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(54) Rail supporting assembly with cushioning fastening elements

(57) There is disclosed an assembly (100) for supporting and fastening to the ground (10) rails railway and/or subway lines with cushioning of vibrations, comprising a plurality of slabs (1) comprising fastening means (11) in the form of a parallelepiped formed by a rigid central structure (15) fixed to the plane (10) bearing said slab and by a cushioning frame (12) which surrounds said central part (15), said means being housed in a through cavity (8) formed by two recesses (4) of two adjacent slabs (1) formed on the sides (5) of said slabs (1) perpendicular to the longitudinal axis (3) of said rails (21).

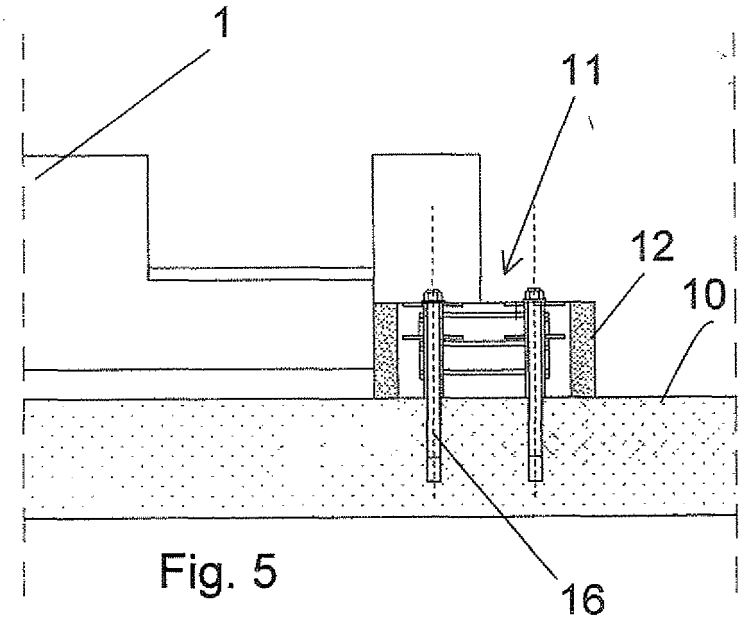

Fig. 5

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Description

[0001] The present invention refers to a rail supporting assembly comprising slabs with cushioning elements for fastening thereof to the ground.

[0002] Subway and railway lines that pass through urban centres present the problem of transmitting to the ground the vibrations generated by the passage of trains, which may damage structures in the vicinity of said lines.

[0003] In order to reduce transmission of said vibrations, efforts are made to insulate the railway line from the ground on which it rests by using elastic cushioning elements which are interposed between the seat of the railway structure represented by the cutting in the ground and the concrete slabs on which the rail supporting elements, for example sleepers, are housed and the rails themselves. In this manner there is a significant mass suspended on elastic cushioning layers, which essentially absorb the vibrations due to vertical oscillations.

[0004] In order to cushion the vibrations more, further cushioning elements may be interposed, underneath and to the sides, between the rail supporing elements and their seats (apertures) formed in said slabs.

[0005] The slabs are generally constrained to the ground to prevent both longitudinal tranlation (in the direction of travel of the train) and lateral translation with respect to the direction of travel, due to snaking of the carriages and the possible presence of bends, and to prevent unwanted movement thereof in the direction of travel in the event of braking.

[0006] The system generally used for fastening said slabs is represented by a pin which is made integral with the ground after having been inserted into a central hole formed in the slab. These pins are rigid elements and therefore are not able to absorb vibrations due to lateral oscillations which are normally of the order of a third of the vertical vibrations. The entity of such lateral vibrations can lead to considerable damage to the surrounding buildings, particularly when in the vicinity of archaeological sites or fragile monuments.

[0007] In general, the problem of cushioning vibrations in particularly fragile areas such as archaeological ones is also overcome by creating subway lines at a greater depth. This is the case of the new C line in the city of Rome, for example, passing under archaeological areas such as the Coliseum, the Imperial Forums, Trajan's Column and Piazza Venezia, which will be situated at a depth of 50 metres to avoid transmitting harmful vibrations to these monuments.

[0008] However, it is not always possible to go very deep into the ground and where it is geologically possible, there is a considerable increase in construction costs of the railway or subway network because of the complexity of the works, for example because of the considerable amount of earth to be moved.

[0009] Other solutions to this problem have been proposed in the art. For example, it has been suggested that cushioning elastic elements should be interposed, both laterally and beneath, between the slabs and the side walls of the seat of said slabs, fastening them adherently. This solution holds the drawback that the laterally positioned elastic elements protrude and may therefore represent a danger of tripping and an obstacle to escape routes in tunnels, thus making it necessary to create wider and therefore more costly tunnels.

[0010] Furthermore, in the case of subway lines, it is very important that if the system requires maintenance the transport stoppage is as short as possible since each line is a single one without by-passes.

[0011] The main object of the present invention is, therefore, to overcome the above mentioned drawbacks of the prior art, by providing a supporting assembly for railway and/or subway lines made up of slabs having a reduced transmission of stresses to the ground and improved cushioning of vibrations, even those due to lateral or transverse oscillations of the slabs during the passage of carriages on the rails.

[0012] A further object of the present invention is that of providing such an assembly that leaves escape routes free, and that does not require wider and thus more costly tunnels to be created.

[0013] Yet another object of the present invention is to provide such an assembly that is reliable, cheap, of simple construction, easy to install and quick to maintain without requiring long stoppages of traffic.

[0014] These and other objects are achieved with a rail supporting assembly whose characteristics are listed in appended independent claim 1.

[0015] Further advantageous characteristics of the invention form the subject matter of the dependent claims.

[0016] The invention refers to an assembly for supporting railway and/or subway lines and fastening them to the ground with high cushioning of vibrations comprising a plurality of slabs balancing on portions of cushioning elastic material in contact with the ground, provided with cushioning elements for fastening of said slabs to the ground.

[0017] Said fastening elements are able to stop longitudinal and/or transverse movements (displacements) of the slabs with respect to the ground, preventing them from shifting with respect to their seat but without impairing their ability to balance (float) in said resting position.

[0018] Each of said fastening elements is formed by a parallelepiped-shaped rigid central structure fixed to the ground (seat) and an outer rubber part (frame) which laterally surrounds said inner structure and in which each fixing element is housed in a cavity suitably formed in said slabs so that each cavity is a through cavity passing through the thickness of said slabs.

[0019] Each cavity is preferably formed by two recesses of two adjacent slabs made on the sides of each slab perpendicularly to the direction of movement (longitudinal axis of the rails).

[0020] Alternatively, each cavity as defined above may be replaced by a through cavity formed completely inside said slabs; or each cavity as defined above may be re-

placed by a plurality of cavities formed between adjacent slabs or formed completely inside each of said slabs.

[0021] In addition each of said cavities as defined above may be open at the bottom towards the ground but closed at the top towards the rails.

[0022] The central structure of the fastening element has such a stiffness as to withstand the stresses imparted by the train's passage. This stiffness is given by a plurality of tie bars which are inserted into the ground or supporting surface of the slab (seat) and by a metal cage which connects the tie bars, thus forming the central structure of the fastening element. This structure represents the reinforcement of the concrete in which said tie bars and said cage are immersed.

[0023] In this manner the central part of the fastening element acts as a stopper against movements of the slab in the direction of movement of the train and transversally to said movement whilst the external rubber part which surrounds the central structure acts as a cushioning element for the vibrations generated by lateral oscillations of the slab both in the direction of movement of the train and transversally to said movement.

[0024] The fastening element or stopper is in contact with the slabs through its elastic frame (outer cushioning rubber) and is fastened to the ground by means of tie bars: there are no other tie bars that fix the slab to the ground so that no tie bars pass through the slab.

[0025] This means that the fastening and stopping action exerted by said stopper on the slabs is solely that of preventing longitudinal (in the direction of travel of the train) and lateral shift, at the same time allowing slight oscillations, even lateral ones, which are acceptable thanks to the presence of the outer cushioning rubber which surrounds the rigid central part of each fastening element in a row.

[0026] The number of fastening elements is not binding for the purposes of the present invention. In fact since the rails keep the slabs bound to each other, one might think of using a smaller number of the above described cushioning fastening elements than the number of slabs, for example providing for there to be two or more, preferably three, slabs between two fastening elements.

[0027] More preferably, each slab is in contact with two fastening elements, one in front of and one behind each slab, and each fastening element contributes to block two adjacent slabs laterally and in the direction of the rails.

[0028] In any case it is preferable to "skip" a stopper every so often (for example one out of ten or even twenty) to allow water to drain easily into the manholes beneath.

[0029] What is meant by the term "slab" is any block of reinforced concrete on which one or more rail contact and constraining assemblies must be housed. Said blocks of reinforced concrete are constrained to each other by means of the rails which pass from one block to another.

[0030] What is meant herein by the term "rail supporting (or bearing) elements" is any element on which a rail may be rested and able also to carry the members for fastening of said rail to said element. These elements may be blocks, sleepers or couplers for rails formed directly with the slab by concrete casting, preferably sleepers, commonly used in the railway and subway field. The sleepers may be standard railway sleepers, of wood, French type twin-block, etc.

[0031] In the assembly for supporting and fastening rails to the ground of the present invention, the slabs used are prefabricated reinforced concrete elements, made with such a configuration and profile as to house a predetermined fastening element (stopper). Said stopper also is a prefabricated element.

[0032] Furthermore, said slab is generally in the form of a parallelepiped whose dimensions depend upon the characteristics and the type of railway or subway line that is to be built, the dimensions of the fastening element remaining equal. In fact the shape of the slab also depends upon the type of supporting element that is chosen in creating the line which will be housed in one or more apertures specially formed in the slab.

[0033] It is in fact possible to make a slab suitable for housing one or more sleepers and then divide each housing (aperture) provided for the sleeper into two sectors separated by the use of a dividing wall, even a solid one, thus forming a slab suitable for housing "rail supporting elements" in the form of blocks. Alternatively it is possible to put the two blocks directly into a single housing and keep the two blocks spaced apart with metal spacers able to ensure a correct and constant distance between the rails. Sleepers like blocks are preferably kept still, after having been connected to the rails, by pouring the appropriate liquid mortar into the housings (apertures formed in the slab).

[0034] It is also possible to enclose said elements in a rubber shell with cushioning properties, open at the top, and then insert them inside the apertures formed in the slab and then cast cement or mortar in said apertures so as to constrain said supporting elements to the slab.

[0035] As stated above, in the assembly of the present invention, cushioning elastic elements are also provided, interposed between the seat of the railway structure represented by the excavation in the ground (also known as the slab) and the cement slabs, over which the present slab assembly floats.

[0036] The invention will now be described with reference to a purely exemplifying (and therefore non limiting) embodiment thereof, illustrated in the appended figures, wherein:

- Figure 1 is a diagrammatic, axonometric partial view of the assembly including the sleepers and rails;
- Figure 2 is a diagrammatic, axonometric bottom view of Figure 1;
- Figure 3 is a top plan view, partially broken off, of the assembly;
- Figure 3a is a cross sectional view of the assembly of Figure 3 taken along the line C-C;

- Figures 4a e 4b show two longitudinal sectional views of the assembly of Figure 3 taken along the lines A-A and B-B, respectively;
- Figure 5 is an enlarged view of the area indicated as Part.1 in section A-A of Figure 4;
- Figure 6 is a top view of the central structure of the fastening element illustrated in Figure 5;
- Figure 7 is a diagrammatic, axonometric view of the outer frame of the fastening element.
- Figure 8 is diagrammatic, axonometric view of a slab during linking to two already laid slabs, showing the components of one of the slabs exploded.

[0037] In the appended drawings, like elements will be identified by the same reference numerals.

[0038] Figure 1 shows diagrammatically part of an assembly 100 for supporting and fastening to the ground rails of railway and/or subway lines 21, with vibration cushioning, of the present invention, represented for simplicity of the drawing by three slabs (defined also as plates), each designated by the reference numeral 1 and including sleepers 20.

Reference numeral 11 indicates a fastening element which is placed between one slab 1 and the other (Figure 2). Beneath each slab 1 there are positioned elastic cushioning elements 9 which in turn rest on the seat 10 of the assembly (Figure 3a).

[0039] Said elastic cushioning elements 9 do not form a continuous cushioning layer since they cover the lower surface of each slab only partially, giving rise to a slab assembly floating over said elements 9.

[0040] In actual fact there is a limited number of said elastic elements 9 beneath each slab 1, for example two or three, which cover the lower surface of each slab only partially. In this manner each slab can float in its resting position.

[0041] The seat 10 is created after having carried out the excavation, housed suitable pipes, for example for drainage of rain water, and after having performed compacting operations so as to provide a highly coplanar plane, as illustrated in Figure 3a.

[0042] Figure 3 shows diagrammatically the part of the assembly 100 illustrated in Figures 1-2 but without sleepers 20 (or ties) and rails 21 and without some fastening elements 11 (those adjacent to two slabs 1) for the sake of simplicity of the drawing. Each of said slabs 1 has a plurality of three housings 2 able to accommodate the sleepers 20 (Figure 1). Each slab 1 further has two C-shaped undercuts 4 cut in the sides 5 perpendicular to the axes 3 of the rails. When two slabs 1 come to be in a position adjacent to one another, the respective C-shaped undercuts 4 form a rectangular cavity 8. Said cavity 8 passes through the thickness of the slabs 1.

[0043] The central axis of said undercuts 4 coincides with the central axis of the slab (parallel to the axis 3 of the rails) so that the cavity 8 formed by the two undercuts 4 comes to be lateral with respect to the slab and in a central position with respect to sides 5. However, the position of the cavity 8 with respect to the side 5 perpendicular to the axis 3 is not binding for the purposes of the present invention.

[0044] The fastening element 11 is housed in one or more of said cavities 8 formed by adjacent slabs 1. Said fastening element 11 is only in contact with the undercuts 4 of the slabs as shown in Figure 3.

[0045] In particular said fastening element 11 or stopper is in contact with the slabs through its elastic frame (outer cushioning rubber) and is fastened to the ground by means of tie bars.

[0046] There are no other tie bars fastening the slab to the ground, so no tie bars pass through the slab.

[0047] As stated, rubber or elastic elements 34 can be inserted between the sleepers 20 and their seat in the slab 1 (Figure 8) in order further to reduce vibrations. Said elements 34 are generally glued around the ends of the sleepers 20 and subsequently said sleepers are laid in the respective housing 2.

[0048] After this laying and after having constrained the rails 21 to said sleepers 20 equipped with rubber 34, it is possible to add the appropriate liquid mortar 33 (Figure 8) of the type generally used in the art in housings 2 to constrain the sleepers 20 (Figure 8)or the supporting blocks for the rails 21, after having lifted the rail-sleeper assembly with special means according to the method normally used for laying rails on slabs.

[0049] The fastening element 11 will now be described in detail with reference to Figures 5-7.

[0050] Said fastening element 11 is formed by an outer rectangular frame 12 made of cushioning elastic material, for example rubber, and the outer profile thereof equal to the size of the cavity 8 formed by the undercuts 4 of two adjacent slabs 1. Any cushioning material used in the art to reduce and/or cushion mechanical stresses and the transmission of vibrations can be used as cushioning elastic material.

[0051] The thickness of this frame 12 depends upon the entity of the stresses that must be attenuated or completely cushioned. The major sides of said rectangular frame 12 will attenuate stresses on the slab in the direction of travel of the carriage (directed along the longitudinal axis 3 of the rails) whereas the minor sides of the rectangle will dampen lateral or transversal stresses on the slab 1 due to the oscillating movement of the carriage, as will be described in greater detail.

[0052] The thickness of the frame 12 can advantageously range from 20 to 200 mm, for example. In a preferred embodiment the thickness is 40 mm.

[0053] The lateral surface of said frame 12 preferably has recesses 30 and protrusions 31 (Figure 7) able to ensure a high elastic deformability of the frame 12 following stresses.

[0054] Inside the frame 12 of the fastening element 11 there is provided a rigid structure 15 which includes a plurality of tie bars 16, for example six (Figure 6), which are inserted in the ground or cement of the seat 10. Each of said tie bars 16 is constrained coaxially to a circular

metal strap 19. Said tie bars are also constrained to each other, both longitudinally and transversally, through a metal cage 18. Said cage 18 is formed of a plurality of metal rods which come into contact with the structure 15 that surrounds the tie bars 16 and connect to each other the opposite tie bars 16 positioned along the major sides of said rectangular profile. All these components are further immersed in concrete, thus giving rise to a rigid central reinforced concrete structure 15 wherein the cage 18 represents the reinforcement.

[0055] The combined action between the straps 19, the tie bars 16, the structure 15 and the cage 18, as well as the presence of the concrete, gives the fastening element 11 a high stiffness. In particular the presence of the straps 19 allows the structure 15 to be considerably reinforced, allowing stoppers 11 of more limited size to be created.

[0056] In a preferred embodiment the tie bars 16 are six and have a diameter of 22 mm and a length of 261 mum, the metal rods forming the cage 18 have a diameter of 8 mm, and the straps 19 have a diameter of 100 mm and a thickness of 5 mm.

[0057] In another preferred embodiment the tie bars 16 are eight, keeping the above mentioned characteristics unchanged, giving rise to a rigid structure with a length of 800 mm and a width of about 300 mm.

[0058] The fastening element 11 performs the function of keeping the position of the slab 1 substantially fixed in its seat with respect to the length of the rail like any centring means used in the art and at the same time performs the function of a cushioning element for lateral oscillations of the slab thanks to the rubber frame that surrounds said fastening element. Furthermore, resting the slabs 1 on portions of elastic cushioning material 9 gives the assembly the ability to float but without any forward movement during the passage of the train thus considerably reducing the transmission of stresses to the ground with respect to other systems.

[0059] In practice the stopper as described above allows horizontal transverse and longitudinal thrusts induced by possible movements of the train such as centrifugal, winding and braking movements to be absorbed.

[0060] One of the advantages of the fastening means or stopper according to the present invention is that of being separate and not constrained to the slab so that replacement thereof in the event of breakage is extremely fast since it does not involve the slab. This is particularly advantageous for subways where the line is a single one with a high frequency of journeys so that the stoppage of traffic must be as short as possible.

[0061] Furthermore, such an assembly is also advantageous compared with assemblies used for non-subway lines wherein the slabs rest on an underlying concrete slab thanks to the presence of protruding parts suitable to be fixed in the slabs beneath, provided with non through cavities, by means of a groove-and-tongue coupling, so as to obtain fixing of the slab. However, this embodiment entails long maintenance operations in view of the need to lift the slab to gain access to the underlying concrete slab.

[0062] Another advantage of use of the present stopper is that of representing a fastening element that does not interfere either with the rails or with the ties (or sleepers) as shown in Figure 8. Furthermore, the present assembly can be laid rapidly in that it is formed essentially by prefabricated components that are easily coupled and are fixed in position thanks to a simple addition of concrete or mortar 33 which creates an embedment as shown in Figure 8.

[0063] Without departing from the scope of the invention, an expert can make to an assembly previously described all the modifications and improvements suggested by normal experience and/or by the natural evolution of the art,

Claims

1. Assembly (100) for supporting rails (21) of railway lines and/or subway lines comprising

   - a plurality of floating slabs (1) placed on portions (9) of cushioning elastic material contacting with the ground (10), said slab being able to support elements (20) suitable to bear said rails (21); and
   - fastening means (11) suitable to stop the longitudinal and/or transversal movements of the slabs with respect to the ground (10) thus fixing said slabs (1) to their seat in the ground (10)

   characterized in that the fastening means (11) are housed in through-cavities (8) formed between adjacent slabs (1) and that said means (11) are formed by a central rigid structure (15) fixed to said ground (10) surrounded laterally by a peripheral frame (12) made of cushioning elastic material which is in contact with said cavities of said slabs.

2. Assembly according to claim 1 wherein each of said cavities (8) is formed by two undercuts (4) cut in the sides (5) of two adjacent slabs (1), said sides (5) being perpendicular to the longitudinal axis (3) of said rails (21).

3. Assembly according to claim 1 wherein each of said cavities (8) is replaced by a cavity formed completely inside said slabs (1); or each of said cavities (8) is replaced by a plurality of cavities formed between adjacent slabs (1) or by a plurality of cavities formed completely inside each (1) of said slabs (1).

4. Assembly according to any one of the preceding claims wherein said central structure (15) of the fastening means (11) comprises a plurality of tie bars (16) suitable to be inserted into the ground (10), or

in a plane bearing said slabs (1), and constrained to each other, both in longitudinal and transversal direction, through a metal cage (18) which forms the reinforcing structure of each of said fixing elements (11).

5. Assembly according to claim 4 wherein said cage (18) is formed of a plurality of metal rods that surround said tie bars (16) and connect to each other the opposite tie bars (16), each of said tie bar being constrained co-axially to a circular metal strap (19).

6. Assembly according to claim 5 wherein the central structure (15) further comprises concrete reinforced by said reinforced structure (18).

7. Assembly according to any one of the preceding claims wherein said peripheral elastic frame (12) has recesses (30) and protrusions (31).

8. Assembly according to any one of the preceding claims wherein the portions of cushioning elements (9) interposed between each slab (1) and the ground (10) bearing said slabs (1) are three and cover the lower surface of each slab only partially.

9. Assembly according to any one of the preceding claims wherein said elements (20) bearing said rails (21) are selected from blocks, sleepers, couplers for rails and similar, which are housed into seats (2) provided into the slabs (1), optionally by means of mortar addition.

10. Assembly according to any one of the preceding claims wherein two or more slabs (1), preferably three, are provided between two fastening means (11) in a row.

11. Slab (1) for supporting elements (20) suitable to bear rails (21) as defined in any one of the preceding claims 1-10.

12. Fastening means (11) for fixing to the ground (10) slabs (1) for supporting elements (20) suitable to bear rails (21), as defined in any one of preceding claims 1-10.

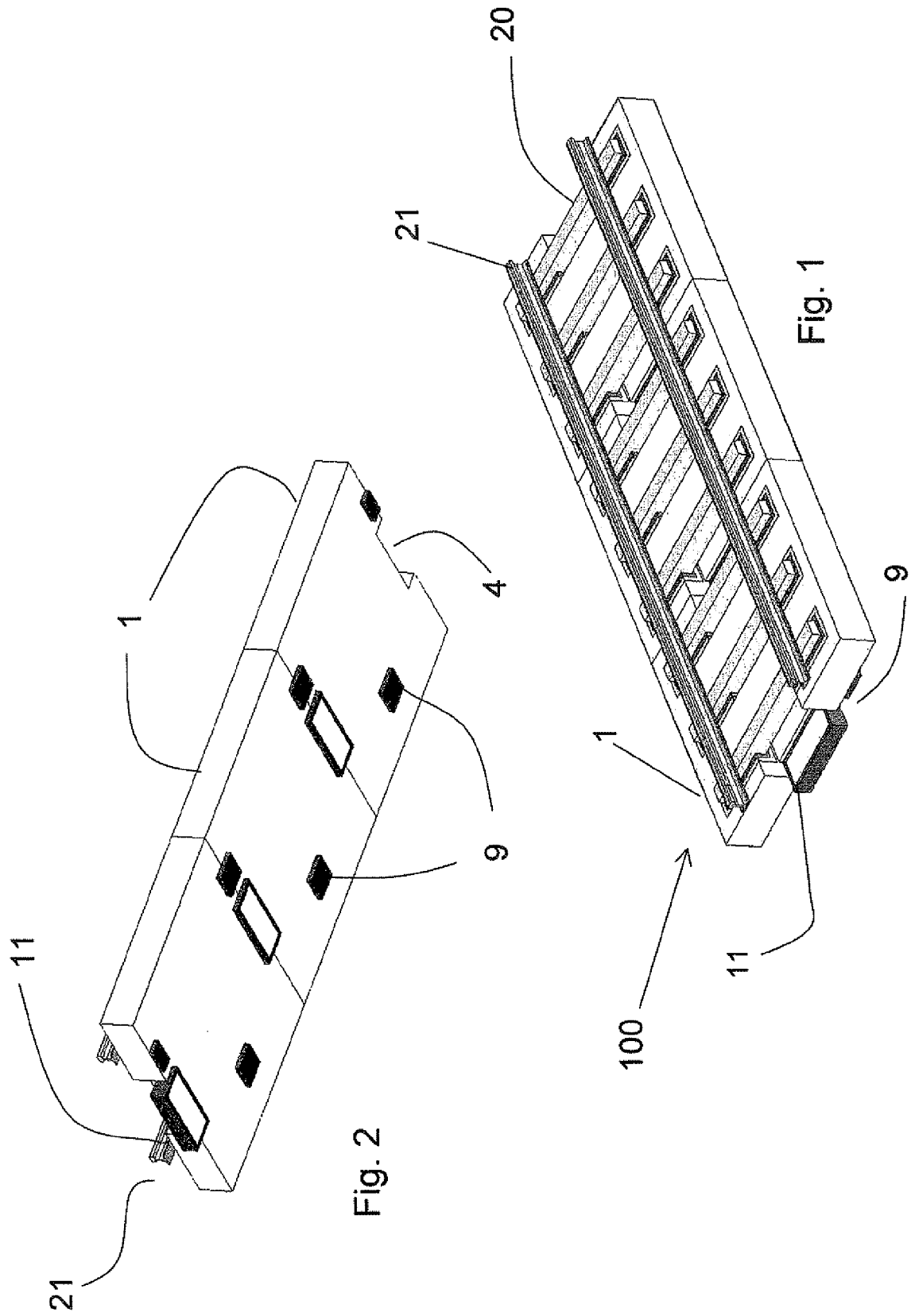

Fig. 1

Fig. 2

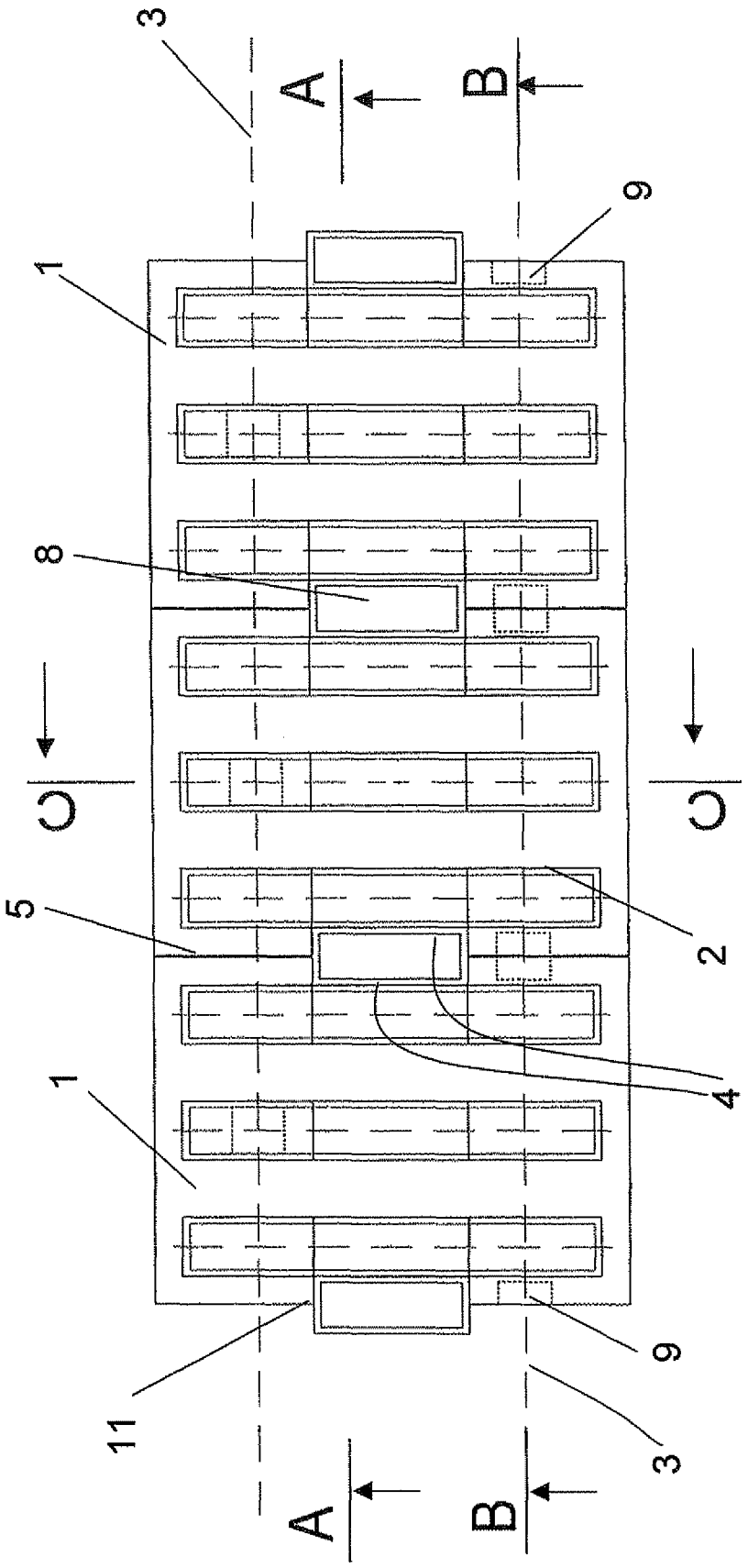

Fig. 3

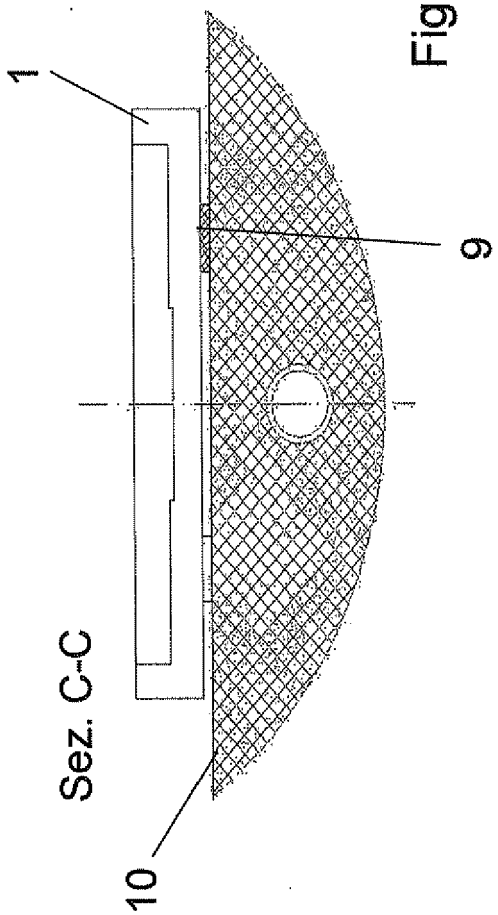

Fig. 3a

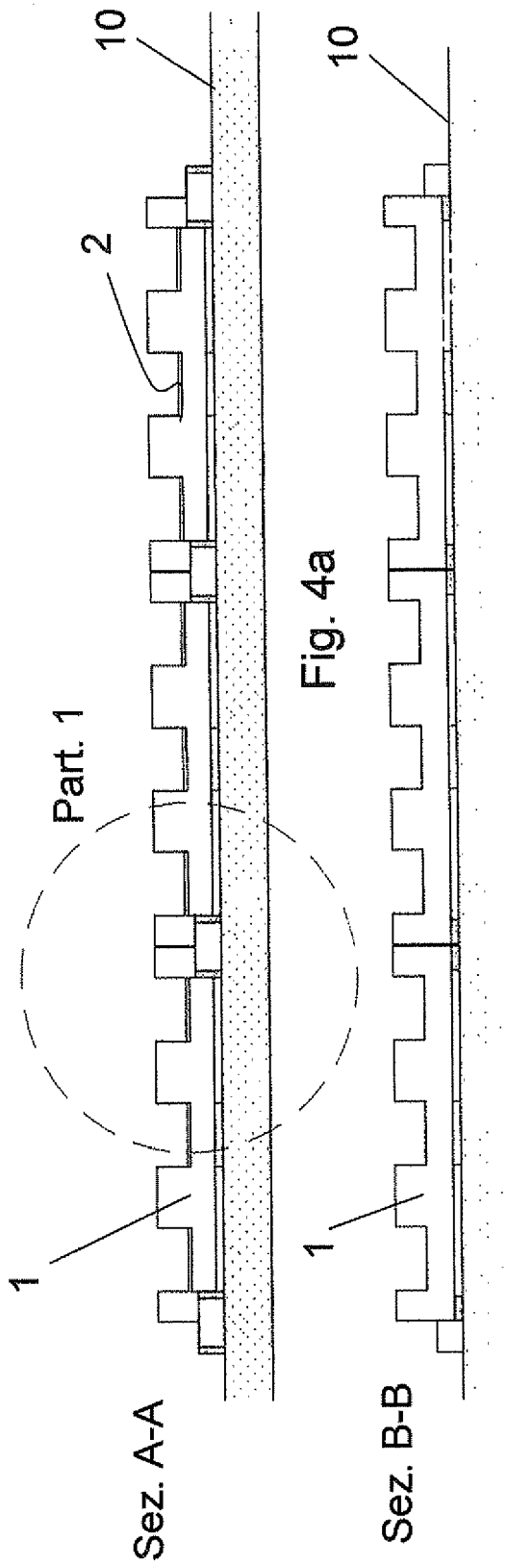

Fig. 4a

Fig. 4b

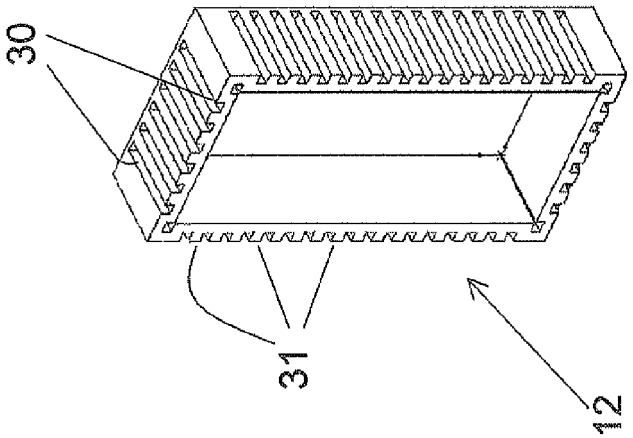

Fig. 7

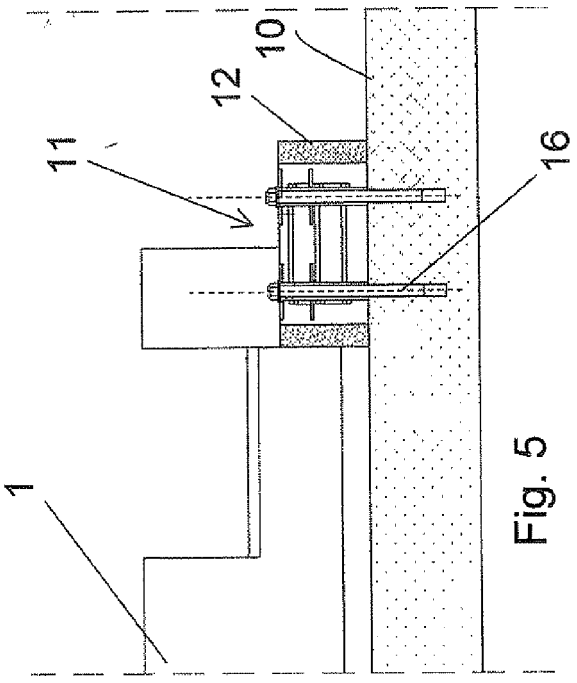

Fig. 5

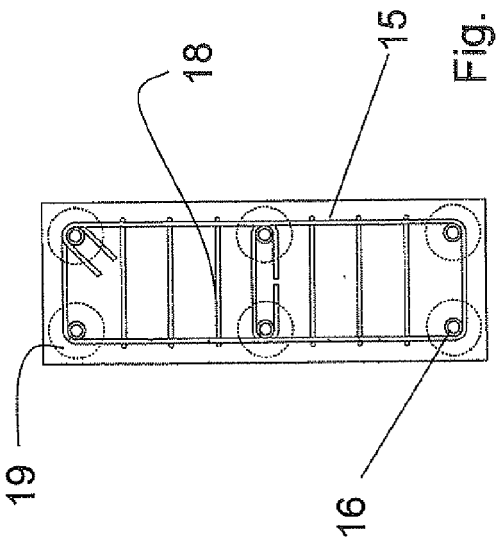

Fig. 6

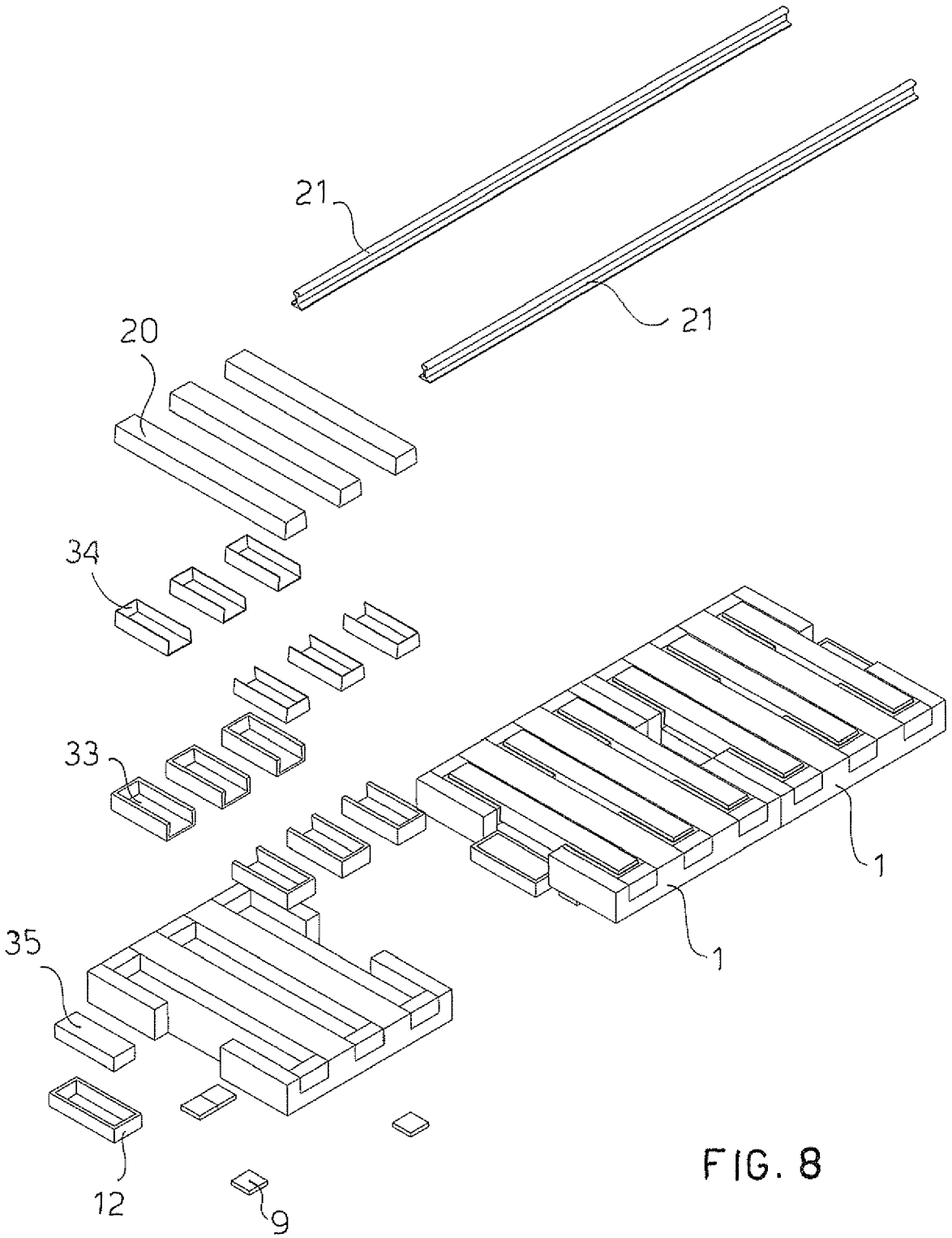

FIG. 8