Nov. 11, 1969 U. FINSTERWALDER ET AL 3,477,080

ELEVATED HIGHWAY STRUCTURES OF PRESTRESSED CONCRETE

Filed July 21, 1967 4 Sheets-Sheet 1

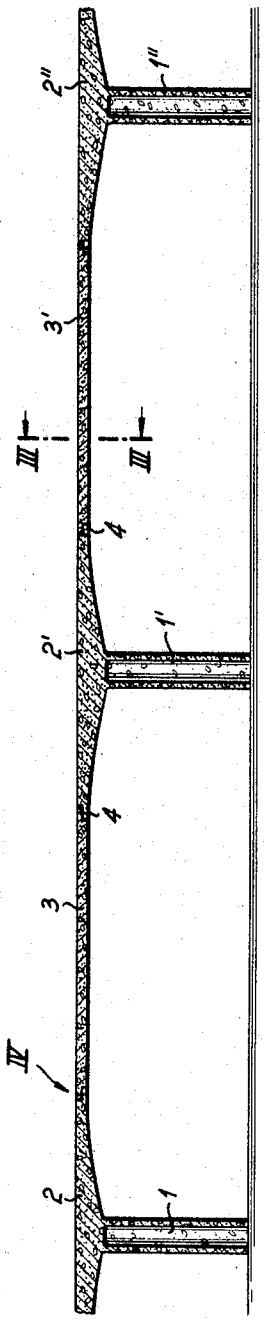

FIG. 1

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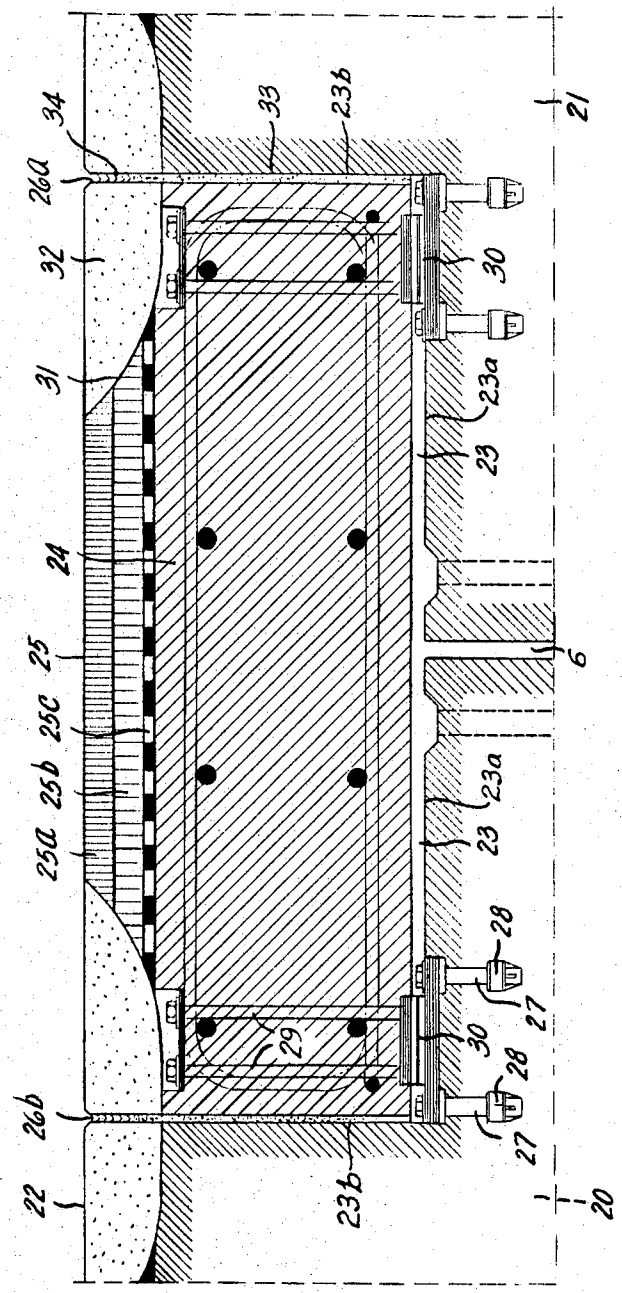
FIG. 2.



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ELEVATED HIGHWAY STRUCTURES OF PRESTRESSED CONCRETE

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FIG. 3.

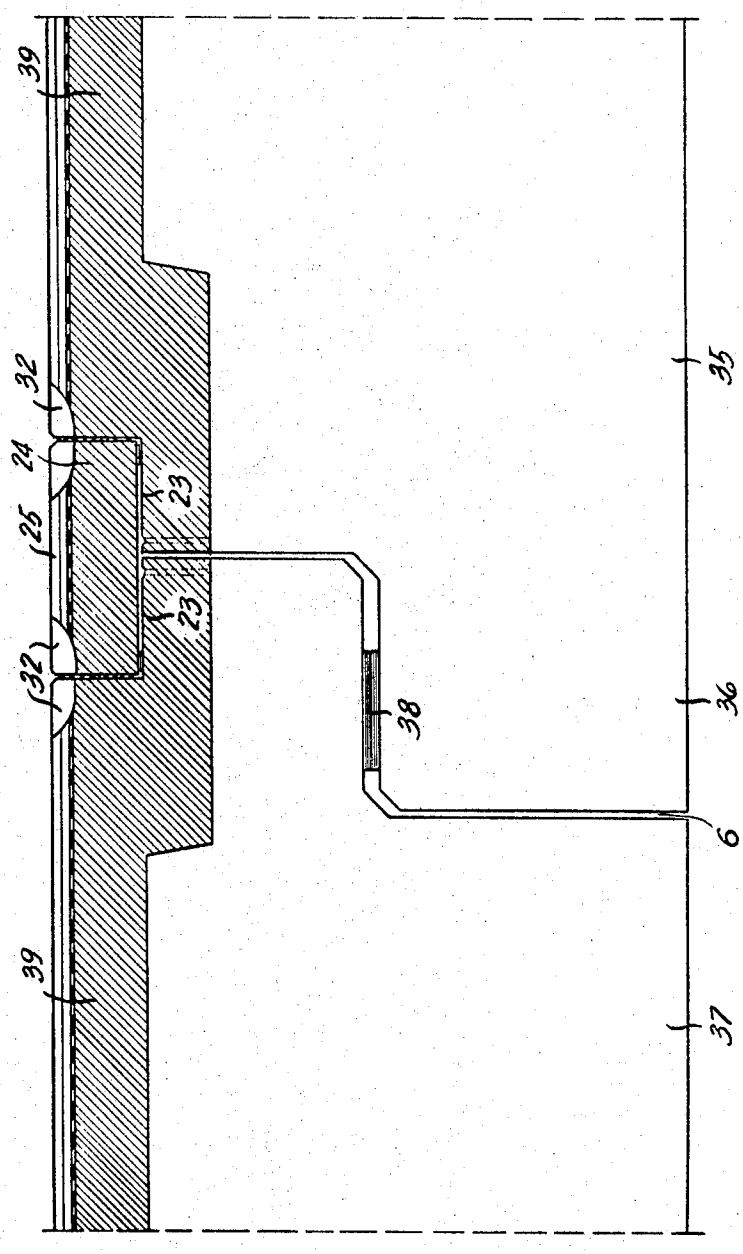

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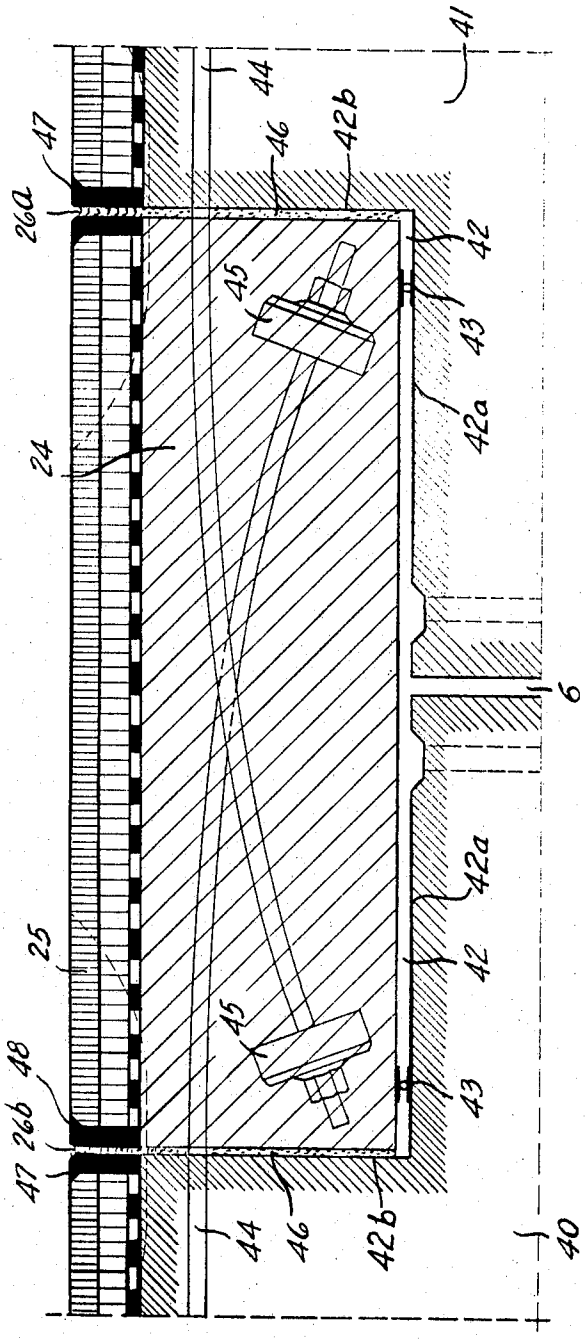
FIG. 4.



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3,477,080

ELEVATED HIGHWAY STRUCTURES OF PRESTRESSED CONCRETE

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Continuation-in-part of application Ser. No. 284,797, May 29, 1963. This application July 21, 1967, Ser. No. 655,070

Claims priority, application Germany, June 1, 1962, D 39,057, D 39,058; Mar. 28, 1963, 1,243,711; Mar. 25, 1967, 1,658,446

Int. Cl. E01d 19/06; E01c 11/04

U.S. Cl. 14—16 5 Claims

ABSTRACT OF THE DISCLOSURE

Elevated highway or bridge construction where concrete elements of generally mushroom-like shape are supported on columns from which they extend in all directions to form rectangular or rhombohedral slabs which are placed at regular intervals, and the gaps between them are bridged by spans of concrete having ends defining inverted steps resting on corresponding step-like configurations formed at the adjacent ends of the supporting slabs with expansion compensating joint configurations between the ends of the support slabs and of the suspended spans.

BACKGROUND OF THE INVENTION

The present application is a continuation in part of Ser. No. 284,797 filed May 29, 1963, by Ulrich Finsterwalder which covers a method and apparatus for constructing prestressed concrete highways in accordance with the invention disclosed in Ser. No. 284,797, while this application covers certain improvements in the highway structure per se, particularly new types of expansion joints which connect adjacent surface supporting elements of the structure. While the fundamental principles of the invention have been disclosed generically in the parent application, Ser. No. 284,797 as illustrated in FIG. 1 of the present application, the additional specific features shown in FIGS. 2 to 4 constitute subject matter of the present continuation in part application which is the joint disclosure of Ulrich Finsterwalder and Klemens Finsterwalder.

The invention is particularly concerned with an elevated highway of the type disclosed in the parent case and the construction of joints for connecting the supported sections with the sections which cantilever out from column-like supports.

DESCRIPTION OF THE PRIOR ART

In known elevated highways of the kind specified, substantially square carriageway slab sections cantilever out freely in all directions from all the intermediate columns, such sections being disposed immediately adjacent one another. This leads to a relatively large number of expansion joints. In supporting structures of this kind, the between-suports distances, and therefore the between-joints distances, are something like 30 meters. These joints, which must be bridged by appropriate constructions, must in any case be considered weak points since the carriageway surfacing is interrupted at the joint and since the conventional steel transition disturbs traffic, wears, and requires constant attention.

The nearer the supports are to one another, the greater is the number of joints. Where the supports are not so far apart, the movements to be dealt with and evened out are much less and the joints can be of much simpler

construction than when the supports are far apart from one another. Constructions with closely spaced columns, however, have proved unsatisfactory for elevated highways because there are so many joint transitions, each of which is noted as an impact by the vehicles passing over them, that the transitions are a disturbance to comfort and even to road safety.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an elevated highway which obviates the disadvantages of the known constructions, i.e., the reduced separation between joints and the considerable overall height near the supports, but loses none of the advantages of the known constructions, which advantages reside more particularly in the statically very desirable mushroom shape of the supports.

According to the invention, therefore, in an elevated highway of the kind specified with carriageway portions cantilevering out from central supports, further slab-like sections are placed lengthwise of the carriageway between the cantilever sections and freely supported on the ends thereof; resilient tensioning members which are rigidly anchored in the contiguous sections and which extend through the expansion joints interconnect the cantilever sections and the sections therbetween; and means are provided so to distribute the total changes in length caused by temperature differences over an appropriately long stretch of the, for instance, asphalt carriageway surfacing covering over the joint that such surfacing is not impaired by changes in length.

The provision of a freely borne support or bearer—known as a suspended span—between every pair of mushrom sections means that, as compared with the prior art, the negative bending moments near the support can be reduced considerably for a given span, so that the overall height of the bearing construction can be reduced. The height of the suspended span is, for instance, only about $\frac{1}{25}$ of its span or $\frac{1}{50}$ of the bridge span. This reduced height, which is barely half as much as the height of the thinnest prestressed concrete bridge beams prveiously known, is operative for $\frac{5}{8}$ of the total span, i.e., as far as the connection to the mushroom section.

A suspended span having twice as many cross-joints as the prior art elevated highway is the result of a special construction of the carriageway transitions at the expansion joints, such that the carriageway surfacing can extend uninterruptedly and uniformly over the whole length of the bridge. It is therefore another object of the invention so to construct the joints that there is a smooth connection between the various components of the elevated highway, i.e., between the mushroom supports and the spans suspended between them. It was recognized that the joints need not be uniformly distributed throughout bridge length but can be placed correspondingly closer together if means are provided for distributing changes in length at the expansion joints between the various elements of the construction over a distance sufficient to ensure that such changes do not impair the carriageway surfacing.

According to the invention, therefore, the tensioning members interconnecting the structural elements which abut one another at the expansion joints are in the form of tendons extending through concrete joists which are pierced transversely of their longitudinal axis and which are mounted for displacement and closely adjacent one another, transversely of bridge length, in a recess in one element, while the joists are covered by the continuous carriageway surfacing above them.

In accordance with a further embodiment of the invention a structural element having the shape of a beam the cross section of which is preferably a flat rectangle, which

is disposed parallel to and bridges the expansion joint and located in recesses of the adjacent sections of the highway and supported to yield elastically in horizontal direction that it maintains its position relative to the joint for any opening width and that the runway cover passes over the structural element where it is interrupted at extensions of the gap between the element and the adjacent sections of the highway. This structural element is suitably made of steel reinforced concrete and preferably prefabricated.

By providing a single structural element in the form of a beam transversely of the highway and symmetrically with respect to the expansion joint, the entire change in length of the adjoining highway sections that must be absorbed by the expansion joint or gap is distributed among two slots between the structural element and the adjacent highway sections. Inasmuch as the expansion gap construction in accordance with the invention is intended primarily for supporting structures of relatively short length, the expansion in length apportioned to each of the individual slots becomes only so large as a result of the division of the total expansion, that no load absorbing slot bridging means are needed and that only a seal needs to be provided in the individual slot. Due to the particular placement of the beam shaped element eventual vertical displacements and angular twisting are made possible without introducing restraining means, to be sure, but their effects on the runway cover are made negligible.

The beam shaped structural element may be connected with the adjacent highway sections in a manner known per se by elastic, yielding pull members, that are under tension for any gap width. However, in accordance with a particularly advantageous embodiment of the invention it may also be placed upon rubber-metal elements, known per se, which on the one hand are connected with the highway sections and on the other hand with the structural element proper. Both possibilities safeguard that the beam shaped element maintains for any gap width its relative position thereto, so that exact division of the expansion gap into two parts is obtained.

Since the runway layer or cover is to be interrupted in the area of the slots between the structural element and the adjoining sections of the highway, the slots have to be secured in the upper part of the runway cover. The slots can be filled with a sealing substance which elastically follows the changes in form.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention in the form of an elevated highway will now be described by way of example and with reference to the accompanying drawings wherein:

FIGURE 1 is a longitudinal section through an elevated highway;

FIGURE 2 is a section showing one embodiment of joint construction;

FIGURE 3 is a further section of the embodiment in accordance with FIGURE 2 drawn to a smaller scale; and

FIGURE 4 is a section of a further embodiment of a joint similar to that in FIGURE 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An elevated highway according to the invention comprises supports or columns or the like **1**, **1'**, **1''** and so on, disposed at appropriate distances apart from one another. The supports have mushroom-like tops forming slabs which extend in all directions so that widened parts **2**, **2'**, **2''** are produced which form the carriageway. The gaps between the mushrooms or slabs are bridged by means of flat suspended spans **3**, **3'** or the like supported on bracket-like steps **4** as in FIG. 1, or **36** as seen in FIG. 3 and which project from the widened parts **2** (or **35**, FIG. 3). Sliding bearings **5** are interposed between the part **4** and the suspended span **3**. These bearings are shown in FIG. 3 at **38** between slab ends **35**, **37**. Variations in length of the superstructure due to temperature differences are taken up by gaps **6**. The suspension spans **3**, **3'** can be strengthened in the region of carriageways. The length of the suspended span **3** is about half the distance between two adjacent supports. For instance, span length is about 15 meters if the between-supports distance is 30 meters.

Embodiments of the joint construction in accordance with the invention are illustrated in FIGS. 2 and 4 between two sections or supported slabs **20** and **21** of a highway **22** which adjoin at an expansion joint **6**. The sections **20** and **21** (or **35**, **37** in FIG. 3 or **40**, **41** in FIG. 4) are provided in their upper parts proximate the gap **6** with recesses **23** (FIG. 3, or **42** FIG. 4) into which has been placed a structural element **24** in the form of a beam that extends parallel to the joint **6**. Each recess has a horizontal bottom surface **23***a* and two generally vertical sides **23***b* (**42***a*, **42***b*, respectively, in FIG. 4). The structural element **24** is of flat rectangular cross section and is so dimensioned that it fills the recesses, except for minor gaps, and that the runway cover or surfacing **25** can be passed over the structural element. In lieu of the expansion joint **6** there appear in the runway surface **25** two gaps **26***a* and **26***b*. The runway surfacing consists, for example, of a wear layer **25***a* which is arranged upon a supporting layer **25***b* over an insulating layer **25***c*. In the embodiment shown in FIG. 2 the beam **24** rests on rubber bearings or supports **30**, which on the one hand are rigidly connected with the concrete of the highway sections or slabs **20** and **21** and, on the other hand, with the beam **24**. The fastening of the rubber bearings is effected by threaded bolts **27** which are threaded into threaded sleeves **28** embedded in the concrete as well as by anchoring means such as threaded bolts **29** which pass through the beam **24**.

In the illustrated embodiment of a joint construction any movement of the gap **6** is divided into halves between the gaps **26***a* and **26***b*. This even distribution is obtained by the rubber bearings **30** which can be subjected to tension as well as to pressure.

The edges of the gaps **26***a* and **26***b* passing through the runway surfacing **25** must be protected, because the runway surface does not have sufficient rigidness. This is effected in a particularly suitable manner in that the runway surface is reinforced in the area of the gap by inlays of highly solid or rigid plastic. In the example of FIG. 2 it is indicated how slots **31** are produced through the gaps **26***a* and **26***b* in the runway surface at short distances transversely of the gaps which suitably extend into the concrete of the structure. These slots **31** are subsequently filled with a highly solid plastic material which must rigidly adhere to the material of the runway surface, and which may be enriched with quartz, sand and/or glass fibers for increasing the rigidness. Upon hardening of this mixture of plastic material the actual gap is cut in above the original movable gap.

The gaps now remaining in the surface are sealed against the penetration of water. This can suitably be effected by building in elastically yielding materials in a known manner, but also by inserting a material known under the name "Compriband." This sealing strip consists of a foam rubber type material saturated with bitumen, which can be compressed to about 20% of its thickness and will remain in this condition for a long time, whereupon it will resume its original thickness. It is advisable to arrange this sealing strip only in the lower part of the movable gaps **26***a* and **26***b*, as indicated at **33** in FIG. 2, and to seal or close the upper part with a rubber member **34** known per se, for example of neoprene, which serves the purpose of preventing smaller foreign bodies from penetrating into the gap. Such gap seals are on the market, for example, under the name "Dupon Gap Inserts." If only very small gap movements are to be expected, then the reinforcement of the surface and a special seal of the gaps

by a rubber body may be foregone. The sealing in this case is then brought up to the surface of the runway surfacing.

FIGURE 3 shows to a smaller scale the introduction of the expansion joint construction in accordance with the invention in the top of a bridge construction. A cantilever support or slab **35** is indicated which terminates in a ledge **36** upon which a hanging slab or support **37** rests on a bearing **38**. The runway plate **39** passing over the supports is thickened in the region of the gap. The concrete beam **24** rests in the recesses **23** over which the runway cover **25** is passed. The reinforcement **32** of the edges of the gap is the same as in the example in accordance with FIG. 2.

A further possibility of arranging the beam type structural element **24** in the region of a gap of the structure is indicated in FIG. 4. Here the adjacent structural elements are indicated at **40** and **41**. Also these are provided with recesses **42** in which the prefabricated beam **24** rests on bearings **43** and fills the recesses. Tensioning or anchoring elements **44** extend from both structural parts **40** and **41** into the concrete beam **24**, which elements cross one another in its cross section and are anchored at the opposite ends by means of anchoring means **45**, known per se. The gaps between the concrete body or beam **24** and the recesses can be lined in a known manner with foam material **46**.

The interruptions in the runway surfacing are shaped and constructed in this embodiment as follows:

In the runway surface **25** that is still uninterrupted, a notch **47** is cut to the desired depth, for example by means of a milling cutter, as the first operation. In the embodiment illustrated this notch is carried down into the insulating layer. After the breaking of the sharp edges of the notch a highly solid plastic material **48** is pressed in, but which is still soft at the time it is inserted and is so worked that the surface of the plastic mass **48** is in alignment with the surface of the runway surfacing and completely fills the wedge. After hardening of the plastic mass an incision is made in a further operation longitudinally of the mass and of the required width of the final joint gap **26***a*, **26***b*. This incision may go as far as the plastic mass **48** but can also be passed through the runway surfacing below this mass into the insulation. Suitably the joint gap can still be filled by elastic seals **46**.

The low overall height achieved by using suspension spans is useful in planning urban elevated highways, more particularly because the distance between the level of the bottom highway and the level of the top highway can be kept to a minimum, with a corresponding reduction in the lengths and heights of the associated slip roads and their construction. The columns, which are secured in the foundation and in the mushroom head, can have the lowest cross-section which is statically necessary, since no spaced is required for bearings. The lower road is therefore kept substantially free from connections to the upper road.

The building system described above also makes it possible to produce bridge spans which in plan are curved, since only bridge sections of the length of about half a span are concreted at any one time and it is a relatively simple matter to move the scaffold bearer used in the construction along a curve.

Having now described our invention with reference to the embodiments illustrated in the drawings, what we desire to protect by letters patent of the United States is set forth in the appended claims.

We claim:

1. In an elevated highway or bridge structure of concrete of the type comprising supports disposed at intervals, supporting slabs cantilevering freely out from said supports and recessed along opposite upper edges to provide supporting ledges, and a supported slab disposed intermediate and bridging a pair of said supporting slabs, said supported slab being recessed along opposite lower edges to define cooperating ledges seated on said supporting ledges, said supporting ledges and said cooperating ledges having vertical surfaces spaced to define an expansion gap, continuous upper edges of said slabs defining a recess having a bottom spaced above said ledges and having spaced vertical sides on opposite sides of said expansion gap and above said ledges, a structural element having the cross section of a beam disposed in said recess and extending parallel to, across and above said expansion gap, the sides of said element and said vertical sides of said recess defining slots therebetween, supporting bearings on the bottom surface of said recess below opposite sides of said element adjacent said slots, and anchoring elements extending from said element proximate one side thereof into the proximate portion of a supporting slab and from proximate the other side thereof into the proximate portion of a supported slab.

2. An expansion gap as set forth in claim **1**, where said structural element is reinforced concrete.

3. An expansion gap in accordance with claim **2**, where said anchoring elements are tensioning elements extending from adjacent slab sections into said structural element to proximate the opposite side thereof and being under tension for any condition of spacing between the ends of the slabs defining the expansion joint.

4. An expansion gap in accordance with claim **1**, where said supporting bearings are anchored to the bottom of said element and to an adjacent surface portion of a slab.

5. An expansion gap in accordance with claim **1**, where said slots present edge portions at the upper end portions thereof proximate the runway surface, said edge portions being reinforced, and an elastic sealing substance adapted to follow changes in the form of the expansion gap being disposed in said slots.

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JACOB L. NACKENOFF, Primary Examiner

U.S. Cl. X.R.

14—1; 52—263, 251, 227; 94—1, 18

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,477,080 November 11, 196

Ulrich Finsterwalder et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 37, "joint" should read -- gap --.

Signed and sealed this 21st day of April 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents