Jan. 16, 1968 R. N. GALBREATH 3,363,522

EXPANSION JOINT

Filed Nov. 1, 1965 2 Sheets-Sheet 1

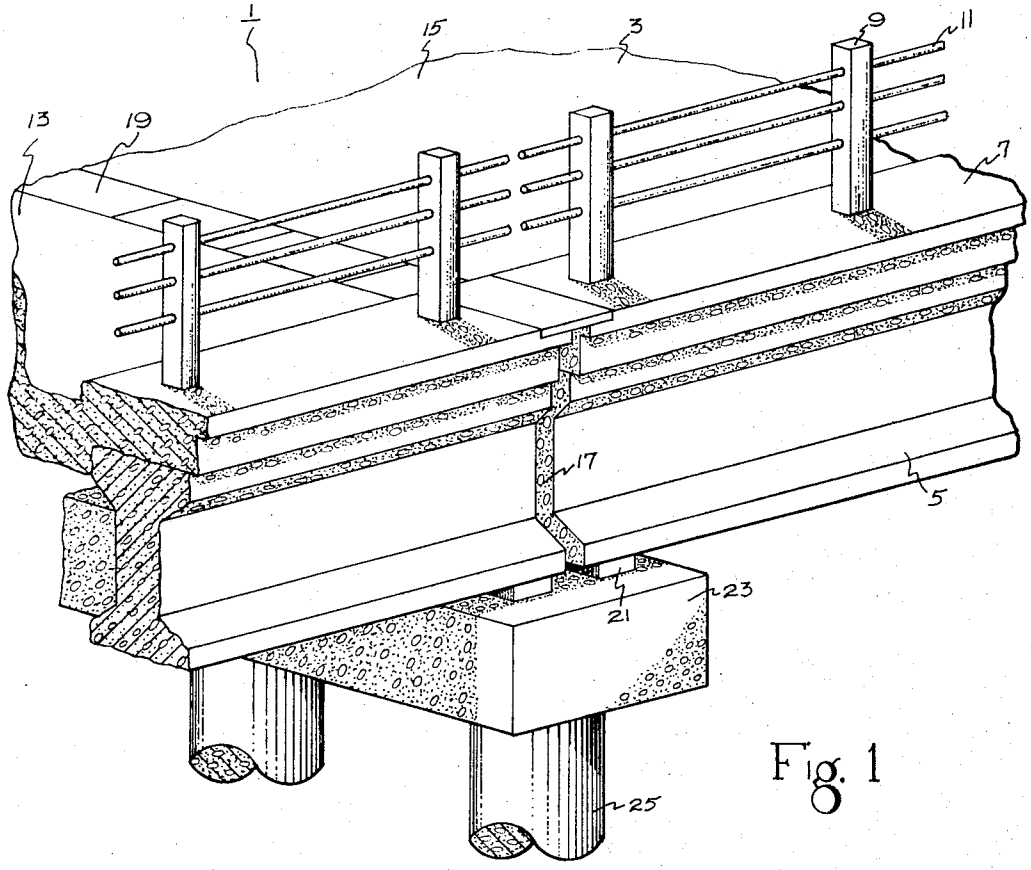


Fig. 1

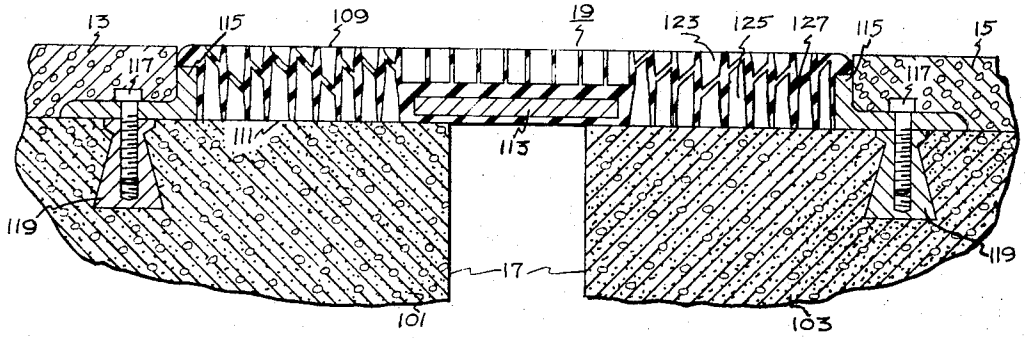


Fig. 2

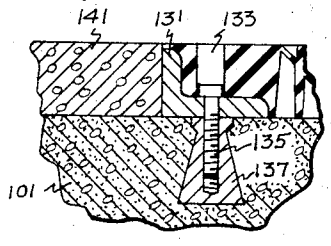


Fig. 3

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EXPANSION JOINT

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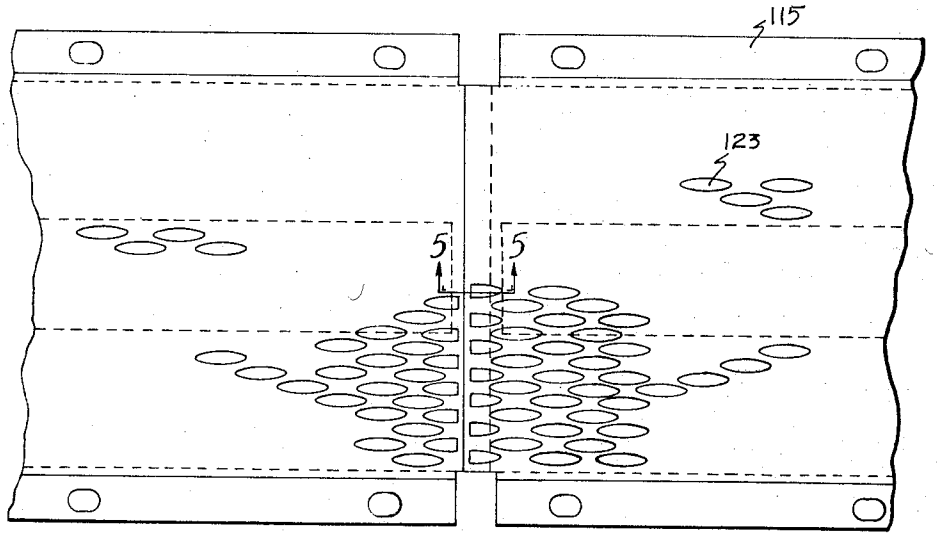


Fig. 4

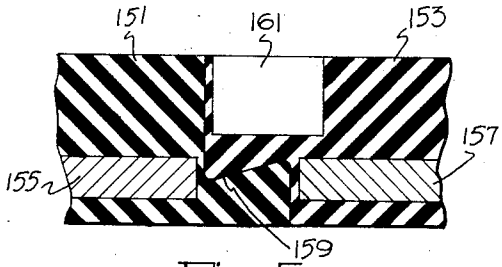


Fig. 5

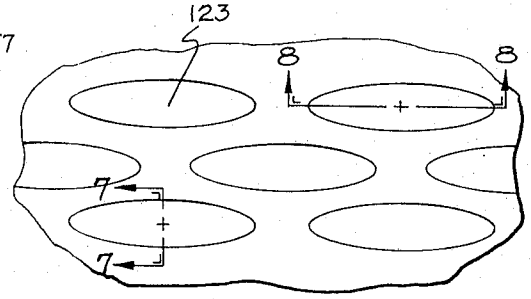


Fig. 6

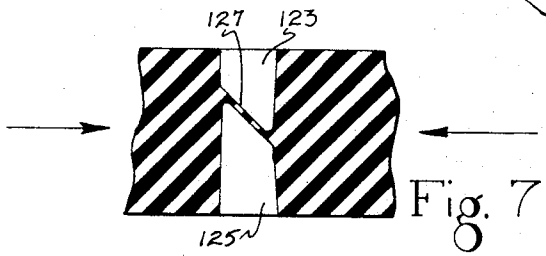


Fig. 7

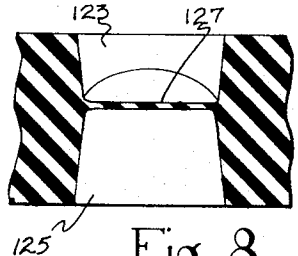


Fig. 8

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EXPANSION JOINT

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ABSTRACT OF THE DISCLOSURE

This roadway expansion joint comprises an elastomeric body portion with a plurality of vertically extending, transversely staggered, elliptical cavities in the top and bottom surfaces thereof separated from one another by thin diagonally disposed webs. A flat reinforcing plate is embedded in the elastomer and is adapted to span the gap between two adjacent sections of a roadway or bridge.

This invention relates to an expansion joint. More particularly, this invention relates to an expansion joint of the type used between adjacent sections comprising the deck of a bridge to permit expansion and contraction of the sections while maintaining a relatively smooth uninterrupted road surface.

In the construction of bridges and viaducts, the road surface is built in discrete sections upon I-beams or other support members extending longitudinally of the bridge. These support members rest upon cross members which in turn are positioned on top of vertical supporting piers. Concrete is generally used for the sections which make up the surface of the roadway and is desirably reinforced by the incorporation of steel rods thereinto. To allow for thermal expansion and contraction of the concrete as well as the supporting beams, gaps are provided between the sections. The width of these gaps may vary from between about ½-inch in hot weather to three inches or four inches or more in cold weather.

In the past it has been the accepted practice to fill the gap between the adjacent sections of concrete with a material such as hot liquid asphalt which becomes relatively hard upon cooling and which serves as a sealant. Generally this asphalt, even after it becomes hard, remains sufficiently pliable and elastic to allow for normal expansion and contraction of the gap. However, its use has certain drawbacks, such as its tendency to become soft and sticky in hot weather and brittle in cold weather. Furthermore, it affords almost no protection to the opposing edges of the adjacent concrete slabs, and thereby permits moisture and foreign objects such as stones, etc., to work their way into the gap and to cause eventual deterioration of the edges. Furthermore, the asphalt often forms a hump above the level of the highway, particularly in hot weather, and this condition causes a noticeable and annoying vibration when a vehicle passes over the gap. Lastly, the use of this type of sealant necessitates frequent maintenance and repeated resealing.

In an attempt to find a suitable replacement for asphalt, others have attempted to use steel joints to span the gap between the adjacent sections of concrete. However, these metal joints have proved to be unsatisfactory in various respects, among them the fact that it is difficult to make them watertight. More recently, various types of elastomeric seals have been tried in an attempt to remedy the problem of filling the gap between adjacent slabs of concrete in roadway construction. These seals have been produced in a variety of shapes and materials and have been partially satisfactory in overcoming the inherent drawbacks of asphalt and steel joints. However,

problems continue to exist. For example, when the elastomeric seal is of the extruded type and has a relatively thin-walled structure, it tends to wear out quickly, particularly when its upper surface is exposed to vehicular traffic. Furthermore, its load bearing characteristics are relatively poor.

There are various factors which must be taken into consideration when evaluating an expansion joint of the type used in bridge and roadway construction. Among these are its ability to withstand traffic abuse and to be capable of taking large and sudden loads with a minimum of vertical deflection. The joint should have an upper surface which provides a smooth transition from one bridge section to the other, or from the bridge deck to the adjacent roadway. Furthermore, it should be capable of expanding and contracting in response to movement of the adjacent sections of the bridge while maintaining said smooth transition. Lastly, it should provide a water and weathertight seal to protect the edges of the concrete against wear and deterioration and to provide some degree of protection of the parts of the bridge underneath the road surface.

It is one object of the present invention to overcome many of the drawbacks found in presently used types of expansion joints, particularly those utilizing asphalt, steel plates, and thin-walled elastomers.

It is another object to provide an elastomeric expansion joint which can be installed essentially flush with the top surface of the roadway, creates no noticeable vibration, and undergoes substantially no vertical deflection when subjected to vehicular traffic.

It is yet another object of this invention to provide an expansion joint which is adapted to form a tight seal between edges of the adjacent slabs of concrete or the like and which prevents contaminants from passing through the gap between the slabs.

These and other objects are accomplished in a manner to be hereinafter described with particular reference being given to the following figures for clarification:

FIGURE 1 shows a perspective view of a portion of a bridge showing the various structural components thereof;

FIGURE 2 is a cross-sectional view showing the adjacent edges of two sections of the bridge with the elastomeric expansion joint installed therebetween;

FIGURE 3 is a partial cross-sectional view showing an alternative arrangement for installation of the joint;

FIGURE 4 is a top view of two juxtaposed sections of the elastomeric expansion joint;

FIGURE 5 is a section taken along line 5—5 of FIGURE 4;

FIGURE 6 represents a close-up of some of the cavities in the surface of the expansion joint;

FIGURE 7 is taken along line 7—7 of FIGURE 6, and

FIGURE 8 is taken along line 8—8 of FIGURE 6.

Generally speaking, this invention relates to an elastomeric expansion joint comprising a substantially rectangular elastomeric body having a flat top and bottom surface essentially parallel to one another, each of said surfaces provided with a plurality of inwardly extending cavities. A rigid reinforcing plate is embedded in the body and is adapted to overlie the gap between the sections of the roadway. The opposing surfaces of the adjacent sections are provided with shoulders upon which the joint rests, and means extending along the longitudinal edges of the joint are provided for anchoring the joint to said shoulders.

More particularly, this expansion joint comprises a generally rectangular body of elastomeric material such as

rubber or Neoprene in which is embedded a metal reinforcing plate adapted to bridge the gap between adjacent sections of concrete or the like and to provide support for vehicles rolling across the joint. Means are provided along the edges of the joint for bolting it in place. Additional means are provided, when the joint is manufactured in sections of discrete length, to be laid along side one another across the width of the roadway, and to unite and seal these sections together into one continuous piece. A plurality of elliptical cavities are provided in the top surface of the elastomer, those over the metal plate terminating a short distance therefrom. Each of the remaining cavities is aligned with a similarly disposed cavity extending up from the bottom surface and is separated therefrom by a thin elastomeric web. The long axis of each elliptical cavity extends longitudinally of the joint and the webs traverse the lateral or short axis of the cavity at an angle from the horizontal. In this manner, foreign contaminants which become embedded in the cavity are forced out when the joint undergoes compression due to expansion of the adjacent sections of the bridge.

Referring now to FIGURE 1, there is shown a bridge **1** consisting of a bridge deck **3** resting on reinforced concrete beams **5**. The ends of the beams **5** rest upon suitable bridge bearings **21**; for instance, laminated rubber-steel bearings which, in turn, rest upon cross-members **23** on top of piers **25**. The edges of the roadway are defined by curbs **7** to which posts **9** are securely anchored. These posts support guard rails **11**. The deck **3** comprises a plurality of sections (two sections **13**, **15** being shown) composed of a suitable surface material such as concrete or asphalt. The sections are separated from one another by an expansion gap **17**. Bridging the gap **17** are a plurality of expansion joints **19** extending across the full width of the bridge.

Referring now to FIGURE 2, there is shown a close-up of that portion of the bridge that is germane to the present invention and a cross-sectional view of the novel expansion joint installed in place. In this figure are shown two slabs **101** and **103** which form the subsurface of the roadway and which are separated from one another by an expansion gap **17**. Spanning this gap is an expansion joint **19** comprising an elastomeric body portion of generally rectangular shape having a flat top surface **109** and a flat bottom surface **111** substantially parallel to one another. Embedded in the elastomer near the bottom thereof and spanning gap **17** is a reinforcing plate **113**, preferably steel or the like. Suitable attaching means such as angle irons **115** are embedded in or otherwise attached to the sides of the expansion joint. The joint is anchored in place by bolts **117** passing through the angle irons **115** and screwed into threaded inserts **119** embedded in the subsurface slabs **101**, **103**.

After the joint is anchored into place, the space above the bolts **117** and angle iron **115** is back filled with the material that is used to form the surface of the road. Preferably with this type of installation, the surface of the roadway is composed of asphalt which can be removed from around the bolts without too much trouble if the need should arise for repair or replacement of expansion joints. On the other hand, if the surface of the roadway is to be concrete, the anchoring arrangement shown in FIGURE 3 is more desirable. In this type of installation, the angle iron **131** is turned inwardly so that the horizontally disposed leg is embedded in the elastomer and does not project out therefrom. A hole **133** is molded into the elastomer in alignment with a slot in the angle iron, and bolt **135** is inserted in thereto and is threaded into insert **137** embedded in the concrete subsurface **101**. In this manner, the concrete surface **141** can be poured into place and does not interfere with the removal of the joint for repair or replacement.

Referring again to FIGURE 2, it can be seen that the upper surface **109** of the joint **19** is provided with a plurality of cavities **123** and the lower surface is likewise provided with cavities **125** separated from the upper cavities by thin webs or diaphragms **127** inclined at an angle from the horizontal. It can be seen in FIGURE 4 that these cavities are arranged in longitudinally aligned and laterally staggered rows. The upper cavities located over the reinforcing plate **113** terminate a short distance above said plate. For illustrative purposes, the joint in FIGURE 2 is cross sectioned so as to reveal a portion of the cavities in each of the laterally staggered rows.

FIGURES 4 and 6 show the general shape of the upper cavities **123** and it can be seen therefrom that the cavities are somewhat elliptical in shape with their short axis extending widthwise of the joint toward the angle irons. As the sections of the road expand and the gap between them contracts, the rubber in the joint undergoes compression. The elliptical cavities are placed in a staggered arrangement across the width of the joint so that the rubber in all parts of the joint is subjected to approximately the same amount of compression. In other words, the area of rubber described by a given vertical plane extending laterally across the joint will be approximately equal to the area described by any other plane parallel thereto. This even distribution of stress in all parts of the elastomeric joint results in uniform wear and helps to prevent premature failure of portions thereof due to overworking. Although the arrangement of the cavities permits easy compression in the horizontal direction, deflection in the vertical direction is relatively small because it is resisted by solid columns of elastomeric material. Thus, the joint does not sag appreciably under the load of vehicular traffic. Although it is preferable that the cavities assume the shape of an ellipse, they may be molded into other shapes and can be varied in size and spacing if desired.

The elastomeric joint of this invention is preferably fabricated into relatively short sections rather than in a continuous length to facilitate the handling and installation of the same. These sections are assembled along the length of the gap in such a manner that they will be formed into a self-sealing unitary joint. This is preferably accomplished in the manner shown in FIGURE 5 wherein the two adjacent sections **151**, **153** are juxtaposed to form an overlapping dove-tail joint. The two sections are each provided with reinforcing plates **155** and **157** which terminate near the ends of the section. The ends of the joint are molded so that upon placing them together a dove-tail joint **159** is formed. It should be understood, of course, that other types of joints, such as a tongue and groove joint, can be used. Preferably, but not necessarily, an adhesive is applied to the joint to insure a watertight seal between the two sections. In order to further assure a tight seal, it is noted that the cavities **161** at the edges of one section **153** of the joint are enclosed and do not mate with corresponding cavities in the other section.

FIGURES 7 and 8 represent cross sections taken through the joint showing the upper and lower cavities **123**, **125** and the angular arrangement of the web **127** separating these cavities. The total effect is that of a passageway extending through the joint, normal to and in communication with the top and bottom surfaces, and divided into two parts by the elastomeric web **127**. The web is shown as being disposed at an angle of about 45° across the width, or smaller diameter, of the cavities, while being substantially parallel with the upper and lower surfaces of the joint in the lengthwise direction. It should be understood that this angle may vary and can range from, for example, 30 to 60°. The inclination of the web causes water, or other foreign objects such as gravel and dirt which becomes wedged in the upper cavity **23**, to be expelled upon the widthwise contraction of the joint. As the sections of the bridge expand, the joint undergoes lateral compression as shown by the arrows in FIGURE 7, resulting in a decrease in the lateral diameter of the cavities **123** and **125** and a concomitant deflection of the web **127** angularly upwards, thereby urging the foreign object out of the cavity. Another reason for positioning the web at

an angle from the horizontal is to reduce the horizontal columnar strength of the joint, thereby permitting the joint to be more readily compressed in the lateral direction. By this it is meant that if the webs are at right angles to the direction of the force which causes the joint to be compressed, they will initially resist compression and will buckle before their resistance is overcome. This feature is undesirable in the joint described by the present invention.

The webs or diaphragms **127** in adjacent cavities are preferably located at different heights, the purpose being to evenly distribute the forces of horizontal compressive resistance and to obviate the possibility of buckling or bulging of the joint when it undergoes compression. In other words, the different elevations of the webs serve to break the straight line columnar effect of the rubber during contraction of the gap between the sections of the bridge. It serves the additional purpose of reducing the amount of noise when a tire crosses the joint by breaking up the uniformity of cavity resonances.

It should be noted that the sides of the cavities have a slight draft angle or taper which can range from about one to about five degrees. This taper aids in the self-cleaning of the cavities and also facilitates the molding of these joints.

Preferably the elastomeric joint of this invention is fabricated by compression molding using high temperatures and pressures. The metal reinforcing plate, as well as the angle irons used to attach the joint to the subsurface slabs of the bridge, are typically placed in the mold prior to molding along with a suitably formulated elastomeric compound. The molding temperatures and pressures then cure the elastomer and bond the metal members firmly to and within the body thereof. The reinforcing plate, and the angle irons if desired, are preferably completely encapsulated by at least a thin layer of elastomer to protect these metal parts from corrosion.

There are several elastomers which can be used in the manufacture of this novel expansion joint, the most common of these being natural rubber. Some of the factors which must be taken into account when selecting a suitable elastomer are cost, ease of fabrication, resistance to elements such as ice, snow, salt, and oil, uniformity of properties over a wide temperature range, and resistance to wear and compression.

Other elastomers such as neoprene and ethylene propylene rubber can also be used, particularly inasmuch as they have better resistance to oxidation and/or ozonization than does natural rubber. On the other hand, SBR, a synthetic copolymer of styrene and butadiene, may also be used since it possesses good resistance to abrasion and impact as well as favorable cold weather characteristics.

Because of the design of this joint, which permits it to be readily compressed in a lateral direction, there is no particular difficulty in installing the joint in warm weather when the gap between adjacent sections of concrete is likely to be at a minimum. The joint can be readily precompressed, either at the factory or at the building site, and can thereafter be placed into position and anchored into place. On the other hand, if the threaded inserts are embedded in the concrete during warm weather and are spaced sufficiently far apart so that the joint need not be precompressed, the advent of cooler weather will cause the adjacent sections of the road to contract, and the elastomer in the joint to go into tension. Although maintaining the joint in tension does not normally adversely affect its operation, it does render the elastomer more susceptible to oxidative attack.

Various modifications can be made in the design and construction of this joint without departing from the basic inventive concept embodied therein. For instance, the number, shape, size, and location of the cavities, as well as the angle, thickness, and vertical position of the diaphragms may be varied within relatively wide limits. Furthermore, such factors as the thickness, width, and length of the joint can be varied to suit individual needs. Moreover, other means of attaching the joint to the adjacent sections of the roadway can be utilized. For example, the shoulders of the concrete sections can be lined with metal plates or the like having overhanging lips which serve to hold the longitudinal edges of the joint in place.

Although this novel joint has been described in connection with its use in bridge construction, it should be understood that it can be likewise utilized in the construction of ordinary roads and highways as an expansion joint between sections thereof. Furthermore, it can be used in other structural applications wherein provision must be made for relative thermal movement of adjacent sections of the structure. Thus, utilizations of the joint can be found in the construction of buildings, aircraft runways, loading docks, and the like.

With the foregoing serving as a description of the invention but not as a limitation thereof, I claim:

1. An expansion joint adapted to be interposed between two relatively movable structures and to accommodate the movement therebetween, comprising an elastomeric body portion having essentially flat and parallel top and bottom surfaces adapted to be positioned perpendicularly to the direction of said movement, reinforcing means within said body portion intermediate and substantially parallel to said surfaces, a plurality of cavities extending downwardly from said top surface toward said bottom surface, those disposed over said reinforcing means terminating near thereto, and the remainder aligned with corresponding cavities extending upwardly from said bottom surfaces and separated therefrom by elastomeric webs, each of said webs being inclined with respect to said top and bottom surfaces in the direction of movement of said structures and being substantially parallel with said surfaces in the direction normal to said direction of movement, said cavities being staggered in the direction of movement of said structures to provide uniform resistance to compression.

2. An expansion joint according to claim 1 wherein the webs of adjacent cavities are staggered in respect to their distance from the top surface of said joint.

3. An expansion joint according to claim 1 including means for attaching said joint to the adjacent structures.

4. A joint according to claim 1 wherein said joint consists of several longitudinally extending sections placed in end-to-end relationship.

5. A bridge expansion joint comprising a generally rectangular elastomeric body portion having a flat bottom surface and a flat top surface parallel thereto, and when installed being essentially flush with the surface of the bridge deck, a plurality of discrete upper cavities communicating with the top surface and extending downwardly into the body portion of the joint, means intermediate the edges of the joint to reinforce the same in the area overlying the gap between adjacent sections of the bridge, the upper cavities over this reinforcing means terminating in proximity thereto, the upper cavities in the remainder of the body being separated from, and axially aligned with, lower cavities communicating with the bottom surface thereof by a thin elastomeric web, all of said upper and lower cavities being elliptical in cross section with their longitudinal axis extending lengthwise of said joint, all of said cavities being aligned in longitudinal rows and staggered in alternate rows in a lateral direction, said webs being inclined, in the lateral direction, at an angle of between approximately 30 and approximately 60 degrees from the top and bottom surfaces and being substantially parallel to these surfaces in the longitudinal direction, the webs of adjacent passageways being placed at varying distances from said surfaces.

6. A joint according to claim 5 provided with a longitudinally extending angle iron attached to each side of said joint, one leg of said angle iron adapted to be secured to one section of the bridge.

7. A joint according to claim 5 wherein the joint is divided into a plurality of longitudinally extending sec-

tions, each of said sections abutting the next adjacent section in watertight relationship.

8. A joint according to claim 7 wherein the abutting edges of said sections are provided with a dove-tail joint.

9. A joint according to claim 7 wherein the sections are abutted together utilizing a suitable adhesive.

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