This invention relates to a highway expansion joint which is principally used in connection with joints in roadways that are supported on piers and which are generally known as bridge structures.

It is quite common in the building industry to first lay a concrete deck slab as the foundation for the roadway and then place on top of this slab three inches of asphaltic concrete. The slabs which generally are of a length on the order of forty feet are laid in a fashion so that a space is left between adjacent slabs to accommodate the normal expansion that takes place in concrete. Normal expansion for concrete is something in the order of approximately three-quarters of an inch per hundred feet, and it is, therefore, quite common to leave a space of one inch between the abutting ends of concrete slabs. A similar practice is adhered to when concrete is used for the vehicle surface itself wherein a small area left between adjacent slabs which in the past have been generally filled with an asphaltic compound generally of the tar family. In the following description which will be principally directed to the use of concrete slabs as the foundation piece in bridge construction, it should be understood that alternate uses are available for the expansion joint disclosed herein and that the specific example herein given and illustrated is not to be construed as limiting except within the scope of the appended claims.

In bridge construction it is quite common after the supporting piers have been erected to place beams across these supporting piers, which beams may either be steel I beams or pre-cast concrete beams. Directly on top of these supporting beams, on the upper flanges thereof, forms are erected which serve as the base for pouring a concrete slab. The concrete slabs are then poured onto these forms that have been erected and are poured to varying thicknesses and usually will be reinforced through the use of steel reinforcing rods as is quite common in the industry. It is common to form the concrete slabs in rather large single poured sections on the order of seventy feet in length and of varying widths depending upon the job, and it is therefore quite apparent that a considerable mass of concrete is poured in a single piece. Each of these slabs is spaced from each other longitudinally of the roadway a distance of an inch or so to permit expansion between adjacent slabs. In the past it has been quite common to use metallic plates such as steel plates that overlap the joint between the concrete slabs or alternatively in some structures finger plates are used to bridge the gap between the slabs. In any event no matter which prior method is used, it permits a continuous road surface to be presented, and the gap successfully bridged between the slabs. The difficulty with using this form of construction is twofold. Basic to this form of construction involves considerable time consuming fabrication and consequent expense. Additionally the steel plates become loose after a period of time, and since they are fastened to foundation members that are embedded in the concrete slabs, they must be removed from their foundation pieces and re-attached. This is a time consuming and costly method of replacing worn out expansion joints, and it has long been a desire of the road-building industry to have a joint which is simple in construction and which could be more easily replaced in the field. It is accordingly a main object of this invention to provide a new form of expansion joint which may be preformed away from the job and readily installed.

Another object of the invention is to provide an elastomer expansion joint formed at least in part from material which has elastic properties and which will be resistant to surface wear by vehicle traffic.

Another object of the invention is to provide an expansion joint for a roadway which will be quiet for the travel of vehicles thereover.

Another object of the invention is to control any tendency of the body to bulge or buckle when in position.

Another object of the invention is to provide an expansion joint that will seal out moisture.

With these and other objects in view, the invention consists of certain novel features of construction as will be more fully described and particularly pointed out in the appended claims.

In the accompanying drawings:

FIG. 1 is a broken perspective view of a portion of a bridge using the invention;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1;

FIGS. 3 and 4 are diagrammatic views illustrating the forces as they act in the body member of the expansion joint; and

FIGS. 5 and 6 are enlarged sectional views taken through the expansion joint with FIG. 6 a modification of the expansion joint as shown in FIG. 5.

In proceeding with this invention, I form an elastomer expansion joint by extruding, molding or otherwise forming a bridging member which will have a mid portion to span the gap or space at the joint which is left for expansion, with means at one side of the member to fasten it in place, while at a point either side of the mid bridging portion I provide an area which may be more resilient or more compressive than the mid section and the end sections and in order to control the tendency of the member as a whole to bulge or buckle in one direction or the other as compressive forces are applied to it, I have located a plate above the horizontal centroid and in a position to span the gap between the structural elements and I have anchored this plate or mid portion of the member so it cannot buckle upward. Thus, the forces which are produced will tend to bulge or buckle the member at either side of the mid portion downwardly where they are well supported and prevent any upward buckling which would be undesirable. In order to enhance this tendency toward downward bulging or buckling, I have provided voids which are located below and laterally spaced from the horizontal plate and thus these also assist and tend to cause the portion between the mid portion and the end portions to buckle downwardly and provide a thrust against portions which are well supported.

Referring now to FIG. 1 of the drawings, I have illustrated therein a bridge structure in which there has been shown a typical pier having a footing 12 with a number of columns 13, 14 and 15 supporting a top beam 16 spanning the lateral distance between the columns. Purley for illustrative purposes and in conjunction with one form in which such bridges are constructed, a number of steel I beams such as 21, 22 suitably spaced span the distance between adjacent piers. Usually the I beams 21 and 22 are free to slide on the horizontal beam 16. The sliding movement is desired since the I beams 21 and 22 will expand and contract along their length creating a movement of something on the order of three-quarters of an inch per 100 foot of length, and it is to permit this expansion that the sliding motion on the lateral beam 16 is permitted. Additionally, the inner ends of the I beams 21 and 22 are spaced from each other on the
lateral beam 16 so that during this expansion and contraction and particularly upon expansion, they will not abut each other. On top of the I beams there rests slabs of concrete 25 and 26.

Referring now to FIG. 2 for a more detailed illustration of the joint on the lateral beam 16, there is illustrated an enlarged cross section of the portion of this joint, and here we see that the I beams 21 and 22 have welded to the bottom flanges thereof wear plates 28, 29 which in turn rest on domed feet 30 and 31 that are secured to the lateral beam 16. Peripherally secured to the webs of the beams 21 and 22 are channels 32, 33, which serve to support the thickened end portions of the slabs 25 and 26. At the ends of slabs 25 and 26 pockets 34 and 35 are formed, and into these pockets is fitted the expansion joint made in accordance with the invention and which is generally designated 40. It is further noted in this figure that the pockets 34 and 35 effectively form an abutment for the depressed portions of the concrete slab that hold the asphaltic concrete which is designated 36 and 37.

Referring now to FIG. 5 of the drawings, an enlarged and detailed cross sectional view of the expansion joint is shown. Here we find that the concrete slabs have cast therein to form the end pockets a formed sheet of metal 41 which is reversely bent in S form to provide end walls 42 and 43 with a bottom wall 44. The sheet metal piece 41 may be formed in any convenient length and has affixed at spaced locations to the wall 44 thereof concrete bolt anchors designated 45. These bolt anchors are of standard form and are provided with a threaded bore therein to receive a threaded bolt 46. A similar sheet metal piece 41' is embedded in the concrete slab 26 which sheet metal bar bears like specific reference numerals with a prime. In some instances it may be possible to eliminate the sheet metal piece in which event only bolt anchors need be provided.

Traversing the space across the two slabs 25 and 26 and received on the bottom walls 44, 44' of the pans 41 and 41' is the expansion joint 40. In one form this expansion joint consists of end bars 50, 51 which have a thickness equal to the depth of the pocket formed in the illustrated example by the sheet members 41, 41'. The inner end walls of these bars 50 and 51 are provided with a discontinuous surface 52 and 53 which may take a variety of forms. Illustrated is a tongue and groove form although a variety of shapes may well suffice, the main requirement being to provide as long a surface as possible to which there may be adhered an elastomeric section generally designated 54. On either side of the mid portion of the section 54 there is provided areas as at 55 and 56 which are characterized as having a number of voids therein that are so arranged to exhibit resistance to deformation in the direction of the arrows 57 with considerable elasticity in the direction of the arrows 58. In some cases it may be unnecessary to provide such voids. One particular form of voids would be a plurality of pseudo elliptical shaped voids such as 59 such that there is a greater void at the upper portion than at the lower portion. The upper portion of the void will be a little lower than the plate 63 which will be in the line of the greatest compression forces.

Adjacent to these two sections is a central section 60 which is provided immediately adjacent and between the sections 55 and 56. Molded within this central section 60 is a bar 63 which is of a dimension to span the open portion between the two concrete deck slabs 25 and 26 and to provide a stiffening factor and a resistance to a bending moment from a force applied in the direction of the arrows 57. The reinforcing bar or plate 63 is permanently anchored so that it and the expansion joint 40 cannot bulge upwardly due to endwise compression. A number of means are available for anchoring the reinforcing plate 63 into vertical position. For illustrative purposes only as one of many means, a bolt 80, threaded on both ends may be screwed into a threaded hole 81 in plate 63, through a void 82 formed in the member 49, and fastened by a nut 83 to a bracket 84 attached to channel 32 or alternately to channel 33. The lower surface of the central section 60 is conceave on either side of the center as at 89. The end bars or anchorage sections 50 and 51 are provided with a bore 65 and 66 respectively which are countersunk bores, these bores being arranged on the same centers as the centers of the concrete anchors 45, 45'. Since the anchorage sections, as 50' and 51' in FIG. 6 are resilient, reinforcing bars such as 67 and 68 may be embedded therein at locations to be engaged by the head 65 of the anchoring screw 46. In this fashion the expansion joint 40 by the use of socket head bolts may be fastened to each of the deck slabs 25 and 26 by being bolted thereto through and into the anchors and in this fashion the expansion joint may be readily placed into the structure. Preferably the expansion joint is made of a width that will accommodate any variations in the forming of the concrete slabs 25 and 26 and inaccuracies in the setting up of the sheet metal portions 41 and 41' so that, if necessary, a sealant composition may be poured into any voids formed between the end walls 42, 42' and the expansion joint 40 such as at 69, 69', recesses such as 70, 70' being provided to assist in pouring the composition, thus forming a water-tight joint.

In FIG. 6 an alternate form is illustrated which shows the more elastic areas as provided by separable elastic sections 90 and 91 which are shown as provided with grooves 92 on either edge thereof so as to receive tongues 93 on the anchorage sections 50' and 51' and tongues 94 on the mid section 60 so as to retain them in place. Each of these removable sections are provided symmetrical openings 95, 96 and 97 located midway between the top and bottom portions of the sections and with their upper edges at a point slightly below the center of the plate 63. These sections are also concave at 99 on their lower surfaces.

Referring to FIGS. 3 and 4, it has been found in a joint, such as shown at 100, that the compressive forces on the joint are transmitted through a plate or bar such as 67 and 68 inwardly toward each other of the joint while a reaction force from the supporting bar 101 is located below the horizontal centroid as shown at 104. These forces tend to move the bars down as shown by arrows 102 and 103 as a certain couple between these forces is created. As the compressive forces are increased, the resistance to further downward movement as at 106 and 107 creates first a bulge as at 108 and 109, continued increase in compressive forces creating a bulge such as shown by dotted line 110. This is highly undesirable, and in order to eliminate the tendency for the bulges at 108 and 109 or as at 110, I have found that by elevating this spanning bar now designated 115 to the position shown in FIG. 4 that I do not obtain the reactive couple of forces causing the upward bulge at 108 and 109 but rather the forces are substantially in line opposition and create resultant forces as shown at 116 and 117 or 118 and 119. With an increase in compressive force, it is apparent that the bar 115 would tend to rise. Accordingly, the bar is held against rising by the anchor designated by the line 120. All forces then tend to move the area about the bar 115 intermediate the mid portion and the end portions downwardly, and I do not get the couple of forces such as tend to cause the bulges 108 and 109 or bulge 110, this coming about by the elevation of the bar 115 above the horizontal centroid and the anchoring it against moving upwardly as I have explained above.

Again referring to FIGURES 3 and 4, and also to FIGURES 5 and 6, it is seen that by locating the central
plate 63 (101 and 115 of FIGURES 3 and 4) at least in line with the resultant of the endwise compressional forces, in lieu of below them (FIGURE 3) secondary buckling will be inhibited. Thus, in FIGURE 6, the plate 63 is shown slightly above the plates 67 and 68. In FIGURE 5, the uniform interface contact between members 59 and 51 results in a uniform transmittal of endwise compressive forces and the plate 63 is positioned above the horizontal centroid of the elastomer block.

As the joint of either FIGURE 5 or 6 shuffles endwise compression, the central portion of the elastomer block immediately below and immediately above the plate 63 undergoes fluid displacement, the elastomer being incompressible. The elastomer volume immediately above the plate 63 bulges upwardly, but because of the relatively small thickness of this volume, its magnitude is correspondingly small. The elastomer volume immediately below the plate 63 is precluded from vertical displacement by virtue of the tie bar 80 being anchored. Flow of this volume laterally is allowed by the concave portions 89 (FIGURE 5) and 99 (FIGURE 6) and by the voids within the elastomer block which are located laterally of the plate 63.

While the foregoing specification is directed primarily to a highway structure such as bridges, it is perfectly possible that this structure might be utilized in buildings or in some similar form.

This structure has application in any instances where it is important to provide continuity across a gap whose width is subject to variation due to temperature or other changes over a period of time.

I claim:

1. An expansion joint between two spaced structural elements defining an expansion gap comprising an elastomer block whose midportion spans said gap, a rigid plate embedded in said elastomer block, said plate lying above and spanning said gap, said elastomer block having a substantially plane surface adapted to serve as a portion of a roadbed with said plate being substantially parallel to said plate portion, said elastomer block being positioned above the horizontal centroid of said elastomer block, means for maintaining the position of said plate fixed relative to said structural elements, said elastomer block provided with a plurality of voids located between the ends of said elastomer block and said plate in the region generally below said plate.

2. The expansion joint of claim 1, wherein said means comprises an elongated rod whose upper end passes through said elastomer block and is joined to said plate, with the lower end of said rod being fixed to one of said structural elements.

3. An expansion joint between two spaced structural elements defining an expansion gap comprising an elastomer block whose midportion spans said gap, a rigid plate embedded in said elastomer block, said plate lying above and spanning said gap, said elastomer block having a substantially plane surface adapted to serve as a portion of a roadbed with said plate being substantially parallel to said plate portion, said elastomer block being positioned within upper recesses in said spaced structural elements with end portions of said elastomer block being anchored to said structural elements, said plate being positioned above the horizontal centroid of said elastomer block, means for maintaining the position of said plate fixed relative to said structural elements, said elastomer block being anchored to said structural elements, said plate being positioned above the horizontal centroid of said elastomer block, means for maintaining the position of said plate fixed relative to said structural elements, said elastomer block provided with a plurality of voids located between the ends of said elastomer block and said plate in the region generally below said plate.

References Cited by the Examiner

UNITED STATES PATENTS
2,135,048 11/1938 Giffin 94—18
2,230,303 2/1941 Leguillon 94—18
3,113,493 12/1963 Rinker 94—18

FOREIGN PATENTS
1,239,446 7/1960 France.

JACOB L. NACKENOFF, Primary Examiner.