

(19)



(11)

EP 2 749 696 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.07.2014 Bulletin 2014/27

(51) Int Cl.:
E01D 19/06^(2006.01)

(21) Application number: **12199747.2**

(22) Date of filing: **28.12.2012**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME

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(54) **Roadway section including an expansion joint device with an exchangeable cartridge**

(57) Provided is a roadway section (100) including a concrete substructure (110), an asphaltic concrete top structure (120), and an expansion joint device (122) that includes:

- a permanent cradle (210), disposed at a joint end (112) of the roadway section (100) and extending over substantially an entire length thereof, said cradle comprising at least one anchor (214, 216) embedded in the substructure (110) to permanently connect the permanent cradle thereto, and at least one cradle engagement provision (218);
- an exchangeable cartridge (230) comprising a cartridge

interface portion (232) that is disposed on the permanent cradle (210), and that defines at least one cartridge engagement provision (234);

- sacrificial connection means (250) that engage both the at least one cradle engagement provision (218) and the at least one cartridge engagement provision (234) to releasably fixedly connect the exchangeable cartridge (230) to the permanent cradle (210), wherein the sacrificial connection means (250) include at least one sacrificial connection member (252) that is configured to be sacrificed upon disconnection of the exchangeable cartridge from the permanent cradle.

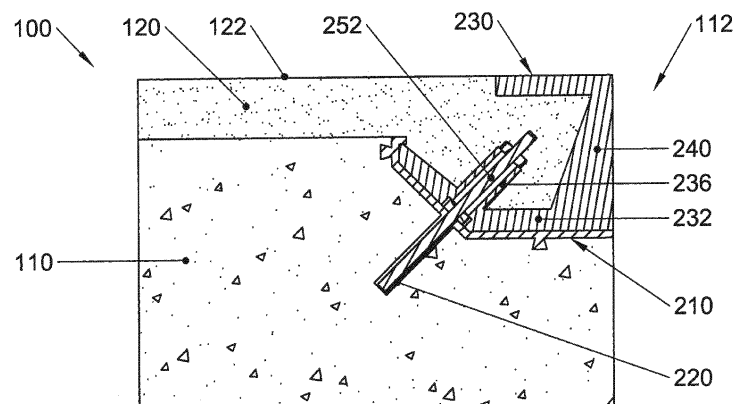


Fig. 2E

Description

Field of the invention

[0001] The present invention relates to an expansion joint system for roadways.

Background

[0002] Expansion joints are commonly applied between two roadway sections of a structural work, e.g. an overpass or a bridge, and serve to interconnect the roadway sections in such a way that they may still exhibit expansion and contraction due to temperature changes. A known drawback of expansion joints is that their service life is generally short (often below 10 years) and significantly shorter than the expected service life of the structural work (for a bridge, typically over 50 years).

[0003] The required periodic inspections of expansion joints and subsequent interventions thereon in the form of repair or full replacement, cause them to have relatively high maintenance costs. Typically, maintenance may require the demolition and removal of the old impaired expansion joint to be replaced, the reparation of damage to the structural work done by removing the old expansion joint, and the application of a new expansion joint. Furthermore, because lanes need to be cut to complete the interventions, inconvenience results to the normal flow of traffic, which penalizes users and the reputation of the entities responsible for the use of the roadways.

[0004] All in all, the replacement of expansion joints is a costly and time consuming process that forms a dominant limiting factor in the planning of road maintenance.

Summary of the invention

[0005] It is an object of the present invention to provide for a expansion joint system for roadways that facilitates interventions on expansion joints, in particular the replacement thereof, so as to decrease the time involved to perform these interventions and to lower the overall maintenance costs of the expansion joints.

[0006] To this end, a first aspect of the present invention is directed to a roadway section. The roadway section may include a typically concrete substructure having a longitudinally extending joint end that is intended to be disposed opposite a joint end of a further roadway section, such that a gap exists between said joint ends to allow the roadway sections to expand, and a typically asphaltic concrete top structure disposed on top of said substructure and providing for a road surface. The roadway section may further include an expansion joint device. The expansion joint device may include a permanent cradle, disposed at said joint end and extending over substantially an entire length thereof, preferably at a level below said road surface. The permanent cradle may comprise at least one anchor embedded in the substructure to permanently connect the permanent cradle

thereto, and at least one cradle engagement provision. The expansion joint device may further include an exchangeable cartridge comprising a cartridge interface portion that is disposed on the permanent cradle, and that defines at least one cartridge engagement provision. The exchangeable cartridge may also comprise an expansion joint portion that is fixedly connected to the cartridge interface portion and that provides for at least part of an expansion joint configured to bridge the gap. The expansion joint device may further include at least one sacrificial connection member that engages both the at least one cradle engagement provision and the at least one cartridge engagement provision to releasably fixedly connect the exchangeable cartridge to the permanent cradle, wherein the sacrificial connection member is configured to be sacrificed upon disconnection of the exchangeable cartridge from the permanent cradle.

[0007] The presently disclosed expansion joint system features an expansion joint device that conceptually consist of three parts: a permanent cradle, an exchangeable cartridge, and sacrificial connection means including at least one sacrificial connection member. The permanent cradle is the part of the expansion joint device that is to be permanently integrated with the substructure of a roadway section of a structural work. It may be applied once when the structural work is constructed, and is not to be removed during its subsequent life, not even during replacement of the expansion joint that the expansion joint device provides for. The permanent cradle is configured to detachably receive an exchangeable cartridge, which may include an expansion joint portion that provides for at least part of an expansion joint. During replacement of an expansion joint, the exchangeable cartridge providing for the old expansion joint may be quickly demolished and removed, and a new exchangeable cartridge providing for a new expansion joint may be installed. In this process, the cradle serves to protect the substructure of the roadway section against damage. The key to the quick demolition and removal of the exchangeable cartridge is formed by the sacrificial connection member of the sacrificial connection means. This sacrificial connection member, which releasably fixedly connects the exchangeable cartridge to the permanent cradle, may have a known position and orientation within the expansion joint device. Accordingly, it may be targeted directly and with precision in order to break it, and to release the exchangeable cartridge. The expansion joint device may preferably be designed such that the loads thereon, due to traffic and settling of the substructures, are primarily accommodated by the exchangeable cartridge. Accordingly, during use, the cartridge may be considered to protect the cradle.

[0008] It is understood that the expansion joint device enables the quick replacement of expansion joints, and may thus contribute to lowering the time and costs involved in expansion joint maintenance. Furthermore, the expansion joint device allows for a high level of standardisation and exchangeability: the permanent cradle

may provide for a universal interface to which complementary exchangeable cartridges providing for different expansion joints and/or produced by different manufacturers may be releasably connected.

[0009] A second aspect of the present invention is directed to a method of manufacturing a roadway section according to the first aspect of the invention. The method may comprise pouring concrete to form the substructure of the roadway section while embedding the at least one anchor of the permanent cradle therein, such that, once the concrete has cured, the permanent cradle is permanently connected to the substructure. The method may further comprise releasably fixedly connecting the exchangeable cartridge to the permanent cradle by means of the at least one sacrificial connection member. The method may also comprise applying the top structure over the substructure and, optionally, also over at least part of the expansion joint expansion device. In the latter case, the top structure may be provided such that at least the permanent cradle and the cartridge interface portion of the exchangeable cartridge are disposed below the road surface provided by the top structure.

[0010] A third aspect of the present invention is directed to a method of replacing an expansion joint in a roadway section according to the first aspect of the invention. The method may comprise cutting, e.g. milling, through the sacrificial connection member, and removing the exchangeable cartridge and any pieces of the sacrificial connection member from the permanent cradle. The method may further comprise providing a replacement exchangeable cartridge and at least one replacement sacrificial connection member, and releasably fixedly connecting the replacement exchangeable cartridge to the permanent cradle by means of the at least one replacement sacrificial connection member. The method may - in particular in case the top structure was damaged during removal of the exchangeable cartridge - also comprise re-applying a top structure over at least part of the expansion joint expansion device, such that at least the permanent cradle and the cartridge interface portion of the replacement exchangeable cartridge are covered and/or disposed below the road surface provided by the top structure.

[0011] These and other features and advantages of the invention will be more fully understood from the following detailed description of certain embodiments of the invention, taken together with the accompanying drawings, which are meant to illustrate and not to limit the invention.

Brief description of the drawings

[0012]

Figs. 1A-C schematically illustrate an exemplary embodiment of an expansion joint device according to the present disclosure, once in a side perspective view (Fig. 1A), once in a back bottom perspective

view (Fig. 1B), and once in an exploded view (Fig. 1C);

Figs. 2A-E schematically illustrate in a series of transverse cross-sectional side view a method of manufacturing a roadway section comprising the expansion joint device of Fig. 1;

Figs. 3A-C schematically illustrate in a series of transverse cross-sectional side view a method of replacing an expansion joint in a roadway section as shown in Fig. 2E; and

Fig. 4 schematically illustrates in a transverse cross-sectional side view a roadway structure including two roadway sections whose opposing joint ends are provided with respective expansion joint devices, each featuring a customized exchangeable cartridge that provides for a nosing joint to bridge the gap between them.

Detailed description

[0013] Figs. 1A-C schematically illustrate an exemplary embodiment of an expansion joint device 200 according to the present disclosure, once in a side perspective view and a back bottom perspective view of the expansion joint device in an assembled state, respectively (Fig. 1A-B), and once in an exploded view (Fig. 1C). In addition, Fig. 2E schematically illustrates in a transverse cross-sectional side view a roadway section 100 according to the present disclosure, including a substructure 110 whose joint end 112 is provided with the expansion joint device 200 shown in Fig. 1.

[0014] Below, the construction of the expansion joint device 200 and the roadway section 100 according to the present disclosure are described first, where appropriate with reference to in particular Figs. 1A-C and Fig. 2E. Directly thereafter a method of manufacturing of the roadway section 100, and a method of replacing the expansion joint provided by the expansion joint device 200 incorporated therein, are discussed.

[0015] Referring now to in particular Figs. 1A-C and Fig. 2E. The joint expansion device 200 according to the present disclosure may be regarded to be comprised of three conceptually different parts: a permanent cradle 210, an exchangeable cartridge 230, and sacrificial connection means 250 including at least one sacrificial connection member 252.

[0016] The permanent cradle 210 is the part of the expansion joint device 200 that is configured to be permanently, fixedly connected to a substructure 110 of a roadway section 100, and that is not intended to be separated therefrom during the technical life span thereof. This life span may typically be in the range of 30-70 years. Within a roadway section 100 or similar structural work, the permanent cradle 210 may typically be arranged below (a level of) the road surface 122, and thus be hidden from the eye, as shown in Fig. 2E.

[0017] The permanent cradle 210 may include a base member 212, which may have a substantially uniform

transverse cross-sectional profile over the length of the joint end 112. The base member 212 may be manufactured from a typically metal, e.g. stainless steel, sheet or plate material, having a thickness in the range of about 10 ± 4 mm. The sheet material may have been bent around a number of mutually parallel, longitudinally extending bend axes to create a plurality of typically flat sections 212a-d, of which adjacent sections, e.g. sections 212a and 212b, may extend at an angle relative to each other. Viewed on end, the sections 212a-d may together define the transverse cross-sectional profile of the base member 212.

[0018] Installed in a roadway section 100, the base member 212 of the permanent cradle 210 may be at least partially received in a longitudinally extending cut-out 114 in the substructure 110 thereof. To warrant a reliable installation, the sections 212a-d of the base member 212 may typically include at least two main or support sections 212a, 212c, each having a substructure-abutting side for direct connection to/abutment against wall portions of the cut-out 114. In a preferred embodiment, the two main sections 212a, 212c may extend at approximately right angles relative to each other, and be configured to abut against substantially horizontally and vertically extending wall portions 114a, 114c of the cut-out 114, respectively; see Fig. 2A. In the depicted embodiment of the roadway section 100, the inclined intermediate section 212b may also be regarded as a main section as it is in abutment with an inclined wall portion 114c of the cut-out 114; see Fig. 2C. In other embodiments of the roadway section 100, however, such as in an embodiment wherein the cut-out 114 in the substructure is of a rectangular shape, the intermediate section 212b need not directly contact wall portions of the cut-out 114.

[0019] To enable the base member 212 to be fixedly connected to the substructure 110, in particular the substructure-abutting sides of its main sections 212a, 212c may be provided with at least one, and typically a plurality of anchors 214, 216. The anchors 214, 216 may have been manufactured separately and subsequently been connected to the substructure-abutting sides of the main sections 212a, 212b, for instance through welding. In one embodiment, the anchors 214, 216 may take the form of protrusions that can be embedded in the substructure 110 and that are shaped to resist release therefrom. In the depicted exemplary embodiment, the anchor protrusions 214, 216 are frusto-conically shaped. It is contemplated, however, that different embodiments may feature differently shaped anchors. In an alternative embodiment, for instance, curved anchor bars or cables may extend continuously between the substructure-abutting sides of the main sections 212a, 212c. In yet another embodiment, the substructure-embedded socket 220 of the cradle engagement provision 218 (to be discussed infra) may be provided with a non-smooth outer surface structure, for instance including radially extending protrusions, that enables it to serve as an anchor. The main sections 212a, 212c may be interconnected by the al-

ready mentioned intermediate section 212b. The intermediate section may include an angle $180^\circ - \varphi$ with the first main section 212a, with $0^\circ < \varphi < 90^\circ$, such that when, in use, the main section 212a is arranged parallel to the road surface 122 of a roadway section 100, a plane of the intermediate section 212b includes an acute angle φ with a plane of the road surface 122 (see Fig. 2B and Fig. 3A). The angle φ may be relevant in the method of replacing the expansion joint provided by the expansion joint device 100, as is elucidated infra.

[0020] The sections 212a-d of the transverse cross-sectional profile of the base member 210 may further include a typically relatively small catch or hook section 212d. This catch section 212d may be exclusively connected to second main section 212c, and preferably include an angle $\leq 90^\circ$ therewith. As is clarified infra, the catch section 212d may serve as a catch for the cartridge interface portion 232 of the exchangeable cartridge 230, and facilitate the controlled removal of the exchangeable cartridge 230 from the permanent cradle 210 as it allows the exchangeable cartridge 230 to be rotated around a longitudinally extending contact line between the longitudinally extending tip 233 of the second section 232b of the cartridge interface portion 232 and the lower side of the longitudinally extending catch section 212d (see Fig. 3B).

[0021] The permanent cradle 210 may also comprise at least one cradle engagement provision 218. As in the depicted embodiment, the cradle engagement provision 218 may include an optionally cylinder jacket-shaped socket, bushing or sleeve 220 defining a threaded bore 222 that is configured to receive the sacrificial connection member 252. The socket 220 may be connected to the base member 212, for instance to the substructure-abutting inclined intermediate section 212b thereof, preferably such that an axis of the bore 222 extends perpendicular to the longitudinal direction L of the permanent cradle 210.

[0022] It is understood that the permanent cradle 210 may in practice have a length that corresponds to a length of a joint end 112, which length may vary per specific situation. To accommodate the variation in joint end lengths, the permanent cradle 210 and the exchangeable cartridge 230 of an expansion joint device 200 may preferably be manufactured in long segments, which may be cut to a desired length in-situ. Accordingly, both the anchors 214, 216 and/or the cradle engagement provisions 218 may be provided in a respective predetermined longitudinal pattern. This pattern may preferably repeat itself at least every 50 cm, so as to enable a proper connection to a substructure 110 of practically any length. In one embodiment, for instance, the anchors 214, 216 and/or the cradle engagement provisions may be mutually longitudinally, equidistantly spaced apart at a distance of about 10-30 cm.

[0023] The exchangeable cartridge 230 is the part of the expansion joint device 200 that is configured to be releasably fixedly connected to the permanent cradle

210. The exchangeable cartridge 230 may provide for the actual expansion joint. Accordingly, its releasable connection to the permanent cradle 210 may enable the expansion joint to be replaced by disconnecting and removing the exchangeable cartridge 230 from the permanent cradle 210, and replacing the removed exchangeable cartridge 230 with a new one.

[0024] The exchangeable cartridge may include two conceptually different portions: a cartridge interface portion 232, and an expansion joint portion 240.

[0025] The cartridge interface portion 232 may be the exchangeable cartridge's analogue of the base member 212 of the permanent cradle 210. It may have a substantially uniform transverse cross-sectional profile over the length of the joint end 112. The cartridge interface portion 232 may be manufactured from a typically metal, e.g. stainless steel, sheet or plate material, having a thickness in the range of about 10 ± 4 mm. The sheet material may have been bent around a number of mutually parallel, longitudinally extending bend axes to create a plurality of sections 232a-b. Viewed on end, the sections 232a-b may together define the transverse cross-sectional profile of the cartridge interface portion 232. Each of the sections 232a-b may define a permanent cradle-abutting side that is configured to mate with an exchangeable cartridge-abutting side of a respective section 212a-b of the base member 212. In the depicted embodiment, for instance, the permanent cradle-abutting side of the first section 232a of the cartridge interface portion 232 is configured to mate with the exchangeable cartridge-abutting side of the first main section 212a of the base member 212, and the permanent cradle-abutting side of the second section 232b of the cartridge interface portion 232 is configured to mate with the exchangeable cartridge-abutting side of the intermediate section 212b of the base member 212.

[0026] The cartridge interface portion 232 may be provided with at least one cartridge engagement provision 234. As in the depicted embodiment, the at least one cartridge engagement provision 234 may include an optionally cylinder jacket-shaped socket, bushing or sleeve 236 defining an unthreaded bore 238 that is configured to receive a sacrificial connection member 252. A diameter of the unthreaded bore 238 may be significantly greater than a diameter of the sacrificial connection member 232, so as to provide for some play. The socket 236 of the at least one cartridge engagement provision 234 may be connected to the section 232b of the cartridge interface portion 232 whose permanent cradle-abutting side mates with the section 212b of the base member 212 to which the socket 220 of the cradle engagement provision 218 is connected, preferably such that the axes of their respective bores 222, 238 are in alignment. In case the exchangeable cartridge 230 includes multiple cartridge engagement provisions 234, these provisions may preferably be identical, and be longitudinally spaced apart according to a predetermined longitudinal pattern, which may, of course, preferably correspond to the lon-

gitudinal pattern according to which the cradle engagement provisions 218 are spaced apart. The expansion joint portion 240 of the exchangeable cartridge may be fixedly connected to the cartridge interface portion 232, and provide for at least part of an expansion joint. That is, the expansion joint portion 240, which may be prefabricated (ex-situ), may effectively mimic a joint end of a conventional roadway section that is provided with an expansion joint of an arbitrary type. Because of this versatility the expansion joint portion is depicted in the Figures without any particular structural features, except in Fig. 4. Fig. 4, shows, by way of example, a roadway structure comprising a first 100 and a second 100' roadway section, whose joint ends are disposed opposite to each other, such that a gap 300 exists between them. Here, the customized expansion joint portions 240, 240' of the exchangeable cartridges provide for a nosing joint with flexible elastomeric strips. It is understood, however, that the expansion joint portion 240 may in principle provide for any type of expansion joint, such as, for instance, open joints, buried joints under continuous surfacing, asphaltic plug joints, nosing joints with poured sealant, preformed compression seal joints, steel sliding plates, reinforced elastomeric cushion joints, cantilever finger-joints, reinforced elastomeric composed joints, rolling leaf joints and multiple seal in metal runners joints.

[0027] The sacrificial connection means 250 may comprise the parts of the expansion joint device 200 that serve to releasably fixedly connect the exchangeable cartridge 210 to the permanent cradle 210, in particular by interconnecting the at least one cradle engagement provision 218 and the at least one cartridge engagement provision 234. In general, the sacrificial connection means 250 may include at least one sacrificial connection member 252 that is configured to be sacrificed, and that, through its sacrifice and accompanying loss of structural integrity, enables the disconnection of the cartridge 230 from the cradle 210.

[0028] In one embodiment, the sacrificial connection member 252 may include an elongate, optionally threaded bar 252. In case the bar includes a thread over at least one portion of its length, such as the thread bar 252 in the depicted embodiment, the sacrificial connection means 250 may additionally include one or more nuts for cooperation with the threaded portion(s) of the bar. In the depicted embodiment, for instance, each thread bar 252 is associated with one pair of nuts 254, 256, a first 254 of which is fixedly attached to the threaded bar 252, and a second 256 of which is a loose nut. The position of the first nut 254 along the length of the threaded bar 252 is chosen such that the nut 254 abuts the base member 212 of the permanent cradle 210 when the thread bar 252 engages the threaded bore 222 of socket 220 over the latter's entire length. The major or nominal diameter of the screw thread on the thread bar may typically be in the range of 14 ± 6 mm, e.g. M14. - In case the bar is unthreaded, alternative fastening means may be provided, such as lock pins or hitch pins, which may be config-

ured to be passed through a hole or passage extending through the bar in a direction perpendicular to its longitudinal axis, in order to fix the bar relative to the cradle and cartridge engagement provisions 218, 234. The use of an at least partially threaded bar in combination with nuts may be preferred, however, as it may allow for easy assembly of the expansion joint device 200 and a tightenable connection between the exchangeable cartridge 230 and the permanent cradle 210. - The optionally threaded bar 252 may be configured for cooperation with the aforementioned sockets 220, 236 of the cradle and cartridge engagement provision 218, 234, such that the bar 252 may be fittingly passed through the bores 222, 238 in these sockets to releasably fixedly connect the permanent cradle 210 and the exchangeable cartridge 230.

[0029] One skilled in the art will appreciate that the expansion joint device 200 may take different forms in different embodiment. In one alternative embodiment, for example, the (bores 222, 238 of the) sockets 220, 236 may not extend perpendicular to the longitudinal direction L, but parallel thereto. The bores 222, 238 may then be threaded or unthreaded, and be arranged such that their axes are in alignment when the exchangeable cartridge 230 is received by the permanent cradle 200, so that a sacrificial connection member may pass through all of them.

[0030] Now that the construction of a roadway section 100 according to the present disclosure has been elucidated in some detail, attention is invited to a method of manufacturing the roadway section, and to a method of method of replacing an expansion joint provided by the roadway section. The former method will be clarified with reference to Figs. 2A-E, the latter with reference to Figs. 3A-C.

[0031] Referring first to Figs. 2A-E and the method of manufacture. A roadway section 100 according to the present disclosure may be pre-fabricated, or, more typically, be manufactured in-situ. In a first step, one may manufacture the substructure 110 of the roadway section, in particular by pouring concrete in prepared formwork. Where desired, reinforcements, such as steel reinforcing bars (rebars), may be positioned within the formwork before the concrete is poured in. In the process, a longitudinal cradle section that is cut to the length of the joint end 112 of the roadway section 100 may be incorporated into the concrete substructure 110, such that the anchors 214, 216 provided on the substructure-abutting sides of the main sections 212a, 212c are embedded in the wall portions of the cut-out 114, so as to cause them to be permanently connected thereto once the concrete cures, as shown in Fig. 2A. It is noted that the substructure 110 may be conveniently poured in more than one stage. One may, for instance, first pour a lower slab having a top surface 114a with which the horizontally extending main section 212a of the base member 212 of the cradle 210 may be integrated. Subsequently, one may pour an upper slab, which may be somewhat smaller

than the lower slab, on top thereof. The upper slab may have a vertically extending side surface 114c with which the vertically extending main section 212c of the base member 212 of the cradle 210 may be integrated. In a second step, illustrated in Fig. 2B, one may screw the sacrificial connection member 252, i.e. the thread bar, into the threaded bore 222 of the socket 220 of the cradle 210, in particular by means of a nut spanner or wrench that is applied to the nut 254 fixed to the thread bar. The thread bar 252 may be screwed into the socket 220 up until the point that the nut 254 abuts the base member 252. Then, in a third step, one may position an exchangeable cartridge 230 in the permanent cradle 210. The exchangeable cartridge 230 and the permanent cradle 210 may have a same length (cf. Fig. 1). To position the exchangeable cartridge 230, one may slide its socket 236 over the portion of the thread bar 252 that projects from the inclined intermediate section 212b of the base member 212 of the cradle 210, while catching the tip 237 of the second section 232b of the cartridge interface portion 232 behind the catch section 212d of the base member 212; see Fig. 2C. The exchangeable cartridge is properly positioned when the first section 232a of the cartridge interface portion 230 abuts and covers the first main section 212a of the base member 212, the second section 232b of the cartridge interface portion 230 abuts and covers the intermediate and second main sections 212b, 212c of the base member 212, and the thread bar 252 projects from the bore 238 in the socket 236 of the exchangeable cartridge 230. In this position, the exchangeable cartridge 210 may be tightly, releasably fixedly connected to the permanent cradle 210 in a fourth step by a second nut 256 on the thread bar 252, as schematically shown in Fig. 2D; i.e. the second nut may be tightened to tighten the connection between the exchangeable cartridge 230 and the permanent cradle 210. Finally, in a fifth step which is illustrated in Fig. 2E, a typically asphaltic top structure 120 may be applied over the substructure 110 and, optionally, also over at least part of the expansion joint device 200. A top surface of the top structure 120 may provide for a road surface 122.

[0032] Turning now to Figs. 3A-C, which schematically illustrate the method of replacing the expansion joint in the roadway section 100. It is understood that the expansion joint may be provided by the expansion joint portion 240 of the installed exchangeable cartridge 230, and that the key to a quick release and replacement of the exchangeable cartridge 230 is the well-aimed cutting of the sacrificial connection members 232 connecting it to the permanent cradle 210.

[0033] Accordingly, in a first step of the method, one may cut the sacrificial connection members 252 of the installed expansion joint device 200. In case the sacrificial connection members 252 all extend at a known angle relative to the road surface 122, it is also known at what angle one must mill through the top structure 110, along the joint end 112, to provide for a clean longitudinally extending cut that intersects all sacrificial connection

members 252. In the depicted embodiment, all thread bars 252 extend at an angle of $\varphi + 90^\circ$ relative to the horizontal road surface 122. Accordingly, one may repeatedly insert a milling cutter 400 into the top structure under angle φ along the length of the joint end 112, to so to create a longitudinally extending cut that intersects all sacrificial connection members 252 at a right angle, as shown in Fig. 3A. It is understood that cutting a sacrificial connection member 252 may entail cutting through the respective socket 236 of the exchangeable cartridge 230, thereby demolishing it. This is not a problem, however, since the entire exchangeable cartridge 230 is to be replaced.

[0034] Once all sockets 236 and sacrificial connection members 252 of the installed expansion joint device 200 are cut, the exchangeable cartridge 230 may be wrested and disengaged from the permanent cradle 210 in a second step, as shown in Fig. 3B. This step may involve the controlled upward rotation of the exchangeable cartridge 230 around a contact line between the longitudinally extending tip 233 of the second section 232b of the cartridge interface portion 232 and the lower side of the longitudinally extending catch section 212d of the base member 212 of the permanent cradle 210. While wresting the exchangeable cartridge 230 from the permanent cradle 210, the latter protects the substructure 110 of the roadway section 100 from damage. Subsequently, when the exchangeable cartridge 230 is removed, one may quickly strip the permanent cradle 210 from the portions of the sacrificial connection members 232 threaded into the sockets 220, and dispose of any debris, such as pieces of top structure 110. Finally, when the cradle 210 is cleaned up, one may, in a third step schematically shown in Fig. 3C, install a replacement exchangeable cartridge by means of replacement sacrificial connection members, and optionally re-apply the top structure over the replacement exchangeable cartridge, essentially as described above with reference to Figs. 2C-E.

[0035] Although illustrative embodiments of the present invention have been described above, in part with reference to the accompanying drawings, it is to be understood that the invention is not limited to these embodiments. Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, it is noted that particular features, structures, or characteristics of one or more embodiments may be combined in any suitable manner to form new, not explicitly described embodiments.

List of elements

[0036]

5	100	roadway section
	110	concrete substructure
	112	joint end
	114	cut-out
	114a,b	first, horizontal (a) and second, vertical (b) wall of cut-out
10	120	top structure, e.g. an asphalt layer
	122	road surface
	200	expansion joint device
15	210	permanent cradle
	212	base member (profile)
	212a-d	first main (a), intermediate (b), second main (c) and catch (d) section of base member
	214	anchor attached to first, horizontal main section of base member
20	216	anchor attached to second, vertical main section of base member
	218	cradle engagement provision
	220	socket
25	222	threaded bore
	230	exchangeable cartridge
	232	cartridge interface portion
	232a-b	first (a) and second (b) section of cartridge interface portion
30	233	tip of second section of cartridge interface portion
	234	cartridge engagement provision
	236	socket
35	238	unthreaded bore
	240	expansion joint portion
	250	sacrificial connection means
	252	sacrificial connection member, e.g. thread bar
40	254	first nut, fixed to thread bar
	256	second nut
	300	gap
	400	milling cutter
45	L	longitudinal direction of joint end
	φ	acute angle between intermediate section and road surface
	θ	acute angle between sacrificial connection member and road surface
50		

Claims

- 55 1. A roadway section (100) including:
- a typically concrete substructure (110) having a longitudinally extending joint end (112) that is

- intended to be disposed opposite a joint end of a further roadway section (100'), such that a gap (300) exists between said joint ends to allow the roadway sections to expand;
- a typically asphaltic concrete top structure (120) disposed on top of said substructure (110) and providing for a road surface (122);
 - an expansion joint device (122), including:
 - a permanent cradle (210), disposed at said joint end (112) and extending over substantially an entire length thereof, said permanent cradle comprising at least one anchor (214, 216) that is embedded in the substructure (110) to permanently connect the permanent cradle thereto, and at least one cradle engagement provision (218);
 - an exchangeable cartridge (230) comprising a cartridge interface portion (232) that is disposed on the permanent cradle (210) and that defines at least one cartridge engagement provision (234), and further comprising an expansion joint portion (240) that is fixedly connected to the cartridge interface portion (232) and that provides for at least part of an expansion joint configured to bridge the gap (300); and
 - sacrificial connection means (250) that engage both the at least one cradle engagement provision (218) and the at least one cartridge engagement provision (234) to releasably fixedly connect the exchangeable cartridge (230) to the permanent cradle (210), wherein the sacrificial connection means (250) include at least one sacrificial connection member (252) that is configured to be sacrificed upon disconnection of the exchangeable cartridge from the permanent cradle.
2. The roadway section according to claim 1, wherein the permanent cradle (210) has a first side facing the substructure (110), and a second side facing away from the substructure (110), and wherein the cartridge interface portion (232) of the exchangeable cartridge (230) abuts and covers substantially an entire surface area of said second side.
 3. The roadway section according to claim 1 or 2, wherein the permanent cradle (210) includes a base member (212) that is made of a sheet material, and that has a substantially uniform transverse cross-sectional profile along the length of the joint end (112), and wherein the at least one anchor (214, 216) and the at least one cradle engagement provision (218) is either provided by or fixedly connected to the base member (212).
 4. The roadway section according to any of the claims 1-3, wherein the substructure (110) includes a cut-out (114) of a substantially uniform transverse cross-sectional profile extending adjacent the gap (300) and over the length of the joint end (112), said cut-out being defined by at least a first wall portion (114a) that extends substantially parallel to the road surface (122) and a second wall portion (114c) that extends substantially perpendicular to said road surface, and wherein the cross-sectional profile of the base member (212) includes a first main section (212a) that abuts the first wall portion (114a) of the cut-out (114), and a second main section (212c) that abuts the second wall portion (114c) of the cut-out.
 5. The roadway section according to claim 4, wherein the transverse cross-sectional profile of the base member (212) further includes an intermediate section (212b) that interconnects the first and second main sections (212a, 212c), which intermediate section extends at an acute angle (ϕ) relative to the road surface (122), and either provides for or directly connects to the cradle engagement provision (218).
 6. The roadway section according to any of the claims 1-5, wherein the at least one cradle engagement provision (218) includes a plurality of longitudinally spaced apart cradle engagement provisions, and wherein the at least one cartridge engagement provision (238) includes a plurality of the longitudinally spaced apart cartridge engagement provisions.
 7. The roadway section according to any of the claims 1-6, wherein both the at least one cradle engagement provision (218) and the at least one cartridge engagement provision (234) include at least one socket (220, 236) with an optionally threaded bore (222, 238), which sockets are arranged such that their bores are in alignment when the exchangeable cartridge (230) is releasably fixedly connected to the permanent cradle (210), and wherein the sacrificial connection member (252) includes an optionally threaded bar (252) that is configured to be fittingly passed through the bores (222, 238) in the sockets (220, 236) of the cradle engagement provision (218) and the cartridge engagement provision (234) to releasably fixedly interconnect the exchangeable cartridge (230) and the permanent cradle (210).
 8. The roadway section according to claim 7, wherein, the threaded bar of the sacrificial connection member (252) extends substantially parallel to the longitudinal direction (L) of the joint end (112), such that it extends parallel to the road surface (122).
 9. The roadway section according to claim 7, wherein the threaded bar of the sacrificial connection mem-

ber (252) extends substantially perpendicular to the longitudinal direction (L) of the joint end, such that it includes an acute angle (θ) with said road surface (122).

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10. A roadway structure comprising a first and a second roadway section (100, 100') according to any of the claims 1-9, wherein the joint ends (112) of the first and second roadway sections are disposed opposite to each other such that a gap (300) exists therebetween, and such that the exchangeable cartridges (230, 230') provide for an expansion joint that bridges the gap (300). 10
11. A method of manufacturing a roadway section (100) according to any of the claims 1-9, comprising: 15
 - pouring concrete to form the substructure (110) while embedding the at least one anchor (214, 216) of the permanent cradle (210) therein, such that, once the concrete has cured, the permanent cradle (210) is permanently connected to the substructure (110); 20
 - releasably fixedly connecting the exchangeable cartridge (230) to the permanent cradle (210) by means of the at least one sacrificial connection member (252); and 25
 - applying the top structure (120) over the substructure (110) and, optionally, also over at least part of the expansion joint device (200). 30
12. A method of replacing an expansion joint in a roadway section (100) according to any of the claims 1-9, comprising: 35
 - cutting, e.g. milling, through the sacrificial connection member (252);
 - removing the exchangeable cartridge (230) and any pieces of the sacrificial connection member (252) from the permanent cradle (210); 40
 - providing a replacement exchangeable cartridge (230) and at least one replacement sacrificial connection member (252), and releasably fixedly connecting the replacement exchangeable cartridge to the permanent cradle (210) by means of the at least one replacement sacrificial connection member; and 45
 - optionally, re-applying a top structure (120) over at least part of the expansion joint expansion device (200), such that at least the permanent cradle (210) and the cartridge interface portion (232) of the replacement exchangeable cartridge (230) are disposed below the road surface (122) provided by the top structure (120). 5055

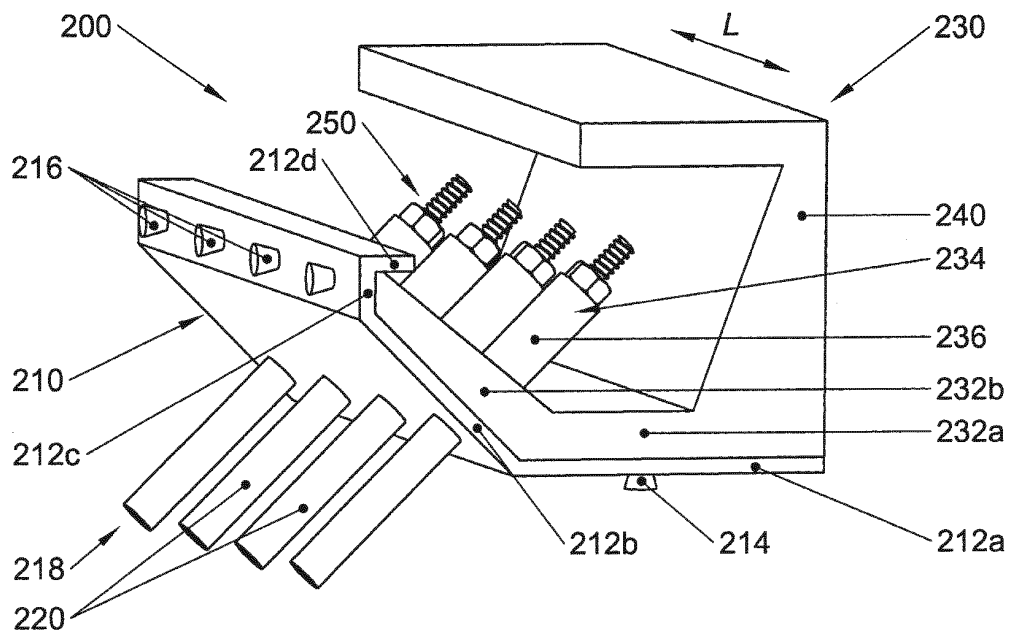


Fig. 1A

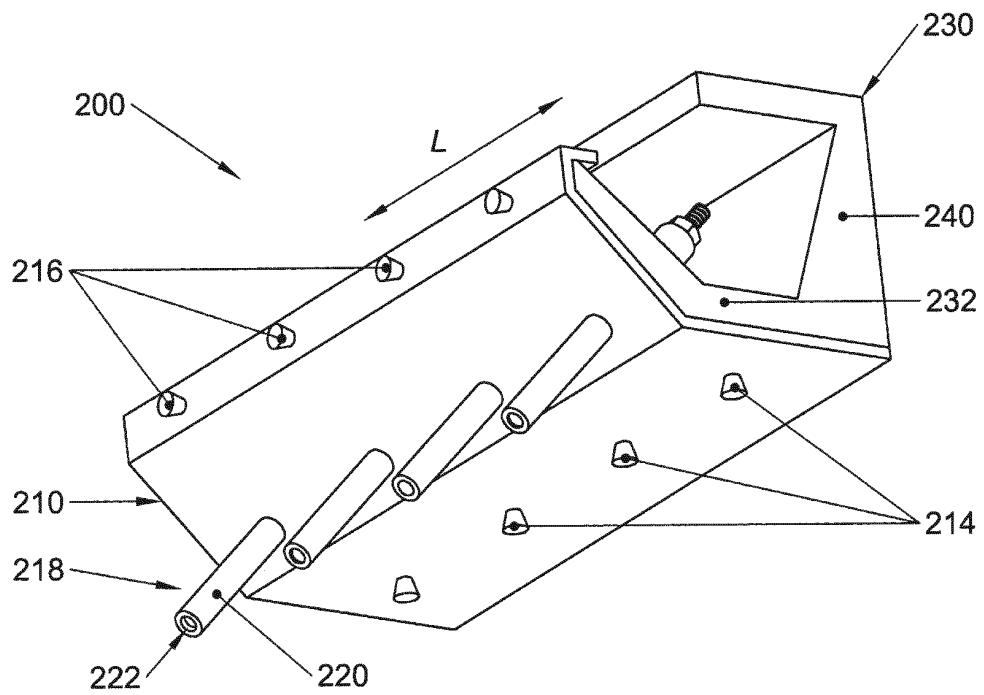


Fig. 1B

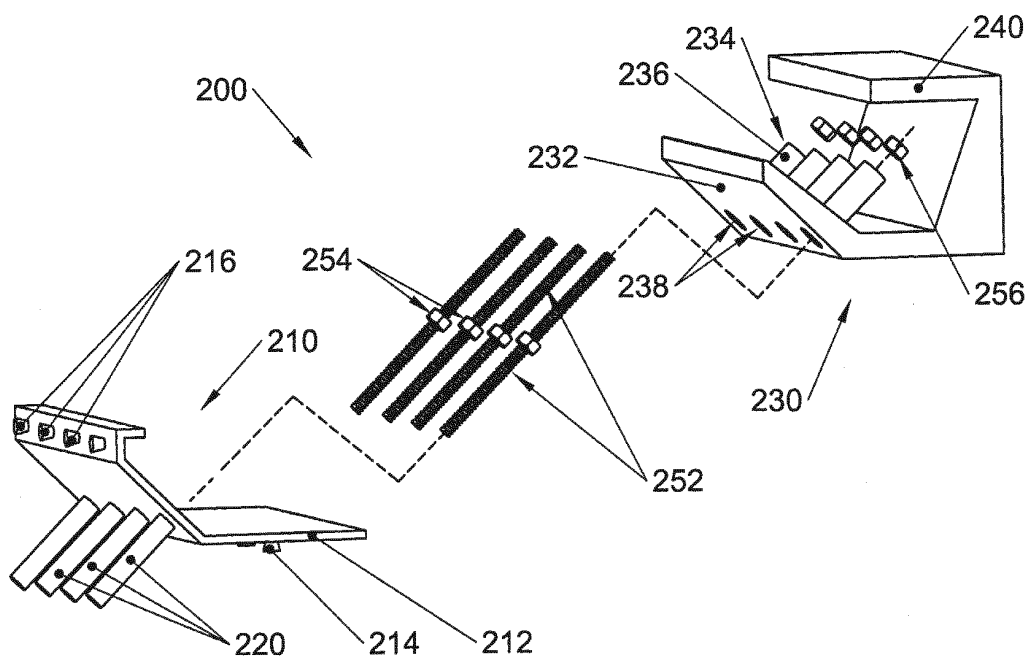


Fig. 1C

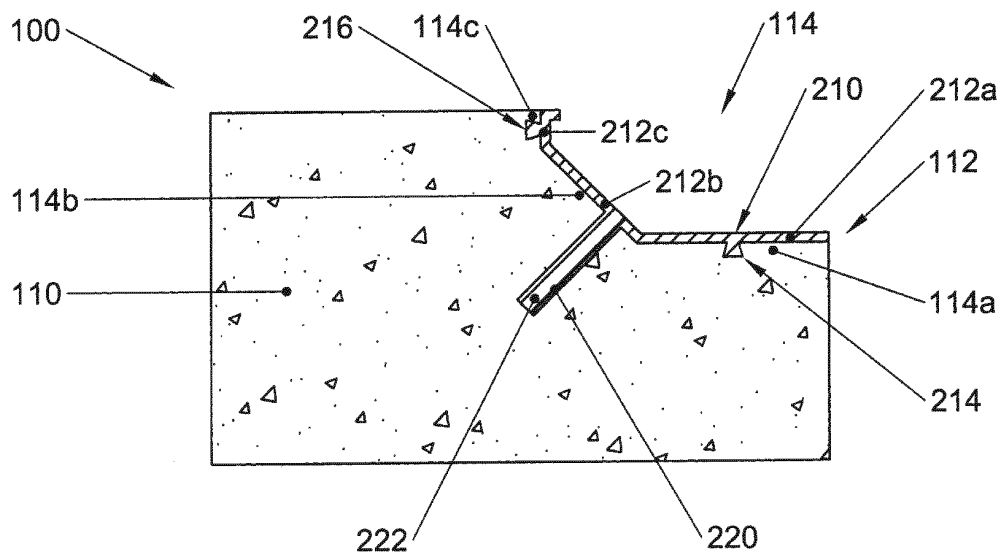


Fig. 2A

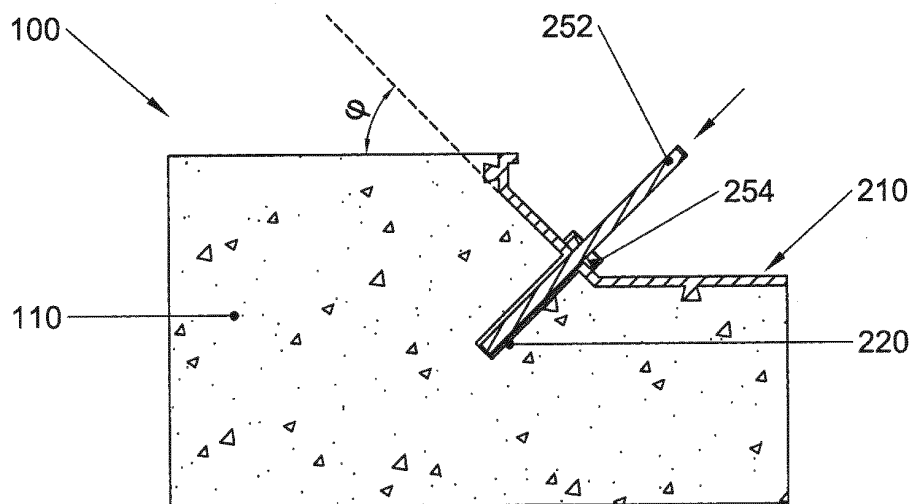


Fig. 2B

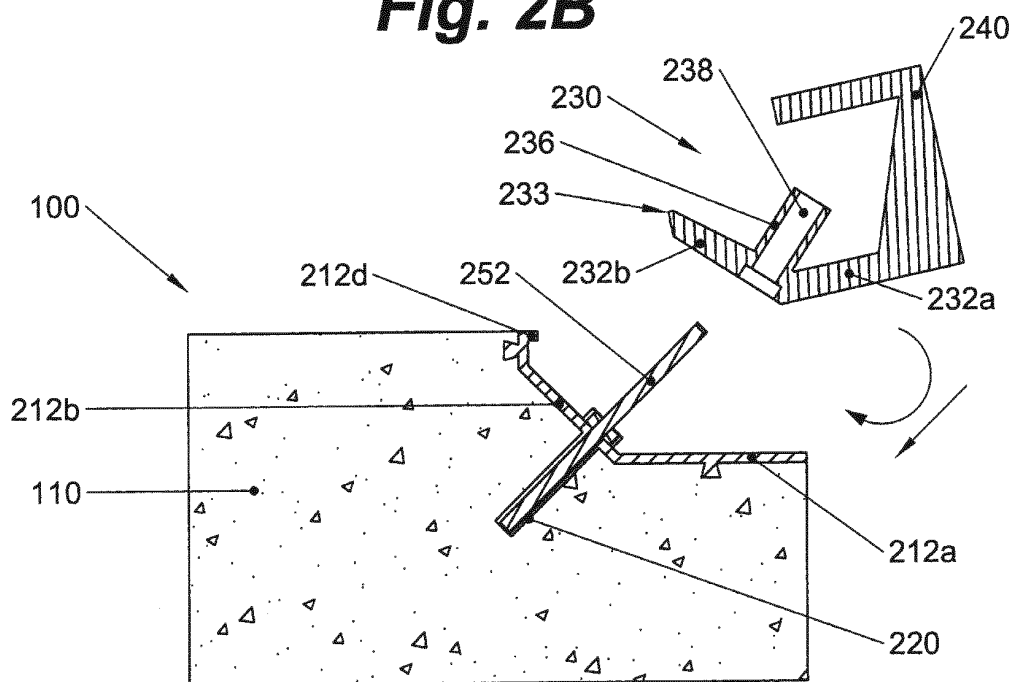


Fig. 2C

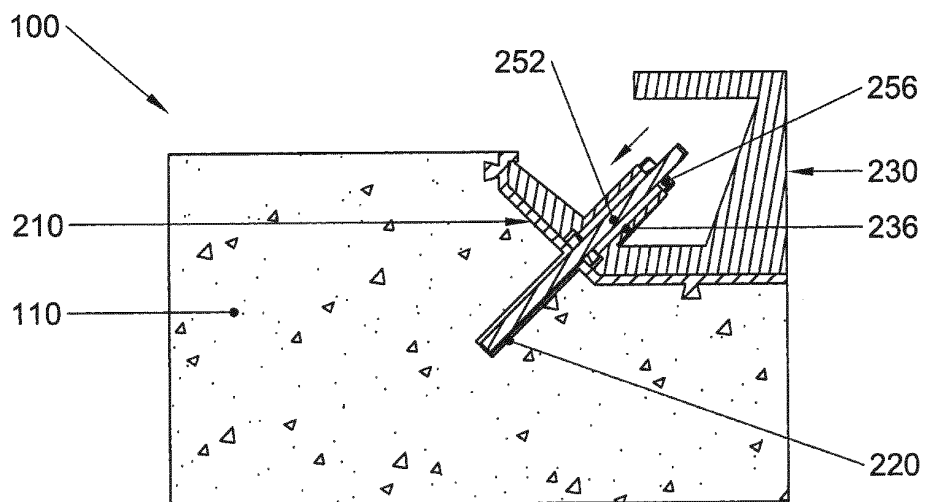


Fig. 2D

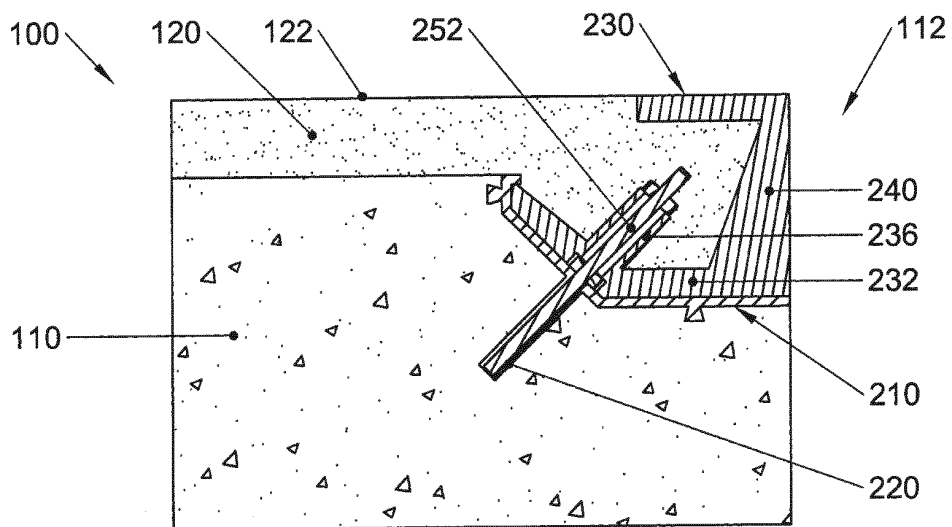


Fig. 2E

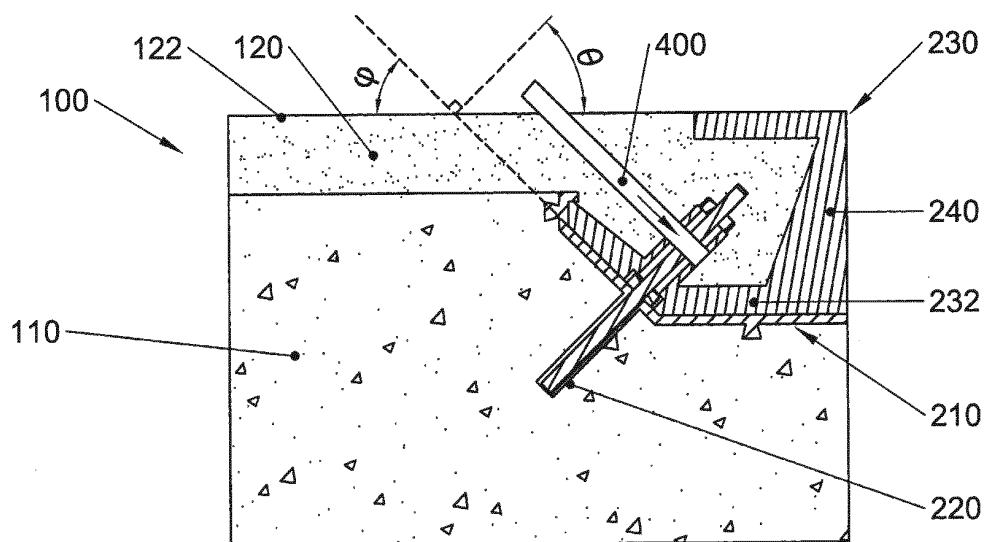


Fig. 3A

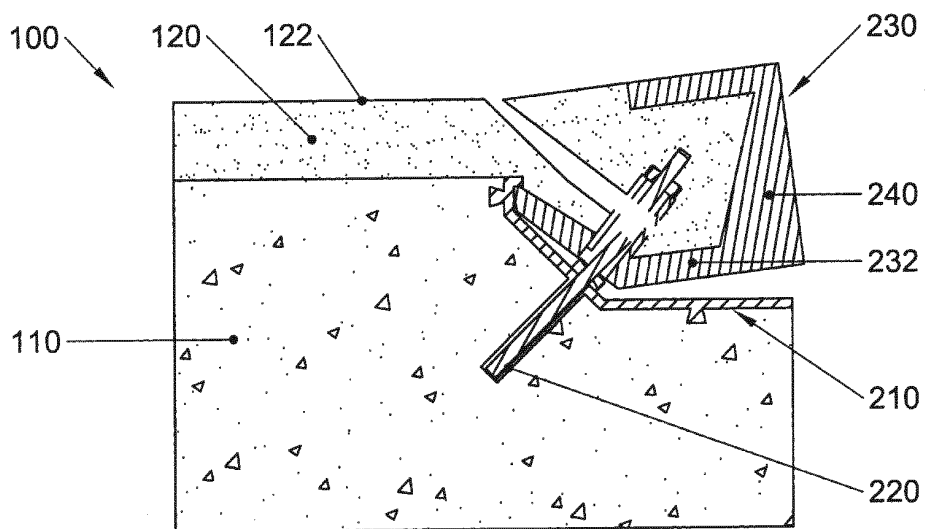


Fig. 3B

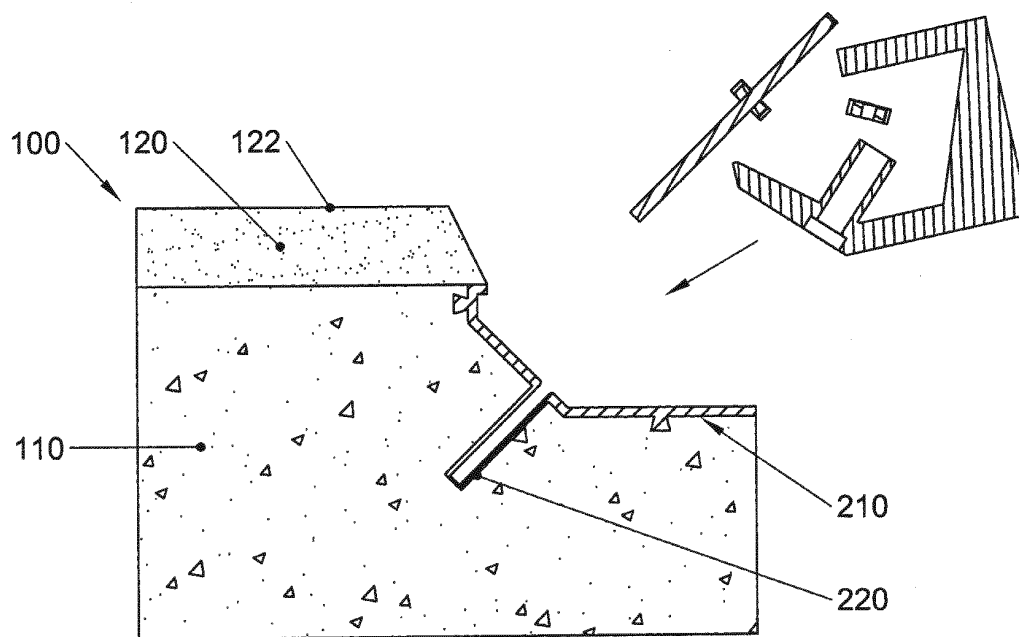


Fig. 3C

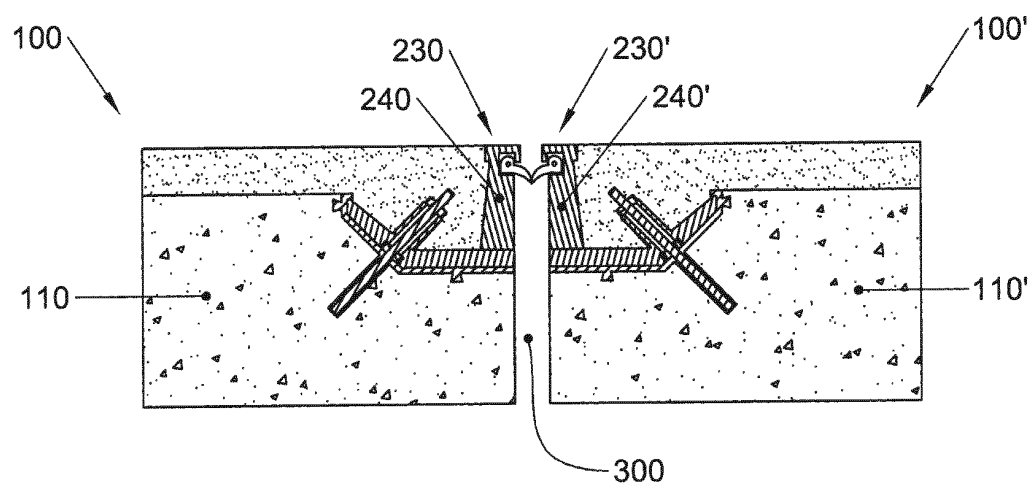


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 12 19 9747

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2003 213611 A (ARAI MOTONOSUKE; ARAI YOSHIMASA) 30 July 2003 (2003-07-30) * abstract * * figures 1-10 *	1-4,6-8, 10-12	INV. E01D19/06
A	----- US 2002/138925 A1 (CHANG MING-HUANG [TW]) 3 October 2002 (2002-10-03) * abstract * * paragraph [0032] - paragraph [0044]; figures 1-8 * -----	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01D E01C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 April 2013	Examiner Beucher, Stefan
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 19 9747

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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12-04-2013

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2003213611 A	30-07-2003	JP 3699936 B2	28-09-2005
		JP 2003213611 A	30-07-2003

US 2002138925 A1	03-10-2002	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82