Feb. 15, 1938. W. F. SCHULZ 2,108,393

DOWEL MEANS FOR ROADWAY EXPANSION JOINTS

Filed July 1, 1935 4 Sheets-Sheet 1

Fig. 1.

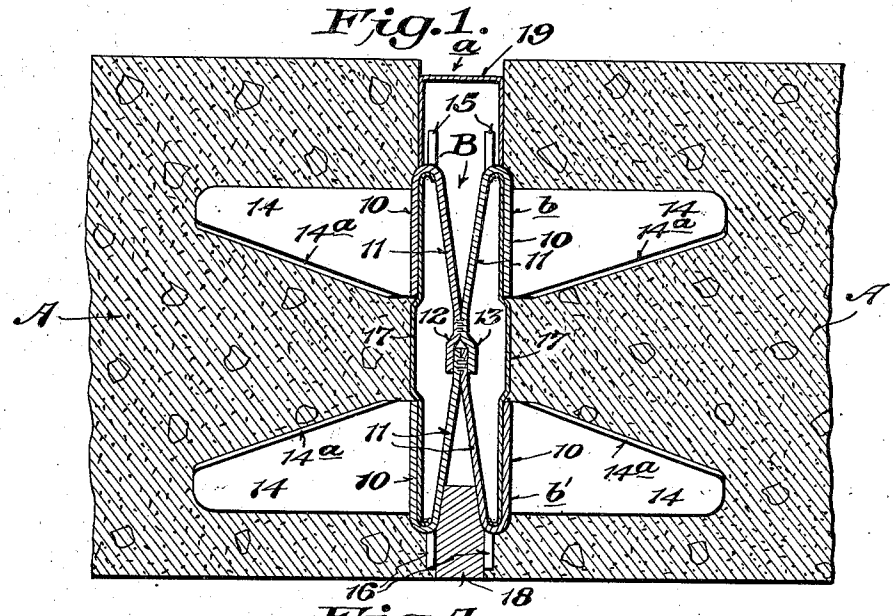
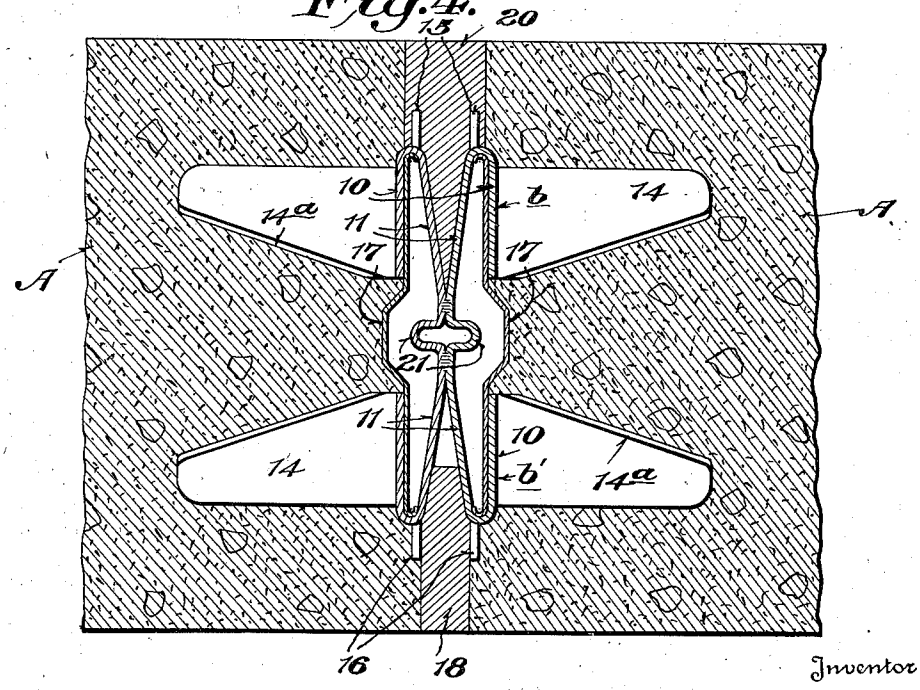



Fig. 4.




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DOWEL MEANS FOR ROADWAY EXPANSION JOINTS

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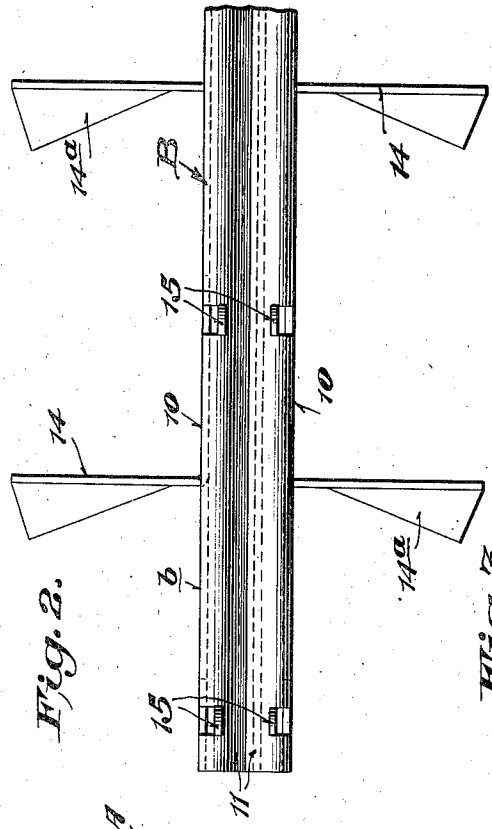



Fig. 2.

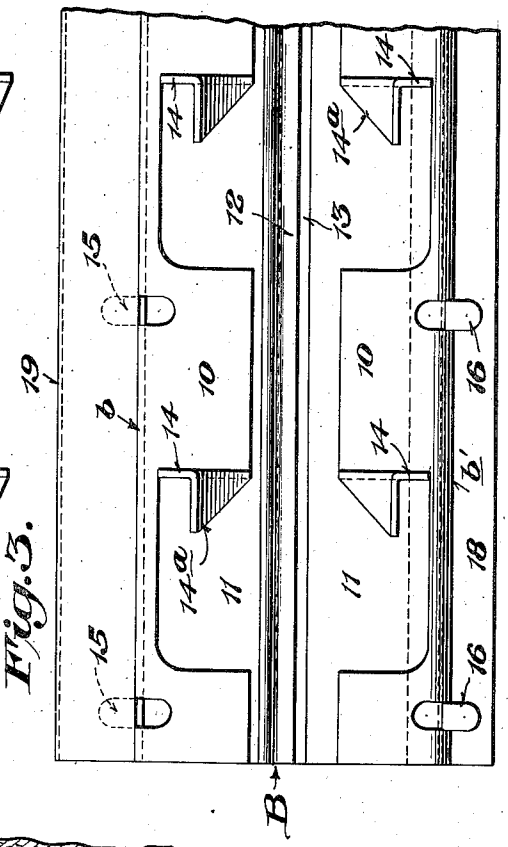



Fig. 3.

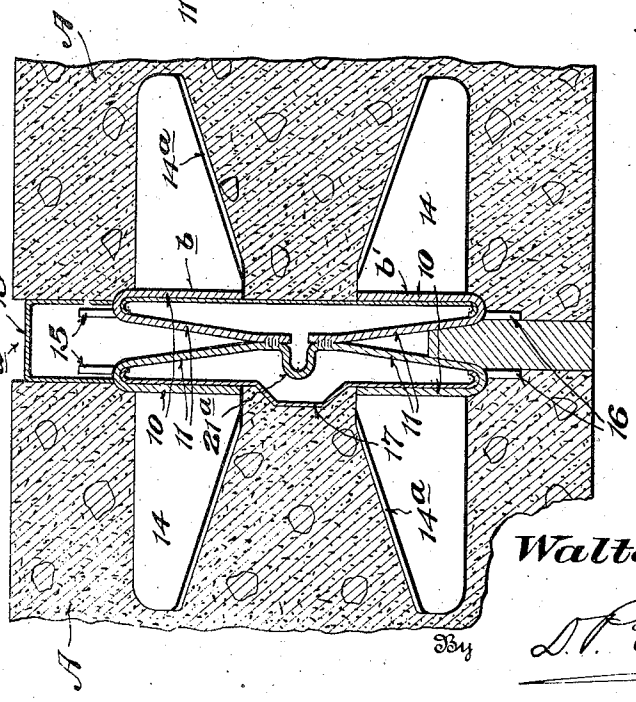



Fig. 5.

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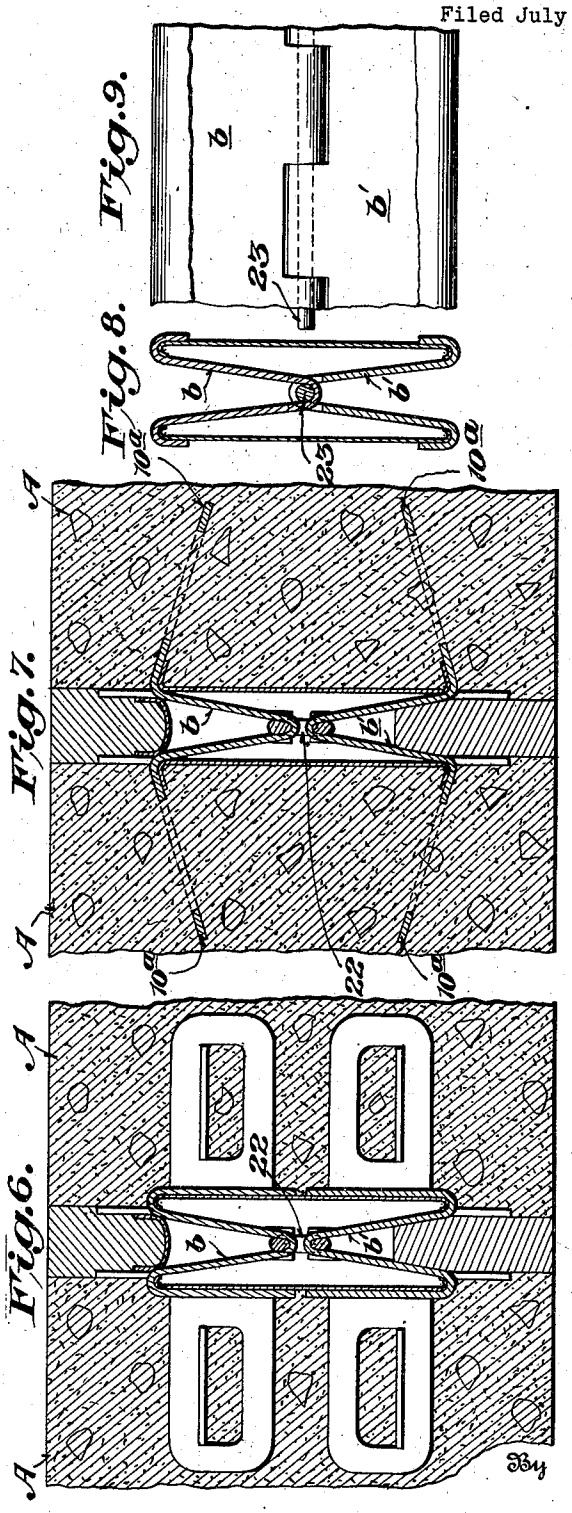
By D. P. Williamson

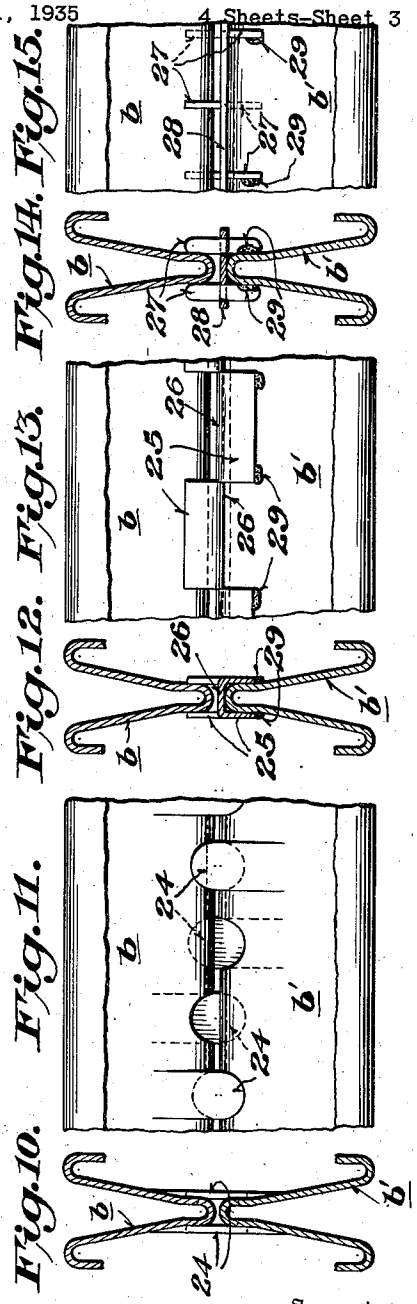
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DOWEL MEANS FOR ROADWAY EXPANSION JOINTS

Filed July 1, 1935 4 Sheets-Sheet 3




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DOWEL MEANS FOR ROADWAY EXPANSION JOINTS

Filed July 1, 1935 4 Sheets-Sheet 4

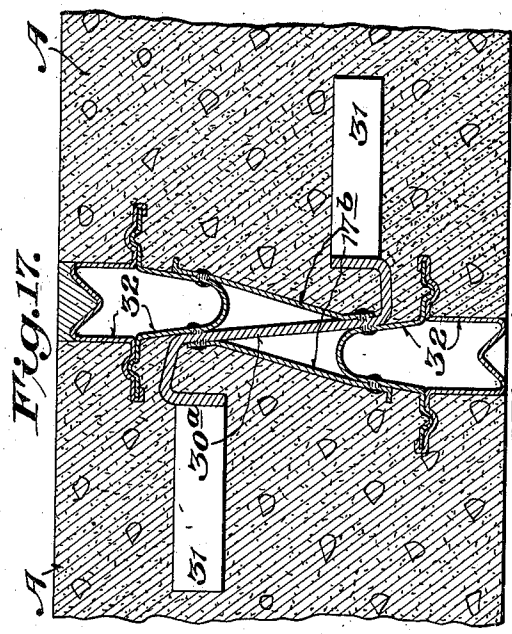



Fig. 17.

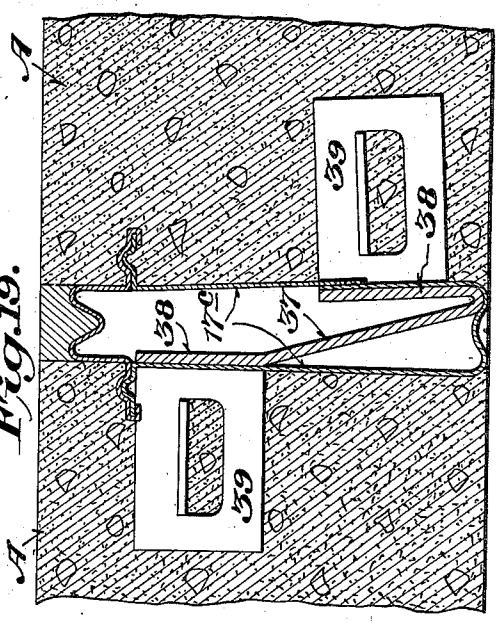



Fig. 19.

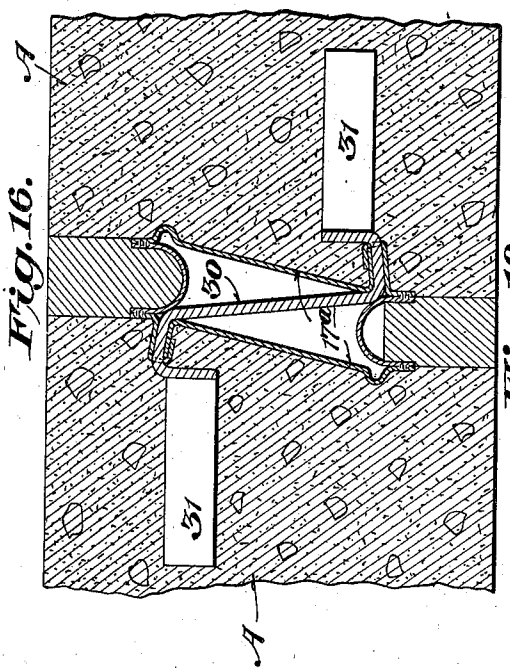



Fig. 16.

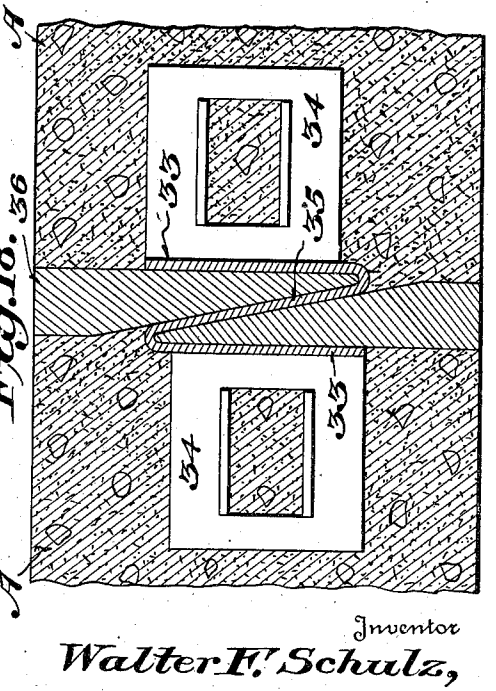



Fig. 18.

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Patented Feb. 15, 1938

2,108,393

# UNITED STATES PATENT OFFICE

2,108,393

## DOWEL MEANS FOR ROADWAY EXPANSION JOINTS

Walter F. Schulz, Youngstown, Ohio, assignor to Truscon Steel Company, Youngstown, Ohio, a corporation of Ohio

Application July 1, 1935, Serial No. 29,354

12 Claims. (Cl. 94—18)

This invention relates to devices for connecting together the concrete slabs of roadways at the expansion joints between such slabs, for the purpose of permitting relative horizontal movement of the slabs and preventing the same from heaving or lifting with respect to each other; and, generally speaking, represents a carrying forward in novel and advantageous structural designs and combinations, of the basic principles underlying the dowel device constructions for a like purpose illustrated, described and claimed in my prior application, Serial No. 23,923, filed May 28, 1935.

In its broader aspects, a slab connecting dowel device as set forth in my aforesaid prior application is characterized by end or anchoring portions to be embedded in the slabs, respectively, and an intermediate yieldable portion of such formation as to cooperate with the end or anchoring portions to hold the slabs against relative vertical movement and, at the same time, to permit the slabs to move relatively horizontally. In connecting a pair of slabs by means of such dowel devices a number of the devices are employed at points suitably spaced along the length of the expansion joint or space between the slabs.

One object of the present invention is to provide a slab connecting device which embodies the foregoing broad and desirable characteristics of the dowel devices described and claimed in my aforesaid prior application, and which includes, in effect, a number of dowel devices embodied in a single unit, thereby to simplify manufacture and installation of the devices and to reduce their manufacture and installation costs.

Another object of the present invention is to provide a slab connecting device embodying, in effect, one or more dowel devices, in which the yieldable formation between the anchoring portions thereof, or the yieldable formations between related pairs of anchoring portions thereof, as the case may be, is or are advantageously vertically disposed.

Another object of the present invention is to provide a slab connecting device embodying a combination of slab connecting elements so cooperating with each other as to hold the slabs in an exceptionally effective manner against vertical movement relative to each other while permitting comparatively free relative horizontal movement of the slabs.

With the foregoing and other objects in view, which will become more fully apparent as the nature of the invention is better understood, the same consists in the novel features of construction, combinations and arrangements as will be hereinafter more fully described, illustrated in the accompanying drawings and defined in the appended claims.

In the drawings:—

Figure 1 is a cross sectional view illustrating one practical form of the invention embodying a cooperating pair of slab connecting elements.

Figure 2 is a top plan view of the upper connecting element shown in Fig. 1.

Figure 3 is a side elevation of the combined connecting elements shown in Fig. 1.

Figures 4, 5, 6 and 7 are views similar to Fig. 1 illustrating slightly alternative embodiments of the invention.

Figures 8, 10, 12 and 14 are cross sectional views, and Figures 9, 11, 13 and 15 are related fragmentary side elevations, respectively, of other alternative forms of the invention embodying cooperating pairs of connecting elements; and

Figures 16, 17, 18 and 19 are views similar to Fig. 1 illustrating alternative single connecting element forms of the invention.

Referring to the drawings in detail, first with particular reference to the form of the invention illustrated in Figs. 1 to 3, A, A designate adjacent portions of a pair of slabs of a concrete roadway, *a* designates an expansion joint or space between said slabs, and B designates, generally, the present slab connecting device comprising the substantially duplicate upper and lower slab connecting elements designated, respectively, as *b*, *b'*.

Both of the elements *b*, *b'* are formed from sheet metal of suitable gauge having a comparatively low degree of fatigue, and in cross section and other respects they are, as aforesaid, substantially duplicates of each other when not disposed in cooperative relationship and considered individually. When, however, they are disposed in cooperative relationship as illustrated in Fig. 1, one of them is inverted with respect to the other. Therefore, while the upper element *b* is of substantially M-shape in cross section and the lower element *b'* is of inverted, substantially M-shape in cross section, said lower element may more properly be considered as being of substantially W-shape in cross section. In any event, each element comprises a pair of vertical side walls 10, 10, joined together by a pair of intermediate walls 11, 11 which are inclined with respect to said side walls and with respect to each other, thereby providing a substantially V-shaped yieldable formation constituting a flexible compensating member or fold permitting the side walls 10, 10, to

move more or less freely toward and away from each other. The intermediate walls 11 of the upper element *b* extend downwardly and inwardly from the tops of the side walls 10 of said element and at or near their lower ends are suitably joined together. Similarly, the intermediate walls 11 of the lower element *b'* extend upwardly and inwardly from the bottoms of side walls 10 of said element and at or near their upper ends are suitably joined together. In this connection and as will be understood, either or both of the elements *b*, *b'* may be formed from a single piece of sheet metal bent into the cross sectional shape shown and described, or either or both of said elements may be formed from two or more separate pieces of metal connected together by welding, riveting or in any other suitable manner. Moreover, said elements *b*, *b'* may be formed of any desired length, or, if they are furnished in greater lengths than should be required in any particular case, they may be cut into desired length to extend continuously from end to end of any given expansion joint *a*; or, alternatively, any two slabs may be connected together by any desired number of sections of the elements *b*, *b'* arranged in end to end relationship.

Regardless of the length of the elements *b*, *b'* and regardless of whether said elements are of one-piece or plural-piece construction, the apices of the substantially V-shaped formations thereof preferably extend below and above the lower and the upper edges of the side walls 10 of said elements, respectively, and are suitably interfitted or formed and connected so as to be more or less freely movable vertically, but unmovable laterally, relative to each other. For example, in the Figs. 1 to 3 form of the invention the apex of one of said substantially V-shaped formations has the form of a channel 12 and the apex of the other of said formations is in the form of a tongue 13 disposed in said channel. As shown in the present instance the substantially V-shaped formation of the upper element *b* is provided with the channel 12 and the corresponding formation of the lower element *b'* is provided with the tongue 13 disposed in said channel. Obviously, however, this arrangement may be reversed. In any event, both the channel and the tongue preferably are coextensive in length with their related elements.

Each side wall 10 of each of the elements *b*, *b'* is suitably slitted at points suitably spaced therealong to provide a plurality of anchoring tongues 14, and, as shown, these tongues, which are vertically disposed, are bent to extend outwardly from said side walls preferably at right angles thereto. In addition, each tongue preferably has a portion 14ª thereof bent to extend laterally therefrom, the said portion 14ª preferably being of triangular shape with its base end disposed outwardly so as to have dovetail interlocking engagement with the concrete of the slab in which the tongue is embedded. Other tongues 15 are struck either from the side walls 10 or from the inclined intermediate walls 11 of the upper element *b* to extend upwardly from said element, and similar tongues 16 are struck from the lower element *b'* to extend downwardly therefrom, for purposes which will presently appear.

In constructing a concrete roadway it is usual, prior to pouring the concrete to form the slabs A, A, to suitably support a pair of spaced plates or the like at the points where the expansion joints or spaces *a* are to be formed between the slabs, thereby to prevent the concrete from flowing into said spaces. A pair of such plates are designated in Fig. 1 as 17, 17 and it is a feature of the present invention that these plates are employed to position and hold the elements *b*, *b'* in cooperative relationship to each other while the slabs A, A are being poured. The upper element *b* is engaged over the tops of the spaced apart plates 17, 17 with said plates engaging the inner faces of the side walls 10, 10 of said element and the upper edges of said plates engaged in the corners at the junctions of the respective side and inclined walls 10 and 11. The lower element *b'* is similarly engaged over the bottom portions of the plates 17, 17, and, as is understood, the height of said plates 17, 17 is such as to hold the elements *b*, *b'* in suitable vertically spaced apart relationship. Prior to pouring the concrete a strip 18 of mastic or premoulded material is provided to extend along the joint below the lower element *b'*, and a channel element 19 of inverted U-shape in cross section is placed upon the top of the upper element *b* to define the expansion space between those portions of the slabs which extend above said element *b*. The concrete then is poured and when it subsequently hardens the element 19 is removed and the space above the element *b* and between the slabs is filled with a strip 20 (see Fig. 4) of mastic or premoulded material. In this connection the tongues 15 obviously serve to correctly position the element 19 prior to pouring of the concrete and subsequently to interlock the strip 20 with the element *b*. Similarly, the tongues 16 serve to assist in interlocking the strip 18 with the lower element *b'*.

The tongues 14 preferably, but not necessarily, are formed in pairs alined transversely of the elements *b*, *b'*, and when the concrete is poured and subsequently hardens about said tongues it is apparent that they become firmly embedded in the concrete and cannot be pulled therefrom, thereby rigidly connecting the side walls 10 of the elements *b*, *b'*, with the slabs A, A. If, now, expansion or contraction of the slabs A, A occurs, with consequent relative inward or outward movement of the side walls 10, 10 of the elements *b*, *b'*, such movement obviously is permitted due to the laterally yieldable nature of the substantially V-shaped formations constituting the flexible compensating members interconnecting the side walls 10, 10, and to the connection between the apices of the substantially V-shaped formations of the respective elements *b*, *b'* permitting relative vertical movement of said formations. On the other hand, it is equally apparent that any upward or downward movement of either slab A with respect to the other slab is effectively prevented. Assuming, for example, that a load is applied to the right hand slab and the left hand slab is held against downward movement, it is apparent that the bottom of the substantially V-shaped formation of the upper element *b* would tend to move to the left and that the top of the substantially V-shaped formation of the lower element *b'* would tend to move to the right. Obviously, these two tendencies would be of equal magnitude and opposite in direction. Consequently, the two forces would exactly equal or balance and no sidewise movement of the substantially V-shaped formations would occur, inasmuch as these formations of the respective elements *b*, *b'* are interconnected against relative lateral movement. Therefore, the right hand slab could not move downwardly relative to the left hand slab, since any relative upward or downward movement of the respective side walls 10, 10 of the elements *b*, *b'* is dependent

upon lateral movement of the substantially V-shaped formation interconnecting said side walls **10, 10**.

In engineering practice it is, of course, well known that a rigid triangle is the basic principle of all structural trusses, and in this connection it will be observed that a double triangle truss is formed by the present elements *b, b'* interconnecting the slabs A, A, thereby assuring constant alinement of said slabs. In other words, it is apparent that the left hand portions of the elements *b, b'* form one triangle and that the right hand portions of said elements form a second triangle; that the outer sides of these triangles are rigid with the slabs A, A, respectively, and that said triangles intersect at the apices of the respective V-shaped formations of the elements *b, b'*. The rigid relationship of said triangles where they intersect may not be at once apparent, but by analytical study it will be found that their relationship at their points of intersection is rigid due to the arrangement whereby forces acting horizontally at their apices are equal and opposite and are guided vertically. Accordingly, it is impossible to move either triangle as a unit vertically without moving the other triangle an equal amount. The two connected slabs must, therefore, move up or down equal amounts and will always remain in perfect alinement, assuming, of course, that the sheet material comprising the elements *b, b'* is of such nature and dimensions as to carry the required joint rated load capacity.

Because of the side walls **10, 10** of the elements *b, b'* extending longitudinally of the expansion joint or space between the slabs A, A, and because of the inclined walls **11, 11** of said elements also extending longitudinally of the joint between the side walls **10, 10**, the said elements *b, b'* may be made of indefinite length and may be provided with as many anchoring tongues **14** as desired limited only by the length of the tongues because of the latter being struck from the side walls of the elements *b, b'*.

In Fig. 4 of the drawings is illustrated a slightly alternative embodiment of the invention in which the substantially V-shaped formations between the side walls of the elements *b, b'* are connected together at their apices and are held against relative lateral movement, but are permitted to move relatively vertically, by oppositely laterally disposed hollow ribs or V-shaped formations **21, 21**, as distinguished from the tongue and channel interfitting connection illustrated in Fig. 1. Obviously, the Fig. 4 construction involves the same mode of operation as the Fig. 1 construction. However, in producing the Fig. 4 construction it is preferred to form the two triangular trusses each as a unit and to weld or rivet said units together adacent to the formations **21, 21**, rather than to form upper and lower elements of M and W-shape, respectively. The Fig. 4 form of the invention may, however, be produced by forming upper and lower elements of M and W-shape, as in the case of the Fig. 1 construction.

In Fig. 5 of the drawings is illustrated another alternative embodiment which is the same as the embodiment of the invention illustrated in Fig. 4, except that only one of the triangular trusses, instead of both of them, is provided with a hollow rib or channel **21a**.

Figure 6 of the drawings illustrates another alternative embodiment of the invention in which the substantially V-shaped formations between the side walls of the upper and lower substantially M and W-shaped elements *b, b'* are connected together at their apices by a link or links **22**.

Figure 7 illustrates another alternative embodiment of the invention which differs from the Figs. 1 to 6 embodiments mainly in that the side walls **10a, 10a** of the elements *b, b'* are themselves directed outwardly and embedded in the concrete of the slabs A, A, as distinguished from being vertically disposed against the end faces of the slabs and having anchoring tongues struck therefrom. While, in Fig. 7, links have been illustrated as connecting together the apices of the substantially V-shaped formations of the respective elements *b, b'*, it is manifest that said formations may be connected together as illustrated in either Figs. 1, 4 or 5 or in any other manner such that they are held against relative horizontal movement and are permitted to move relatively vertically.

Figures 8 and 9 illustrate another alternative embodiment of the invention in which the apices of the substantially V-shaped formations of the elements *b, b'* interfit in the fashion of the leaves of a hinge and in which a rod **23** connects said formations in the fashion of a hinge pintle.

Figures 10 and 11 illustrate another alternative embodiment of the invention in which tongues **24** are struck from the side walls of each of the substantially V-shaped formations of the respective elements *b, b'* and in which the tongues of each formation overlie the sides of the apex portion of the other formation, thereby to hold the respective V-shaped formations against relative lateral movement and to permit them to move relatively vertically.

Figures 12 and 13 illustrate another alternative embodiment of the invention which is substantially the same as the Figs. 10 and 11 embodiment, except that, instead of tongues being struck from the substantially V-shaped formations themselves, tongues **25** are struck upwardly and downwardly from a strip **26** which is separate from and interposed between said V-shaped formations.

According to Figs. 12 and 13 the tongues **25** are bent from the strip **26** along lines extending longitudinally of the strip. As distinguished from this, Figs. 14 and 15 illustrate that a double channel element substantially as illustrated in Figs. 12 and 13 may be obtained by bending tongues **27** from a strip **28** along lines extending at right angles to the strip. Figs. 12 to 15 also illustrate that in order to permanently assemble the strips **26** and **28** with one of the V-shaped formations, some or all of the tongues **25** or **27** of one set may be welded to the related V-shaped formation as indicated at **29**.

Figure 16 illustrates another alternative embodiment of the invention in which an element **30** of substantially Z-shaped cross section is employed to connect the slabs A, A. The web of this element extends substantially vertically within the expansion space between the slabs and the ends of said element are anchored at vertically spaced points in the slabs. Thereby the slabs are held against relative vertical movement, but are permitted to move toward and away from each other as is apparent. The end portions of the element may be of any suitable shape for anchoring in the slabs and may be provided with anchoring tongues **31**. Also, according to this form of the invention, any suitable combination of joint plates **17a** may be em-

ployed to define the joint space between the slabs in which the web of the element **30** is disposed and, as in the case of the other forms of the invention, mastic or premoulded strips may be employed to fill the joint spaces above and below the element **30**.

Figure 17 illustrates a construction which is the same as the Fig. 16 construction, except that, instead of employing mastic or premoulded strips to fill the joint spaces above and below the slab connecting element **30a**, said spaces are closed by sheet metal channel members **32**, crimped, welded or otherwise suitably fastened to the plates **17b** and to the element **30a**. If sheet metal joint space closing elements are employed, the upper of said elements preferably is disposed a suitable distance below the top surfaces of the slabs and a mastic or preformed joint space filler strip is employed thereabout.

Figure 18 illustrates an embodiment of the invention in which the slab connecting element is of N-shape, in cross section; in which the side walls **33** of said element are suitably anchored to the respective slabs A, A, as by means of tongues **34** struck from said side walls and embedded in the concrete, and in which the web portion **35** connecting the side walls extends from the top of one side wall diagonally to the bottom of the other side wall, thereby holding the slabs against relative vertical movement, but permitting them to move toward and away from each other. In this form of the invention the expansion space between the slabs is filled by upper and lower mastic or preformed strips **36**.

In Figure 19 is illustrated an embodiment of the invention which is, in effect, a compromise between the embodiments of the invention illustrated in Figs. 16 and 18. That is to say, the connecting element includes a diagonally extending web **37** and side walls **38**, **38**, both of which extend in the same direction, in this instance upwardly, from the ends of said web, respectively. The side walls are suitably anchored, as by means of tongues **39**, to the respective slabs, and plates **17c** are employed to define the expansion space between the slabs in which the connecting element is disposed.

As will be observed, it is characteristic of all of the forms of the present invention that the yieldable formations or flexible compensating members between the sides or anchoring portions of the connecting elements are disposed vertically in the expansion joint space, as distinguished from the forms of the invention illustrated in my aforementioned prior application wherein the yieldable formations or compensating members between the anchored portions of said elements are disposed horizontally in the expansion space between the slabs.

Without further description it is thought that the features and advantages of the invention will be readily apparent to those skilled in the art, and it will of course be understood that changes in the form, proportion and minor details of construction may be resorted to, without departing from the spirit of the invention and scope of the appended claims.

I claim:—

1. Means for connecting road slabs comprising upper and lower cooperating elements of substantially M-shape and W-shape formation in cross section, respectively, means for anchoring one side wall of each element to one slab and the other side wall of each element to the other slab, and means interconnecting the intermediate apical portions produced by said formations between the side walls of the respective elements for relative vertical movement and holding the apices of said formations against relative lateral movement.

2. Means for connecting road slabs comprising upper and lower elements each having a pair of side portions for anchoring engagement with a pair of slabs, respectively, the upper element having a substantially V-shaped formation connecting the side portions thereof, the lower element having a formation of inverted substantially V-shape connecting the side portions thereof, and means interconnecting said formations at their apices for relative vertical movement and non-lateral movement.

3. Means for connecting road slabs comprising an elongated upper element of substantially M-shaped formation in cross section and a lower elongated element of substantially W-shaped formation in cross section, tongues struck outwardly from the side walls of said elements at points spaced longitudinally therealong for anchoring engagement in the respective slabs, and means interconnecting the apical portions of the substantially V-shaped and inverted substantially V-shaped portions of said formations located between the side walls of the respective elements for relative vertical movement and holding said apices against relative lateral movement.

4. Means for connecting road slabs comprising an elongated element having a pair of spaced side walls, upper and lower sets of tongues struck outwardly from said side walls at points spaced longitudinally therealong for anchoring engagement in a pair of slabs, respectively, said tongues being bent upon themselves to provide substantially right angularly related anchoring portions one of which is of triangular shape with its base disposed outwardly, and means located substantially between planes including said upper and lower sets of tongues for interconnecting said side walls for relative movement toward and away from each other and holding them against relative vertical movement.

5. Means for connecting road slabs comprising an upper element of substantially M-shaped formation in cross section, a lower element of substantially W-shaped formation in cross section, means for anchoring related side walls of said elements to a pair of slabs, respectively, and means interconnecting the apical portions of the substantially V-shaped and inverted substantially V-shaped portions of the said formations located between the side walls of the respective elements for relative vertical movement and holding said apices against relative lateral movement, said means comprising a tongue on one of said formations engaged in a channel in the other of said formations.

6. Road slab connecting means as set forth in claim 5 in which the means connecting the apices of the formations between the side walls of the respective elements comprises a rib of channel-shape in cross section.

7. Road slab connecting means as set forth in claim 5 in which the means connecting the apices of the formations between the side walls of the respective elements comprises a link.

8. Road slab connecting means as set forth in claim 5 in which the apex portions of the formations between the side walls of the respective elements are interengaged with each other and interconnected by a pin.

9. In a roadway, adjacent road slabs having an expansion space therebetween, elongated upper and lower elements within and extending longitudinally of said space, said elements being of substantially M-shape and W-shape formation in cross section, respectively, means anchoring related side walls of said elements to said slabs, respectively, and means interconnecting the apices of the intermediate substantially V-shaped and inverted substantially V-shaped portions of the said formations located between the side walls of said elements for relative vertical movement and holding them against relative lateral movement.

10. The combination as set forth in claim 9 including a strip of elastic material between the slabs above the upper element, and tongues extending from the upper element and embedded in said strip.

11. Road slab connecting means comprising upper and lower elongated elements of substantially M-shape and W-shape formations in cross section, respectively, means for rigidly anchoring related side walls of said elements to a pair of slabs, respectively, plates to hold said elements in vertically spaced relationship prior to pouring of the road slabs and to define the ends of the slabs, and means interconnecting the apices of the substantially V-shaped and substantially inverted V-shaped portions of said formations located between the side walls of the respective elements for relative vertical movement and holding them against relative lateral movement.

12. A dowel for connecting roadway slabs including upper and lower anchoring portions adapted respectively to be rigidly imbedded at upper and lower levels in the ends of adjacent slabs at different horizontal elevations, and means connecting said upper and lower anchoring portions, said means lying within the space between the slabs at an angle oblique to a plane perpendicular to the surface of the slabs and providing vertically disaligned horizontal hinging axes for permitting relative horizontal movement between the slabs but resisting vertical movement thereof.

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