



(11)

EP 1 712 734 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.10.2006 Bulletin 2006/42

(51) Int Cl.:
E21D 9/00 (2006.01) E02D 29/045 (2006.01)

(21) Application number: **05102837.1**

(22) Date of filing: **11.04.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL BA HR LV MK YU

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(54) **Method and apparatus for the construction of underpasses to cross railway lines with one or more tracks**

(57) Method and apparatus for the construction of an underpass (30) to cross railway lines (15) with one or more tracks (11, 12), wherein a structure is used to support the tracks (11, 12) and wherein a step is provided of preparing on site foundations (16) defining a definitive position of the structure. The method provides to construct the structure (10) with a closed section whose inner volume defines the way that crosses the underpass (30),

on travel ways (18) prepared at the side of said railway line (15) and associated with the foundations (16); to associate with the structure (10) containing means (20) in correspondence with the front facing towards the railway line (15); to translate the closed structure (10) by sliding it on suitable brackets along the travel ways (18), until the definitive position is reached on the foundations, and finally to return the railway line (15) to definitive operations.

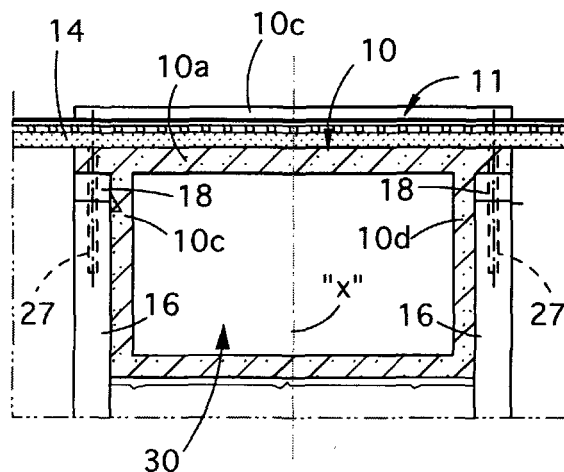


fig. 11

Description

FIELD OF THE INVENTION

[0001] The present invention concerns a method and an apparatus for the construction of underpasses used to cross railway lines with one or more tracks.

BACKGROUND OF THE INVENTION

[0002] Different methods are known to construct underpasses that allow to cross railway lines with one or more tracks.

[0003] Such methods provide to achieve a structure, while the track is still in use, built at the side of the track and then inserted under the railway line at the crossing point, so as to ensure that the tracks have the necessary support and make the road works feasible in the underpass.

[0004] To be more exact, a method and the relative apparatus to construct underpasses is known from the Italian patent application UD2001A000031, filed on 16.02.2001.

[0005] This conventional method provides:

- to prepare, on site, foundations that determine the definitive positioning of the supporting structure;
- to build, in axis with the artefact to be built and in the immediate vicinity of the track, a monolithic structure, with an open, inverted U-shape structure, like a doorway;
- to cut segments of the track, to interrupt and then restore the traffic alternately on the two railway lines and simultaneously translate the supporting structure under the plane on which said railway lines rest, until the position defined by the foundations is reached.

[0006] Although this solution is particularly advantageous with regard to the times of execution, which are reduced to not more than 4-5 hours, it does in any case provide to cut and alternately remove the segments of the railway line, entailing burdensome restoration steps.

[0007] Another disadvantage of the known method is that the inverted U-shape section of the structure, which is therefore not closed, entails further excavation steps at the end of positioning in order to achieve the road system that crosses the railway line.

[0008] Another disadvantage is that the travel ways for the translation of the supporting structure, located at the top of the arrays of piles or diaphragms which make up the walls associated with the ramps, are located at a lower level than the definitive one, and therefore they have to be completed once the launch operations have been terminated.

[0009] One purpose of the present invention is to perfect a method and a relative apparatus which allow to construct an underpass to cross railway lines with one

or more tracks, reducing to a minimum the intervention times, without needing to cut and remove, even partly, any segments of the railway line, and without needing to form, in a subsequent step, the underlying U-shaped structure, which supports, contains and completes the artefact.

[0010] Unlike monolithic structures that rest directly on the ground and are therefore susceptible to considerable yielding, the present invention guarantees a perfect altimetric positioning, without yielding of the structure since it is supported by foundations of piles which guarantee the stability thereof.

[0011] Another purpose of the present invention is to perfect a method, and the relative apparatus, which allow to reduce the times for constructing the way that crosses the railway line, and to allow the excavation of all the material under the track simultaneously with the progressive insertion of the artefact.

[0012] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0013] The present invention is set forth and characterized in the main claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0014] In accordance with the above purposes, a method for the construction of an underpass to cross a railway line with one or more tracks according to the present invention provides to use a monolithic structure, of the box-like type with a closed section, equipped with two overhanging brackets on the level of the upper slab, said brackets being intended to transmit loads to the foundation system adopted by means of suitably sized top guide edges (travel ways or discontinuous supports).

[0015] The method according to the present invention provides the following steps:

- to prepare on site foundations able to allow the correct and definitive positioning of the structure;
- to construct the hollow structure, with a closed rectangular section (tunnel), compatible with the requirements of the road which the underpass is to serve, equipped, in correspondence with the upper slab, with two brackets, resting on travel ways prepared at the side of the railway line at the same height as the intrados of said slab; this height, coinciding with the definitive height according to the design specifications, does not entail additional masonry works;
- to apply on the head of the monolith, on the railway side, a shield intended to contain the earth and to guarantee the static equilibrium of the structure during the launch step;
- to translate the box-like structure, along the travel

ways, and simultaneously excavate inside it, while it is supported by the brackets and thrust by means of suitable oil-dynamic jacks, until the definitive position is reached, on the already prepared foundations;

- to return the railway line to definitive operations.

[0016] In this way, the supporting structure can be inserted under the railway line without cutting and removing the tracks, in a single translation step, further limiting the times and costs of the intervention and the inconvenience to the railway line.

[0017] Moreover, using a monolithic structure with a closed section allows to use excavation means associated with means to remove the material, that are located inside the structure, so that the excavation and the removal of earth under the tracks can be performed simultaneously with the advance of the monolith itself.

[0018] Applicant has found that the construction of an underpass with the method and the apparatus according to the present invention can be carried out normally in not more than about five hours, which substantially corresponds to the duration of an Ordinary Planned Interruption (OPI) associated with a simultaneous planned interruption of the line for ordinary and extraordinary maintenance, thus limiting to a minimum the connected inconvenience for the railway traffic.

[0019] Moreover, since the road that crosses the railway line is perfectly defined by the inner section of the monolithic structural body, the time required for doing the work and for finishing the road surface is drastically reduced. In fact, once the rectangular tunnel has been thrust into its final position, the operations to excavate and remove the material are no longer necessary, since they have already been done during the advance of the monolith.

[0020] In a preferential form of embodiment, the rectangular tunnel structure consists of an upper slab equipped with two brackets with the function of supporting the travel ways, of a lower slab, or base, parallel to the upper slab, and of at least two vertical baffle plates (upright), rigidly connected to the aforementioned slabs, arranged so as to define the inner volume of the monolith that constitutes, when the structure is definitively installed, the way that crosses the underpass. As already mentioned, the structure is envisaged as a single body, in order to ensure that the artefact has great rigidity and a reserve of stability, adequate for its use, which is very particular.

[0021] In another preferential form of embodiment, the shield comprises two wedge-shaped front beaks which, during the translation of the monolith, are partly sunk into the ground in order to facilitate the advance of the structure and the simultaneous removal of the excavated material.

[0022] During the movement step, the brackets of the upper slab allow to rest the box-like structure on the foundations, outside the excavation, so as to prevent any in-

clination of the structure, which would otherwise be possible, and guarantee the final positioning of the box-like structure according to design specifications.

5 BRIEF DESCRIPTION OF THE DRAWINGS

[0023] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- Figs. 1, 3, 5, 7 and 9 show a plane view of the main steps of the method according to the invention;
- Figs. 2, 4, 6, 8 and 10 show the longitudinal sections of figs. 1, 3, 5, 7 and 9;
- Fig. 11 is a cross section of the apparatus according to the invention.

20 DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

[0024] The attached drawings show schematically the method according to the invention to construct, along a longitudinal axis x, an underpass 30, shown by a line of dashes in fig. 2, to cross a railway line 15, in this case with two tracks, first 11 and second 12. The two tracks 11 and 12 are associated at the lower part with relative sleepers 13 arranged on a bed 14.

[0025] According to the invention, to support the tracks 11 and 12 in correspondence with the underpass 30, a monolithic structure 10 is used, hollow or tunnel shaped, with a substantially rectangular closed section, the inner volume of which defines the road to cross the underpass 30. The closed structure 10 rests on foundations, in this case consisting of four diaphragms 16 on the upper edge of which respective guide edges 18 made of reinforced concrete are attached.

[0026] It comes within the field of the present invention that the foundations which support the structure are discontinuous, for example piles or columns.

[0027] The closed monolithic structure 10, made of reinforced concrete, consists of: an upper slab 10a equipped with two supporting brackets protruding laterally, a lower slab 10b and two lateral baffle plates 10c and 10d, which connect the supporting slab 10a and the slab 10b and define the space serving the road that crosses the underpass 30.

[0028] The upper supporting slab 10a is plane and has a greater width than the underpass 30 to be constructed, in order to allow it to rest on the lateral guide edges 18.

[0029] Thanks to the particular conformation of the structure 10, with a closed section and cantilevered bearing wings, the travel ways are made at the top of the guide edges 18, which can therefore already have the defined height and therefore do not need, once the launch is completed, further works for their completion. The distance between the vertical baffle plates 10c and 10d,

which rigidly connect the lower slab 10d to the upper supporting slab 10a, defines the width of the supporting plane of the road surface of the underpass 30.

[0030] In this case, the slab 10a and the slab 10b have a base shaped like a parallelogram, of which two sides are parallel to the foundation system and two sides are parallel to the longitudinal axis "y" of the railway line 15.

[0031] The method according to the invention provides firstly to construct the four diaphragms 16, or piles or columns, as indicated above, symmetrical with respect to the axes x and y and aligned two by two with the guide edges 18.

[0032] At the top of the diaphragms 16 removable metal frames 17 are installed, with the function of preventing the bed 14 or the earthwork from sliding towards the diaphragms 16; then, the launch guide edges 18 are made, of the definitive height as already said, on which the structure 10 will be made to slide.

[0033] On the extrados of the guide edges 18 a device is positioned consisting of metal slabs and profiles covered at the upper part by Teflon or self-lubricating materials intended to minimize the forces of friction at the moment of thrust.

[0034] Subsequently, an excavation is made of the earth between the two diaphragms 16 on one side of the bed 14, as far as the positioning height of the slab 10b, so as to allow the subsequent advance of the structure 10 and the insertion thereof into said excavation, while the supporting slab 10a slides on the guide edges 18.

[0035] Behind the structure 10, on each of the guide edges 18 one or more thrust actuators 23 are anchored, of a conventional type and not described in detail here. Simply to give an example, each thrust actuator can be a piston of the hydraulic, oil dynamic, telescopic or other type, suitable to thrust the monolithic structure 10 towards the bed 14.

[0036] A shield 20 with a box-like structure, equipped with two front beaks, is then associated with the structure 10, on the side facing towards the bed 14; the front beaks 20 have a box-like structure and, as we shall see later, not only facilitate the insertion into the ground of the structure 10, but also have the purpose of containing the lateral thrusts of the ground during the translation steps.

[0037] The shields 20 also have the function of ensuring the operativity of the excavation equipment and the system to evacuate the material excavated during the course of the excavation operations and simultaneous advance of the structure.

[0038] Moreover, the front beaks of the shields 20 also function as provisional supporting brackets for the structure 10 and guarantee the static equilibrium thereof in the most critical steps of the launch.

[0039] In this case the shields 20 are made of metal material, but it cannot be excluded that they can be made of any other suitable material, that is, reinforced concrete together with the structure 10 itself.

[0040] After removing the metal frames 17 applied to the diaphragms 16, the thrust actuators 23 are driven,

making the structure 10 slide on the guide edges 18 in the direction of the railway line 15, until the front part of the shields 20 is inserted by about 1 meter in the ground.

[0041] At this point, the bed 14 is removed and the excavation of the earthwork under the first track 11 and the second track 12 is progressively performed, as the structure 10 advances, up to the intrados height of the slab 10b.

[0042] During this step, the shields 20 contain the ground laterally, preventing it from sliding towards the inside of the excavation, creating impediments against the advance of the structure 10 and weakening the support for the tracks 11 and 12.

[0043] In this way, the tracks 11 and 12 are self-supported without needing to be lifted and removed after being cut into segments.

[0044] At a certain point of the advance of the structure 10, the shields-front beaks 20 reach the guide edges 18 provided on the opposite side of the railway line 15, thus ensuring the static equilibrium of the system and the progressive further cantilevered advance of the structure 10.

[0045] Once the definitive position has been reached, the shields-front beaks 20 are removed from the monolithic structure 10 and the structure 10 is anchored to the four diaphragms 16, in this case by means of appropriate anchoring pins or tie rod elements 27.

[0046] The bed 14 is positioned on the supporting slab 10a of the structure 10 under the first 11 and second track 12, re-establishing the normal functioning of the railway line 15.

[0047] Finally, the underpass 30 is completed with paving, directly on the extrados surface of the slab 10b.

[0048] It is clear, however, that modifications and/or additions of parts or steps may be made to the method and apparatus as described heretofore, without departing from the field and scope of the present invention.

[0049] It is also clear that, although the present invention has been described with reference to specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of method and apparatus for the construction of underpasses to cross railway lines with one or more tracks, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

Claims

1. Method for the construction of an underpass (30) to cross railway lines (15) with one or more tracks (11, 12), wherein a structure able to support said tracks (11, 12) is used in correspondence with said underpass (30), said method providing a step of preparing on site foundations (16) defining a definitive position of said structure, **characterized in that** it provides the following steps:

- to construct said structure (10) with a closed

- section (tunnel), whose inner volume defines the way that crosses said underpass (30), on travel ways (18) prepared at the side of said railway line (15) and associated with said foundations (16);
- to associate with said structure (10) containing means (20) in correspondence with the front facing towards the railway line (15), in order to contain the ground laterally and guarantee the static equilibrium of the structure during the step of passing the free gap between the supports;
 - to translate the closed structure (10) by sliding it on suitable brackets along said travel ways (18), until the definitive position is reached, on the foundations prepared under the railway line (15);
 - to return said railway line (15) to definitive operations.
2. Method as in claim 1, wherein said tracks (11, 12) are arranged on a bed (14), **characterized in that** it provides, before the translation step of said structure (10), a step of excavating the bed (14) in order to permit the progressive translation of the structure (10) to the definitive position.
 3. Method as in claim 2, **characterized in that** said excavation step is performed simultaneously with the translation step of said structure (10) by means of systems, for the excavation and evacuation of materials, housed inside said containing means (20) and/or said structure (10).
 4. Method as in claim 2 or 3, **characterized in that** it provides a step to restore said bed (14) on the structure (10) before said railway line (15) is made to function again.
 5. Method as in any claim hereinbefore, **characterized in that** it provides to construct said travel ways (18) at their definitive height and above said foundations (16), so that said structure (10) rests and remains thereon at the end of its translation under the railway line.
 6. Apparatus to construct an underpass (30) to cross a railway line (15) with one or more tracks (11, 12), comprising at least a structure or supporting structure able to support said tracks (11, 12) in correspondence with said underpass (30), and foundations (16) able to support said supporting structure, **characterized in that** said structure (10) consists of a closed section (tunnel), whose inner volume substantially defines the way that crosses said underpass (30), said apparatus also comprising travel ways (18) arranged at the side of said railway line (15) and on which said structure (10) rests and translates, and movement means (23) able to translate said structure (10), under said railway line (15), in order to be taken to rest on said foundations (16).
 7. Apparatus as in claim 6, **characterized in that** said structure (10) is made of reinforced concrete and comprises a supporting slab (10a) equipped with two brackets protruding laterally and resting on said travel ways (18), a slab (10b) arranged under and parallel to said supporting slab (10a), and at least two lateral baffle plates (10c, 10d) interposed on opposite sides between said supporting slab (10a) and said slab (10b), so as to define the inner volume that constitutes the way that crosses said underpass (30), when the structure (10) is in position.
 8. Apparatus as in claim 7, **characterized in that** said supporting slab (10a), said slab (10b) and said lateral baffle plates (10c) are made in a single piece.
 9. Apparatus as in claim 7 or 8, wherein said tracks (11, 12) are arranged on a bed (14), **characterized in that** said structure (10) laterally comprises shoulders (10e) to contain said bed (14).
 10. Apparatus as in any claim from 6 to 9 inclusive, **characterized in that** it comprises containing means (20), able to be associated at least temporarily with said structure (10) on the side facing towards said railway line (15), said containing means (20) being able to contain the ground laterally and to rest and slide on said travel ways (18), during the translation of said structure (10).
 11. Apparatus as in claim 10, **characterized in that** said containing means consist of a shield having two tapered elements (20) and with a box-like structure.
 12. Apparatus as in any claim from 6 to 11 inclusive, **characterized in that** said travel ways (18) comprise metal profiles covered at the upper part by anti-friction material such as Teflon.
 13. Apparatus as in any claim from 6 to 12 inclusive, **characterized in that** said movement means comprise at least an actuator (23) anchored to said travel ways (18) and thrusting against said structure (10).

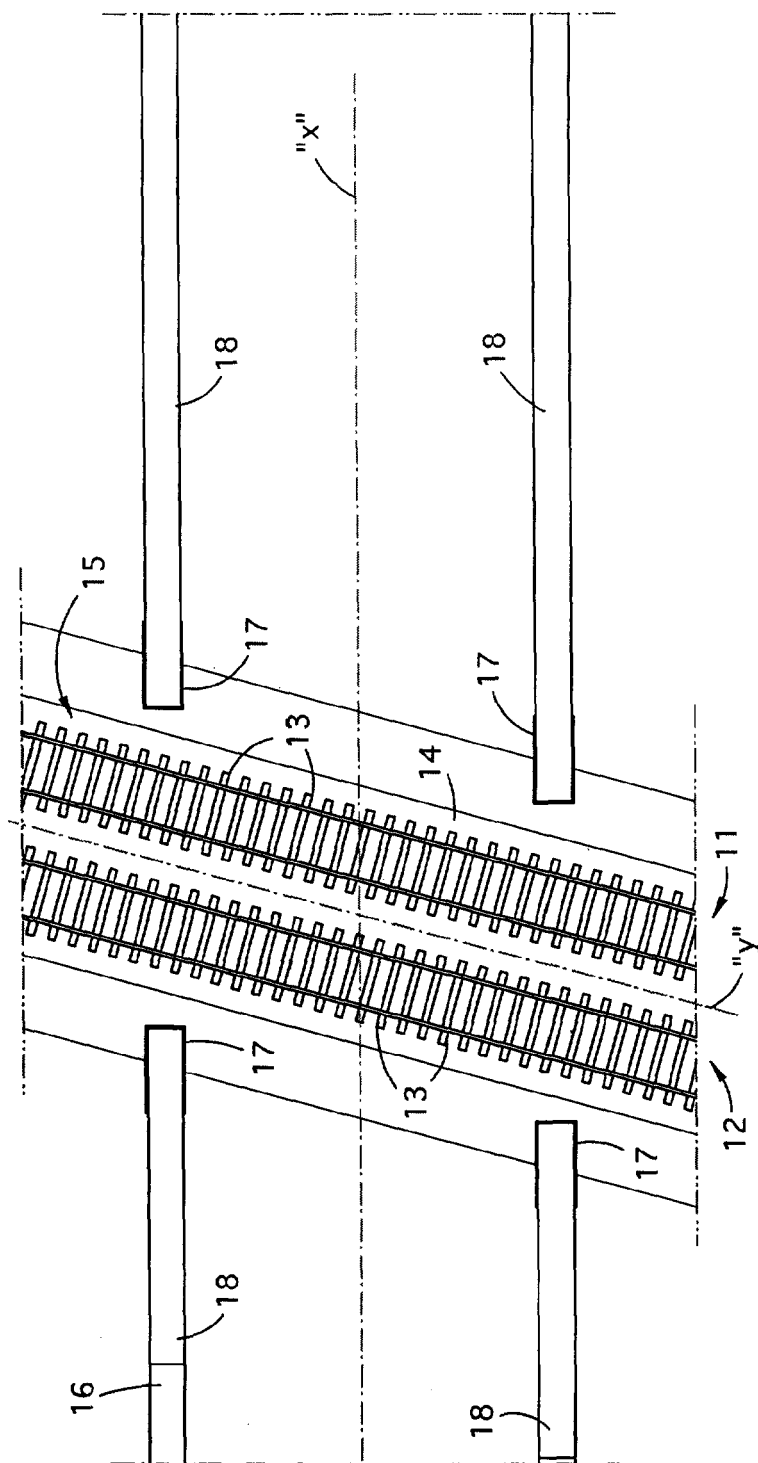


fig. 1

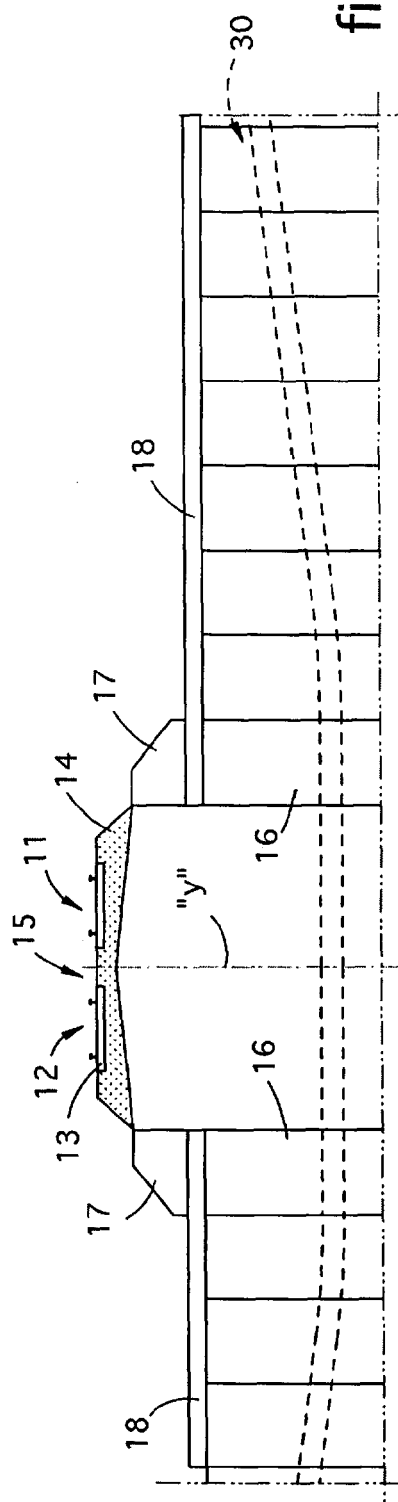
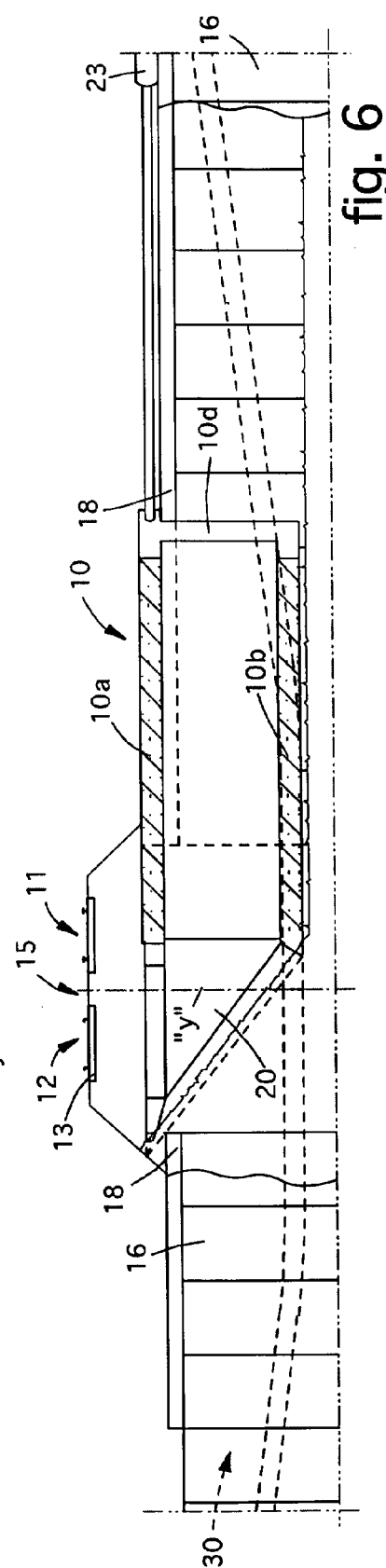
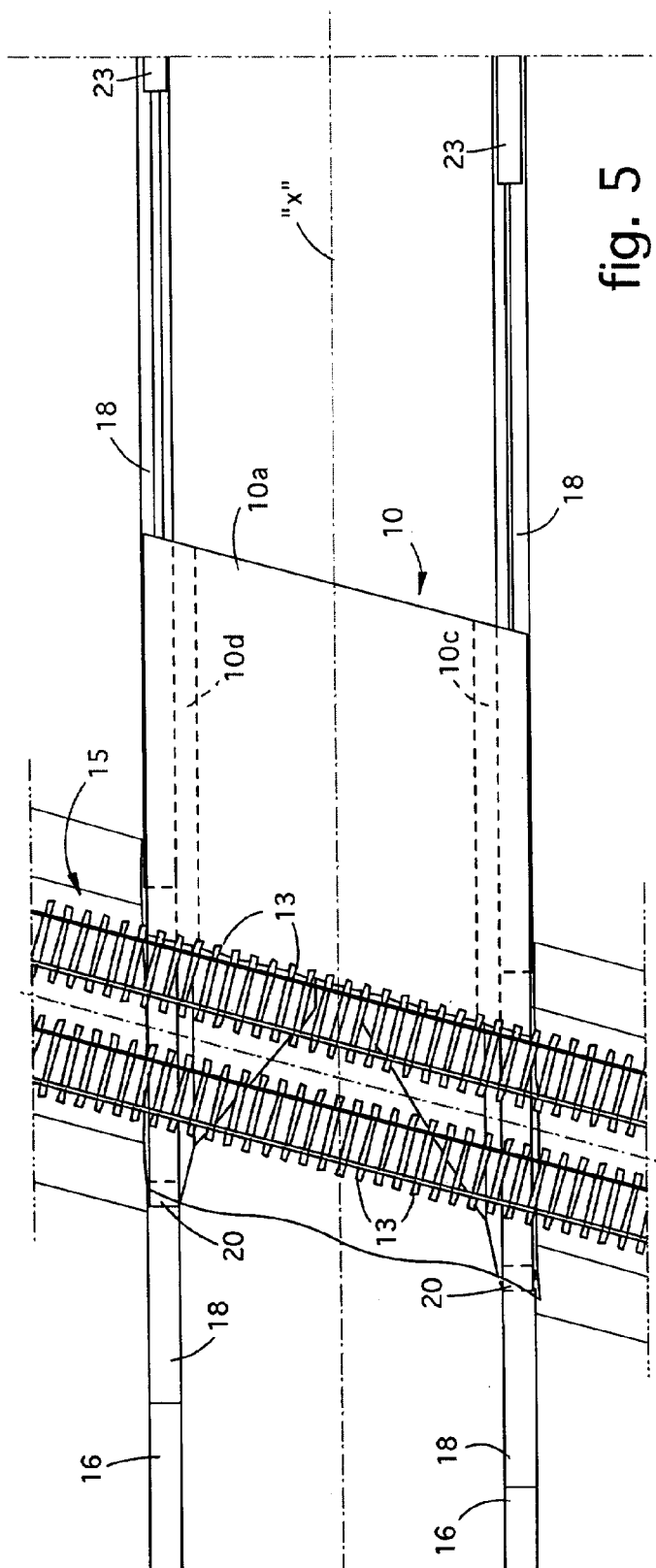


fig. 2



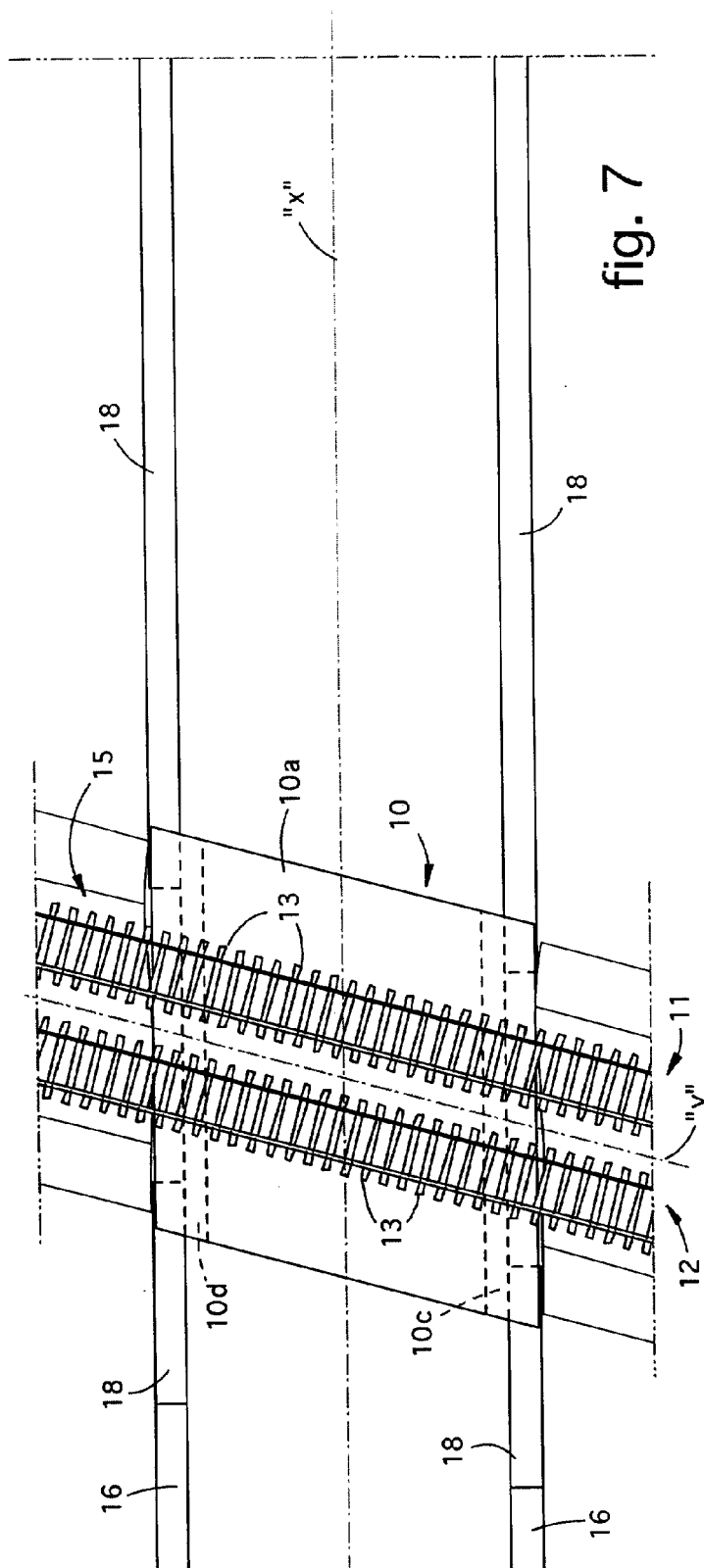


fig. 7

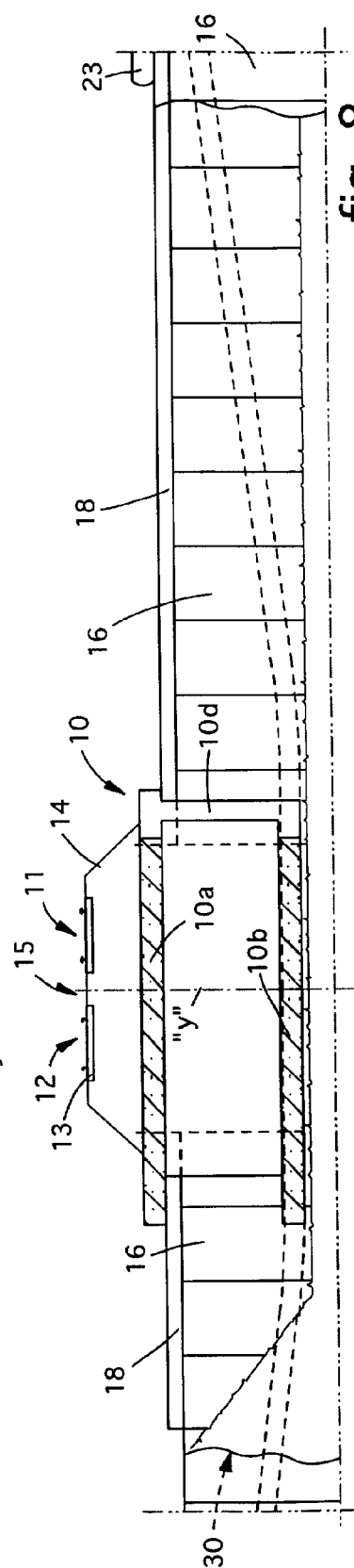
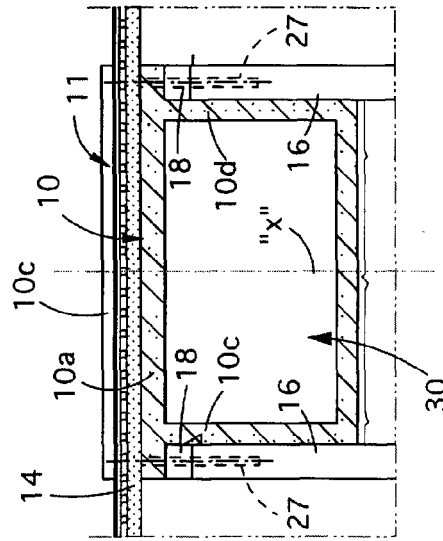
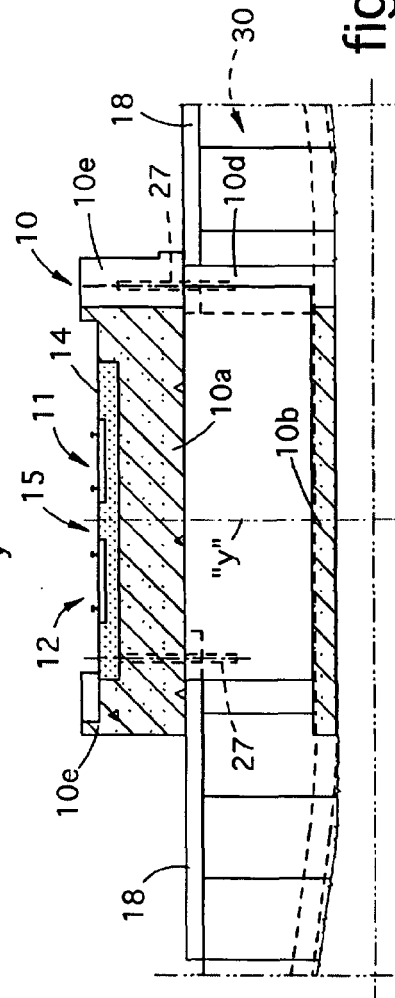
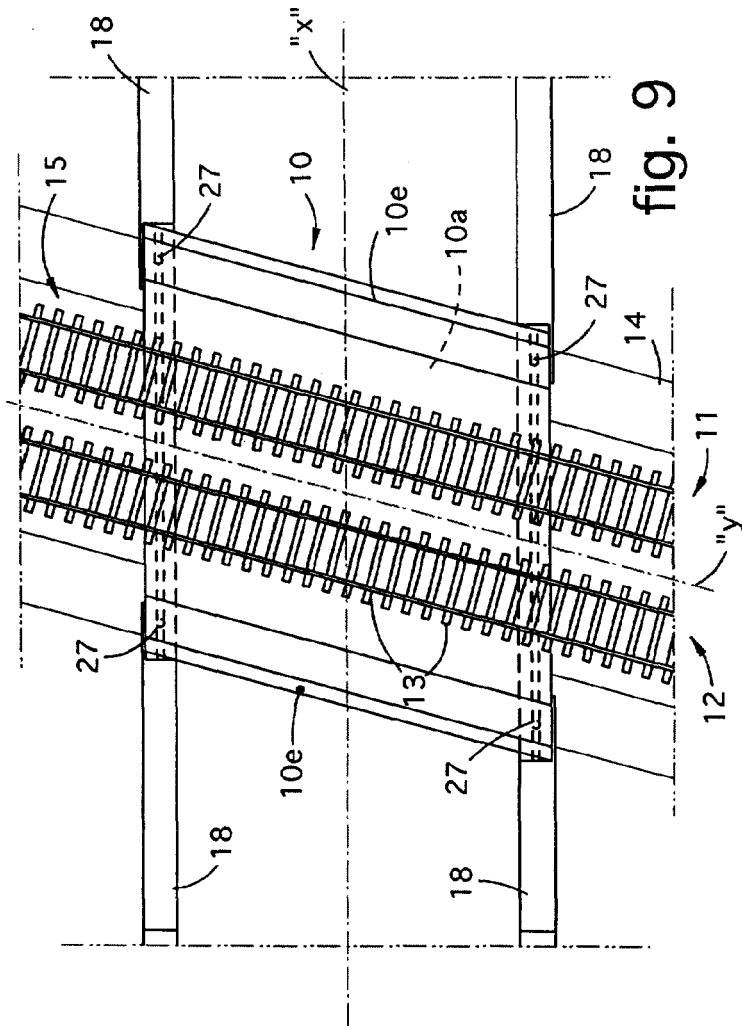


fig. 8





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 05 10 2837

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 309 739 A (ALFRED KUNZ GMBH & CO) 5 April 1989 (1989-04-05) * column 1, lines 2-5; figures 1-7 * * column 2, lines 24-31 * * column 4, lines 25,29-32,46-50 * * column 6, lines 30-45 * * column 7, lines 8-12 * -----	1-6,10, 11,13	E21D9/00 E02D29/045
A	DE 30 07 708 A1 (BILFINGER+BERGER BAUAKTIENGESELLSCHAFT) 10 September 1981 (1981-09-10) * claim 2; figures 1,2 * -----	12	
A	CH 442 404 A (REYMOND,FRITZ) 31 August 1967 (1967-08-31) * the whole document * -----	1-13	
A	GB 1 322 210 A (GEWERKSCHAFT EISENHUETTE WESTFALIA) 4 July 1973 (1973-07-04) * figures 1-4 * -----	2,3	
A	DE 28 02 751 A1 (BONG,FRIEDRICH; JUNG,CLAUS,DIPL.-ING) 26 July 1979 (1979-07-26) * the whole document * -----	1-13	TECHNICAL FIELDS SEARCHED (Int.Cl.7) E21D E02D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 September 2005	Examiner Georgescu, M
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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EPO FORM 1503 03.92 (P04C01)

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

EP 05 10 2837

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13-09-2005

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0309739	A	05-04-1989	DE	3733246 A1	13-04-1989
DE 3007708	A1	10-09-1981	NONE		
CH 442404	A	31-08-1967	NONE		
GB 1322210	A	04-07-1973	DE	2021839 A1	25-11-1971
			FR	2069538 A5	03-09-1971
DE 2802751	A1	26-07-1979	NONE		

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- IT UD20010031 A [0004]