disposed connecting strips **102, 104, 106** and **108,** which respectively intersect and merge with the valleys **101** and **105** and apices **103** and **107** of the top and bottom walls **83** and **84.**

As in the other embodiments, the embodiment of FIG. **4** provides diagonal, internal webs which do not form sharp bends or folds when the seal is laterally compressed. In all emobodiments, these diagonal webs form in the seals a plurality, i.e., two or three, side-by-side, diamond-shaped or substantially diamond-shaped cavities surrounded by substantially triangular, trapezoidal and/or symmetrical hexagonal cavities formed by portions of the outer walls of the hollow seals and diagonal webs.

The seals of the subject invention should be made of good quality elastomer formulations in order that these seals retain their elastic properties with aging under environmental conditions. To this end, the elastomer composition should be an elastomer formulation which is extrudable, and which, upon vulcanization, will be resistant to deterioration and/or loss or resilience after exposure to hot and cold weather conditions, sunlight, and like elements of nature in the use thereof in joints of pavement, air strips, and the like. The preferred elastomer therefore is neoprene, preferably the crystallization-resistant types thereof.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the forms herein disclosed being preferred embodiments for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. An elongated, elastomer, joint-sealing strip comprising an elongated hollow body defined by substantially planar side walls and top and bottom walls including shallow, longitudinal corrugations of shallow W or shallow M configuration in transverse cross-section, and an internal web structure including elongated diagonal webs crossing in the center portion of said body to form a plurality of side-by-side, substantially diamond-shaped cavities, four additional, elongated webs extending respectively transversely diagonally across the four corners of said seal with pairs of said latter webs intersecting a respective side wall at a juncture extending longitudinally along the mid-portion of each side wall, and a single narrow, semi-cylindrical longitudinal bead on the outer face of each of said side walls at the longitudinal midportion of each wall respectively directly opposite each of said junctures, said beads serving the functions of aiding symmetrical lateral collapse of the seal and impeding inward bending or rolling of its corners during such lateral collapse.

2. An elongated, elastomer, joint-sealing strip comprising an elongated hollow body defined by substantially planar side walls, a top wall of substantially shallow W-configuration, a bottom wall of substantially shallow M-configuration, the nadirs of said W-configuration of the top wall being opposite the apices of said M-configuration of the bottom wall, a pair of diagonal webs connected to the nadirs of the top wall and to the apices of the bottom wall and crossing at the centers thereof, additional diagonal webs connected respectively to said nadirs and apices and the midportions of contiguous side walls, and a single, narrow, semi-cylindrical longitudinal bead on the outer face of each of said side walls respectively directly opposite the connection of said diagonal webs with the midportion of each wall, said beads serving the functions of aiding symmetrical lateral collapse of the seal and impeding inward bending or rolling of its corners during such lateral collapse.

3. A joint-sealing strip as claimed in claim **2** wherein said top wall and bottom wall are joined respectively with said side walls by rounded corners.

4. A joint-sealing strip as claimed in claim **2** wherein said diagonal webs are joined at their longitudinal edges directly to said apices and nadirs.

5. An elongated, elastomer, joint-sealing strip comprising an elongated hollow body defined by substantially planar side walls, a top wall having a midportion of shallow-M-configuration with the edges of said midportion joined with the side walls by upwardly sloping strips, a bottom wall having a midportion of shallow-W-configuration with the edges of the latter midportion joined with said side walls by downwardly sloping strips, the three nadirs and two apices of said top wall being respectively opposite the three apices and two nadirs of the bottom wall, two pairs of diagonal web structures crossing at the centers thereof and extending diagonally from the nadirs of the top wall to the apices of the bottom wall, additional diagonal webs extending from the two outer nadirs of said top wall and the two outer apices of the bottom wall to the midportion of contiguous side walls, and a single, narrow, semi-cylindrical longitudinal bead on the outer face of each of said side walls respectively directly opposite the connection of said diagonal webs with the midportion of each wall, said beads serving the functions of aiding symmetrical lateral collapse of the seal and impeding inward bending or rolling of its corners during such lateral collapse.

6. A joint-sealing strip as claimed in claim **5** wherein said additional diagonal webs are joined at their longitudinal edges directly to said side walls, and said additional webs and said webs of said pairs are joined to said apices and nadirs by narrow, vertical webs.

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