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(54) **TRANSPORT SYSTEM**

(57) The invention relates to the field of transport, particularly, to rail transport systems with string-type track structure and represents, at least, one rail cord (3), tensioned above the foundation (1) between anchor (2) supports, which contains at least three discrete load-bearing elements (4), prestressed in longitudinal direction and positioned on the same line L in the cross section of the rail cord (3). The discrete load-bearing elements (4) are fixed resting on the caps (5) of intermediate (6) supports, with use of cross bulkheads (7).

Hereby, each discrete load-bearing element (4) contains contact surface K, continuous along the entire length of the rail cord (3), configured with the possibility of forming in totality, by all discrete load-bearing elements (4), of the rolling surface N of the rail cord (3) for self-powered wheeled vehicle (9), whereby the profile of the tread surface Z of wheels (10) mates with the profile of the rolling surface N of the rail cord (3) in places of fastening thereof on the caps (5) of supports (2) and/or (6).

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Description

Technical field

[0001] The invention relates to the field of transport, particularly, to rail transport systems with string-type track structure. It can be used in development of both single-rail and multi-rail roads to provide passenger and cargo traffic in rough terrain, mountains, deserts, as well as in megacities and on offshore sections of transport lines.

Background Art

[0002] A suspension transport system is known, which comprises a running track and a vehicle in the form of a body. Running track is made in the form of two-rail track located on longitudinal beams installed on internal cantilevers of intermediate supports. The system is equipped with a propulsor in the form of a bogie with an electric motor installed thereon and a body on a pneumatic stabilizer [1].

[0003] The drawbacks of this transport system are the increased material capacity of its design, due to the very limited carrying capacity of the running track beams, as well as the complexity of transporting the beams of extended span structures to the installation site, the complexity of their assembling in the field under difficult landscape and the limited possibilities of their use to construct large spans between adjacent intermediate supports.

[0004] Also known is a guide track comprising two supporting and longitudinal elements connected by transverse elements, provided with side sheets connecting the supporting elements to the longitudinal element which is also sheet-shaped, wherein one part of the transverse elements may be connected to the supporting elements and the other part - to the supporting and longitudinal elements [2].

[0005] The disadvantage of this technical solution is that the known transport system has a bulky metal-capacious design of the track structure, which requires very small spans between the intermediate supports of the overpass to ensure its reliability. The increase in spans between supports, despite the structural stiffness of the rails of such profile, causes (provided that reliability is maintained) an excessive increase in the material capacity of the track structure and a decrease in its specific bearing capacity. Additionally, the conditions for delivery and installation of structural elements to the destination (installation) become significantly more complicated.

[0006] A transport system consisting of a support monorail and a transport module is known, wherein the support monorail is uniformly rested through modules - tetrahedra on piles - cross-ties in the soil, and has starting slides and finishing anti-slopes, and its transport module is a platform with two cabins on four central double-flanged wheels and four side support rollers, with autocentering flywheels - gyroscopes, with the possibility of install-

ing a body - compartment, tank, container, onboard platform with racks for transportation of various cargoes. In another embodiment of such a transport system, it consists of a suspended monorail and a transport module, in which the suspended monorail is an I-beam suspended by braces along the ribs of modules - tetrahedra to two longitudinal load-bearing ropes tightened by transverse ties and also has starting slides and finishing anti-slopes. In this case, the transport module is suspended [3].

[0007] Disadvantages of such technical solution are that said transport system has a low specific bearing capacity, if it is understood to mean the ratio of the payload weight to the dead weight of the members of its track structure, which is especially important for overpass and suspended roads and, in this case, leads to a significant increase in the cost of such a transport system, and also, to increase in the complexity of delivery to the installation site and during assembly in the field of the elements of the running track of the track structure and limiting the possibilities of using the track of the specified structure to build large spans between the adjacent intermediate supports.

[0008] A general drawback of the known overpass-type transport systems is the low specific bearing capacity of their track structures, which leads to a significant increase in the cost of the entire transport system. Such transport systems, as a rule, provide for the design of a track structure in the form of heavy and bulky beams of extended span structures, the delivery and installation of which in real field conditions in a complex landscape is a very time-consuming and costly technology.

[0009] Moreover, the presence of joints in the track and the thermal deformation of the rails of such transport systems do not allow the phenomenon of a "velvet-smoot" track for the vehicle, which means that it is impossible to achieve high speed and ensure high reliability of transportation on track structures of such type.

[0010] The further development of the structures of transport systems of suspended and overpass types was stimulated by the elaboration and creation of a transport system based on the string track structure by Yunitski, which is based on the use as the main structural elements of the rail of its longitudinally prestressed load-bearing string components.

[0011] Transport system by Yunitski is known, which includes at least one track structure tensioned above foundation, in span between supports, in the form of a load-bearing member enclosed in a body with a rolling surface for the movement of wheeled vehicles installed on the track structure [4]. In the abovementioned arrangement, cross-sectional areas of the load-bearing member and the rail body with the rolling surface are optimized, as well as tensile forces of the track structure and the load-bearing member of the said structure, permissible values of sagging of the track structure between adjacent supports and the height of supports are justified.

[0012] However, the known transport system has an excessive material capacity and, therefore, an increased

cost, as well as low manufacturability and, as a result, high labor capacity.

[0013] String transport system by Yunitski is also known, which includes at least one, tensioned above foundation, in span between anchor supports, rail cord in the form of load-bearing member encased in body with rolling surface for self-propelled vehicles. Hereby, the load-bearing elements of the load-bearing member are connected to each other and to the body in a monolith (throughout the volume) by means of filling aggregate. The supports have transition sections of the track, and the rail cord in the span between the supports is made with sagging deflection of a certain slope, and the transition section of the track on the support is made with the same slope as the segment of the suspended section of the track mating therewith in the span between the supports [5].

[0014] The above described track structure possesses both high material intensity and labor capacity, and, therefore, increased cost, and insufficient processability.

[0015] Among transport systems with a rail track structure related to suspended and overpass roads, a rail by Yunitski transport system is known, which contains a hollow tubular body with an overlay head, inside which there is a load-bearing member made of prestressed load-bearing elements, mainly wires and/or ropes, distributed over the cross section of the rail, whereas the walls of the body are closed. Different options of distribution of ropes over rail cross section and optimal ratio of cross-sectional areas of the rail body and the ropes are possible. Hereby, the body is made in the form of a spiral enveloping the load-bearing member, and the overlay head is fastened on the whorls of the spiral. Additionally, the space between the body and the load-bearing member is filled with the filling aggregate [6]. Method of manufacturing of such rail of the track structure by Yunitski consists in the fact that the load-bearing member is formed of the load-bearing elements and used as mandrel in manufacture of rail body, whereby, at the same time, the rail body is produced and the load-bearing member is simultaneously placed therein by laying on the surface of the load-bearing member of layer winding from high-strength wire or band.

[0016] The transport system with such rail cords ensures high processability of manufacturing thereof. However, the materials intensity of the specified track structure obtained by the described method is still excessive. The closest to the claimed invention, in terms of technical essence and the achieved result, is the transport system by Yunitski [7], which is accepted as a prototype. It includes at least one rail cord tensioned above the foundation in spans between supports in the form of a load-bearing member containing load-bearing elements prestressed in the longitudinal direction, concreted into binder layer of the load-bearing member, and enclosed in a hollow body with a rolling surface for movement of wheeled self-propelled vehicles installed on the track structure.

[0017] In the above described technical approach, the rail cord is equipped with a hollow body, which functions as a casing for load-bearing member. Hereby, the hollow body is equipped with rolling surface for self-powered wheeled vehicles, whereas the load-bearing member, positioned in the hollow body, is made in the form of prestressed in the longitudinal direction load-bearing elements, which are concreted into the binder layer of the load-bearing member. The load-bearing member with a hollow body, wherein it is located, are joined with the use of the binder layer. The transport system with track structure of such type provides high specific bearing capacity, however, the materials intensity and processability of the rail cord design remain insufficiently optimized.

[0018] It is expedient to simplify the design of the rail cord.

[0019] The basis of the claimed invention is the task of achieving the following technical goals:

- increase of specific bearing capacity of the track structure;
- simplification of the processes of delivery of components of the track structure and installation thereof in real conditions;
- reduction in materials intensity and labor capacity with increased processability of the track structure manufacture.

[0020] The solution of this task is ensured by the whole set of distinctive features of the proposed transport system.

Summary of invention

[0021] The required technical results and aims of the invention are achieved thanks to the fact that in the transport system by Yunitski, which includes at least one rail cord, tensioned above foundation between anchor supports, containing at least three discrete (isolated) load-bearing elements, prestressed in longitudinal direction and positioned on the same line in the cross section of the rail cord, head, wherein each discrete load-bearing element contains contact surface, continuous along the entire length of the rail cord, configured with the possibility of forming, in totality, by all discrete load-bearing elements, of the rolling surface of the rail cord for self-powered wheeled vehicle, whereby the width S , m, of the rail cord is related to the height H , m, of its discrete load-bearing elements by the ratio:

$$3 \leq S/H \leq 50,$$

whereas the gap δ , m, between the adjacent discrete load-bearing elements is described by the dependence:

$$0 \leq \delta/H \leq 5$$

[0022] The transport system may be embodied in such way that the gap δ , m, between the adjacent discrete load-bearing elements is preferably described by the dependence:

$$0 \leq \delta/H \leq 2$$

[0023] Most preferably, that the transport system is embodied in such way that the gap δ , m, between the adjacent discrete load-bearing elements is described by the dependence:

$$0 \leq \delta/H \leq 1$$

[0024] The above-mentioned technical aim is also achieved thanks to the fact that the rail cord is tensioned up to the force, defined by the ratio:

$$10 \leq T/(Mg + mg) \leq 200,$$

where: T, N - tensile force of the rail cord;

M, kg - total calculated weight of self-powered wheeled vehicles, located simultaneously on the rail cord in span between the adjacent supports;

m, kg - weight of the rail cord in span between the adjacent supports;

g, m/sec² - acceleration of gravity.

[0025] The technical aim is also achieved thanks to the fact that the line of positioning of discrete load-bearing elements in the cross section of the rail cord is embodied as straight line or curve line.

[0026] The technical aim is also achieved thanks to the fact that the wheels of self-powered vehicle are embodied as double-flanged.

[0027] The technical aim is also achieved thanks to the fact that the profile of the tread surface of wheels mates with the profile of the rolling surface of the rail cord in places of fastening thereof on the caps.

[0028] The technical aim is also achieved thanks to the fact that the caps of the intermediate supports are embodied in the form of saddles.

[0029] The technical aim is also achieved thanks to the fact that the load-bearing elements are fastened on the caps of the intermediate supports with use of cross bulkheads.

[0030] The technical aim is also achieved thanks to the fact that the discrete load-bearing elements, in spans between intermediate supports, are connected to each other by cross bulkheads.

[0031] The technical aim is also achieved thanks to the fact that the cross bulkheads are equipped with retainers of lateral displacement of discrete load-bearing elements.

[0032] The technical aim is also achieved thanks to the

fact that the profile of discrete load-bearing element is embodied, for example, in the form of a circle, or an ellipse, or a square, or a rectangle, or a rhombus, or a triangle, or a trapezoid, or a polygon.

[0033] The technical aim is also achieved thanks to the fact that the discrete load-bearing elements are embodied in the form of wire, or twisted or untwisted ropes, or strands, or cords, or rods, or tubes, or combinations thereof.

[0034] It is expedient that the discrete load-bearing elements are made from materials based on high-strength steel, or glass fiber, or Kevlar, or polyetheretherketone, or graphene.

15 Brief description of drawings

[0035] Hereinafter, the essence of the invention will be explained by the accompanying drawings (Figs. 1 - 13) showing the following:

Fig.1 - layout image of general view of the transport system by Yunitski - front view;

Fig.2 - layout image of cross section of rail cord with discrete load-bearing elements of round section, positioned in one straight line (embodiment);

Fig.3 - layout image of cross section of rail cord with discrete load-bearing elements in the form of cables (embodiment);

Fig.4 - layout image of cross section of rail cord with discrete load-bearing elements of elliptic section (embodiment);

Fig.5 - layout image of cross section of rail cord with discrete load-bearing elements of square section (embodiment);

Fig.6 - layout image of cross section of rail cord with discrete load-bearing elements in the form of tubes (embodiment);

Fig.7 - layout image of cross section of rail cord of cross section of rail cord with discrete load-bearing elements of round section, connected to each other by cross bulkhead (embodiment);

Fig.8 - layout image of cross section of rail cord with discrete load-bearing elements of rectangular section, connected to each other by cross bulkhead (embodiment);

Fig.9 - layout image of cross section of rail cord with discrete load-bearing elements of elliptic section, connected to each other by cross bulkhead (embodiment);

Fig. 10 - layout image of interaction area of contact pair "wheel - rail cord" for discrete load-bearing elements of round section (embodiment);

Fig.11 - layout image of interaction area of contact pair "wheel - rail cord" for discrete load-bearing elements of elliptic section (embodiment);

Fig. 12 - layout image of interaction area of contact pair "wheel - rail cord" discrete load-bearing elements of square section (embodiment);

Fig. 13 - layout image of rail cord of the transport system by Yunitski in span between supports - top view (embodiment).

References in the Figures:

[0036]

1 - foundation;
 2 - anchor support;
 3 - rail cord;
 4 - discrete load-bearing element;
 5 - cap;
 6 - intermediate support;
 7 - cross bulkhead;
 8 - span between supports;
 9 - self-powered wheeled vehicle;
 10 - wheel of self-powered wheeled vehicle;
 11 - saddle of intermediate support;
 12 - retainer of discrete load-bearing element;
 S , m, - width of rail cord;
 H , m, - height of discrete load-bearing element;
 δ , m, - gap between the adjacent discrete load-bearing elements;
 T , N, - tensile force of the rail cord;
 M , kg, - total calculated weight of self-powered wheeled vehicles, located simultaneously on the rail cord in span between the adjacent supports;
 m , kg, - weight of the rail cord in span between the adjacent supports;
 g , m/sec² - acceleration of gravity;
 L - line of positioning (distribution) of the discrete load-bearing elements in the cross section of the rail cord;
 K - contact surface;
 N - rolling surface of the rail cord;
 Z - tread surface of the wheels.

Embodiments of invention

[0037] The essence of the invention consists in more detail as follows.

[0038] The claimed transport system by Yunitski (see Fig. 1) includes at least one rail cord 3, tensioned above foundation 1 between anchor 2 supports.

[0039] Depending on the properties of the foundation 1, place of installation and set of functions, anchor 2 supports may have various structural designs - in the form of towers, columns with heads, steel and reinforced concrete columnar and frame buildings and structures equipped with passenger stations and/or cargo terminals, other functional structures or truss structures (not shown on Figures).

[0040] Rail cord 3 contains, at least, three prestressed in longitudinal direction discrete load-bearing elements 4, positioned on the same line L in the cross section of the rail cord 3 (see Figs. 2 - 6). The discrete load-bearing elements 4 are fixed resting on the caps 5 of intermediate

6 supports, with use of cross bulkheads 7 (see Figs. 7 - 9).

[0041] The cross bulkheads 7 may be of various shapes and materials, for example, embodied as metal plates with shaped lateral grooves, which ensure, as shown on Figs. 7 - 9, the desired distribution of discrete load-bearing elements 4 on the same line L in the cross section of the rail cord 3. Cross bulkheads 7 are configured with possibility of their fixation on the caps 5 of intermediate 6 supports.

[0042] The design of the intermediate 6 supports may be different depending on where they are installed. In particular, the shape of the caps 5 (see Fig. 1) with the devices for fastening of the discrete load-bearing elements 4, mounted on the turns of the track, on the linear sections of the track, in mountains or at the ends of the track, may vary, since the said devices must be smoothly mated with the suspended sections of the rail cord 3 in the spans 8 between the intermediate 6 supports. In addition, the shape of the caps 5 may be defined by the function they serve as location of the junction nodes (switch assemblies) of the transport system (not shown on Figures).

[0043] It is of considerable significance that each discrete load-bearing element 4 comprises contact surface K , continuous along the entire length of the rail cord 3, and rolling surface N (see Figs. 2 - 9) of the rail cord 3 for the self-powered wheeled vehicle 9, configured to be formed (see Figs. 10 - 12) in totality by all of the discrete load-bearing elements 4. Thanks to the above-mentioned design of the rail cord 3, uniform redistribution of deformation loads arising during movement of the self-powered wheeled vehicle 9 over the contact surface K of each of the discrete load-bearing elements 4, tensioned between anchor 2 supports and, as a result, an increase in the specific bearing capacity of the track structure, are achieved. The contact surface K , in this case, shall be understood as the surface of each of the discrete load-bearing elements 4, wherein moves the contact spot of the contact pair "wheel-rail cord", during movement of self-powered wheeled vehicle 9 along the rail cord 3 of the track structure, or, in other words - the surface of each discrete load-bearing element 4, directly accepting the contact force of the wheels 10 of the self-powered wheeled vehicle 9 during its movement.

[0044] The self-powered wheeled vehicles 9 (passenger and/or cargo and/or cargo and/or passenger) included in the transport system by Yunitski can be performed in suspended embodiment (from below to the rail cord 3), as shown on Fig. 1, as well as in mounted embodiment (not shown on Figures).

[0045] In accordance with any of the unlimiting embodiments of the proposed transport system, one of its main elements determining the essence of the proposed technical approach is the rail cord 3 of the track structure. A distinguishing feature of the rail cord 3 according to the proposed technical solution is that it is embodied in the form of at least three discrete load-bearing elements 4 prestressed in the longitudinal direction, each of which

contains contact surface K (see Figs. 10-12), continuous along the entire length of the rail cord 3 and configured to form rolling surface N (see Figs. 2 - 9) for self-powered wheeled vehicle 9, formed in totality by all discrete load-bearing elements 4. It is essential that the discrete load-bearing elements 4 do not have a single body uniting them along the entire length of the rail cord 3. Therefore, the rail cord 3 is actually, with the traditional general meaning of the concept of a body - as a unifying shell, made "bodiless".

[0046] Implementation of the innovative modification in the proposed transport system - with rail cord 3 in the form of discrete load-bearing elements 4, which does not have a body in the form of a casing, allows, due to a decrease in the weight of the rail cord 3, to achieve significant advantages compared to known technical solutions. In particular - to ensure an increase in the specific bearing capacity of the track structure with a decrease in materials intensity and labor capacity with an increase in the manufacturability of its production, for example, thanks to deliveries to the installation site of the rail cord 3 of the proposed track structure in the form of blanks of various types of discrete load-bearing elements 4 in the form of coils and/or rolls.

[0047] With such design, each of the discrete load-bearing elements 4 contains a continuous contact surface K. At the same time, in the proposed transport system, the rail cord 3 does not have an additional shell in the form of a common body, which is present in the prototype and analogues.

[0048] As shown by experimental tests, the minimum allowable operational rigidity and transverse stability of the rail cord 3 in the proposed technical solution are achieved provided that it contains at least three discrete load-bearing elements 4 prestressed in the longitudinal direction.

[0049] Such design of the rail cord 3 also allows an increased level of safety of the proposed transport system.

[0050] Hereby, the value of geometric parameters of rail cord 3 and its discrete load-bearing elements 4, their positioning, value of prestressing in longitudinal direction of these discrete load-bearing elements 4 and tensile force T, N, of the rail cord 3 significantly increases.

[0051] The dimensions of the rail cord 3 are chosen so that its width S, m, is related to the height H, m, of its discrete load-bearing elements 4 by the ratio:

$$3 \leq S/H \leq 50 \quad (1)$$

[0052] When making a rail cord 3 with the width of S, m, and discrete load-bearing elements 4 with the height of H, m, the ratio of which is within the limits specified in the expression (1), it is possible to ensure the required strength, reliability and geometry of the track structure.

[0053] If the ratio (1) is less than 3, the rail cord 3 of the proposed transport system will have a low bearing

capacity and strength.

[0054] If the ratio (1) is greater than 50, then the rail cord 3 will have insufficient rigidity, including torsional, when self-powered wheeled vehicle 9 moves there along.

[0055] Hereby, adjacent discrete load-bearing elements 4 are arranged respective each other (see Figs. 2 - 5) with the gap of δ , m, determined from the relations:

$$0 \leq \delta/H \leq 5, \quad (2)$$

$$0 \leq \delta/H \leq 2, \quad (3)$$

$$0 \leq \delta/H \leq 1 \quad (4)$$

[0056] The ratios (2), (3) and (4) cannot be less than 0 because the gap cannot be negative.

[0057] With arrangement of adjacent discrete load-bearing elements 4 with the gap δ , m, between each other, exceeding the value of upper limit specified in ratio (2): $\delta/H \leq 5$, such gap δ , m, will not provide the rail cord 3 with the required rigidity, bearing capacity and safety of track structure.

[0058] In preferred embodiments of the track structure of the proposed transport system, it is advantageous for the adjacent discrete load-bearing elements 4 of the rail cord 3 to be spaced apart with the gap δ , m, not exceeding the upper limit specified in the ratio (3): $\delta/H \leq 2$, thereby improving the safety of the track structure.

[0059] In the most preferred cases of practical implementation of the track structure of the said transport system, it is necessary that the adjacent discrete load-bearing elements 4 of the rail cord 3 are arranged respective each other with the gap δ , m, not exceeding the upper limit value specified in the ratio (4): $\delta/H \leq 1$, which will ensure optimal values of rigidity and bearing capacity of the rail cord 3 with maximum safety of the track structure.

[0060] Hereby, the rail cord 3 is tensioned up to the force T, N, defined by the ratio:

$$10 \leq T/(Mg + mg) \leq 200, \quad (5)$$

where:

T, N - tensile force of the rail cord;

M, kg - total calculated weight of self-powered wheeled vehicles, located simultaneously on the rail cord in span between the adjacent supports;

m, kg - weight of the rail cord in span between the adjacent supports;

g, m/sec² - acceleration of gravity.

[0061] Reaching the lower limit of the ratio (5), equaling to 10, corresponds to the case when the rail cord 3 is slightly stretched and has a large slack on span 8 both

under its own weight (gravity) and under the weight of 8 self-powered wheeled vehicles 9 located in this span, which sharply deteriorates the performance of the system, in particular, traffic safety. In this case, the rigidity of discrete load-bearing elements 4 and the rail cord 3 as a whole is penalized, which is unacceptable.

[0062] If the upper limit of the ratio (5), equaling 200, is exceeded, the rail cord 3 will be tensioned with excessive force at low weight, which will require the use of expensive high-strength materials and lead to deterioration in the technical and economic characteristics of the system.

[0063] The discrete load-bearing elements 4 in the cross section of the rail cord 3 are arranged in straight line L (see Figs. 2 - 6), and, in an alternative embodiment (not shown on Figures) - along the curve (including a broken one). Such arrangement of discrete load-bearing elements 4 ensures uniform redistribution of the working strain therebetween, from wheel 10 of self-powered wheeled vehicle 9, thereby making it possible to increase reliability and reduce materials intensity of the track structure.

[0064] As shown on Fig. 5, the wheels 10 of the self-powered vehicle 9 are made double-flanged, which increases the stability of the self-powered wheeled vehicle 9 and the safety of the entire transport system.

[0065] At the same time, the profile of the tread surface Z of the wheels 10 mates with the profile of the rolling surface N of the rail cord 3 in places of fastening thereof on the caps 5, which also increases the stability of the self-powered wheeled vehicle 9 due to decrease in lateral amplitude of the rail cord 3 in spans 8 during the movement of self-powered wheeled vehicle 9 along it.

[0066] On the supports, there are transitional sections of the track - caps 5 in the form of saddles 11, whereas the rail cord 3 in span 8 between the adjacent supports 2 and/or 6 is made with a sagging deflection of a certain slope. Noteworthy that the track transition section on the saddle 11 has the same slope, as the mating therewith suspended section of the track in span 8 between the adjacent supports 2 and/or 6 (see Fig. 1), which ensures the smooth movement of the self-powered wheeled vehicle.

[0067] Hereby, in any embodiment of the rail cord 3, it is advantageous that the cross bulkheads 7 are provided with retainers 12 of lateral displacement of discrete load-bearing elements 4 (see Figs. 7 - 9), which will prevent the discrete load-bearing elements 4 from moving relative to each other and ensure their fixation in a predetermined position during operation of the transport system. The retainers 12 of lateral displacement of discrete load-bearing elements 4 may be made, for example, in the form of corresponding shaped lugs (wing extensions) of cross bulkhead 7, or shaped grooves enclosing and fixing the relative position of discrete load-bearing elements 4 of the rail cord 3 with their side faces (see Figs. 7 - 9).

[0068] Due to the fact that the load-bearing elements 4 are fastened on the saddles 11 of the caps 5 of the

intermediate supports 6 by means of cross bulkheads 7 equipped with retainers 12 of lateral displacement of the discrete load-bearing elements 4, as well as the following: that the wheels 10 of the self-powered wheeled vehicle 9 are provided with the tread surface Z; corresponding to the profile of the rolling surface N of the rail cord 3 in places of fastening of discrete load-bearing elements 4 by cross bulkheads 7 to the saddles 11 of the caps 5, it is ensured that the specified geometry of the rail cord 3 is preserved and the movement of the self-powered wheeled vehicle 9 is stable throughout the track structure of the proposed transport system.

[0069] Alternative design of proposed transport system provides for implementation of discrete load-bearing elements 4 in spans between intermediate supports 6 interconnected by cross bulkheads 7. This increases the rigidity and safety of the track structure.

[0070] In order to optimize the operational parameters of the rail cord 3 due to the specific design assignment, suitably, the transverse profile of its discrete load-bearing element 4 is made, for example, as shown on Figs. 2 and 7, as circle, or as shown on Figs. 4 and 7, as ellipse, or as shown on Fig. 5, as square, or as shown on Fig. 6 - in the form of tube, or as shown on Fig. 8 - in the form of rectangle.

[0071] Embodiments of the rail cord 3 of discrete load-bearing elements 4 with cross sections in the form of a polygon, or rhombus, or triangle, or trapezoid, or other possible of known shapes, are similar to those above and are not shown on Figures.

[0072] According to any embodiment of the invention, as load-bearing elements of the load-bearing member 5 of the rail cord 3, cross section of which is schematically shown on Figs. 2 - 9, the discrete load-bearing elements 4 made in the form of wire may be used (see Figs. 2 and 7), twisted or untwisted ropes (see Fig. 3), strands, threads, or strips (see Figs. 4 and 9), or tapes or rods (see Figs. 5 and 8), or tubes (see Fig. 6) of any strong materials, for example, high-strength steel, or glass fiber, or Kevlar, or polyetheretherketone, or graphene, which ensures the reliability, efficiency, economy and processability of using such load-bearing elements.

[0073] It will be understood by one of ordinary skill in the art that the present invention allows for the use of plurality of design-based combinations of types of cross section of the rail cord 3 depending on combination of shape and line L of positioning (distribution) of the discrete load-bearing elements 4 contained therein, used in its formation.

[0074] With any versions of the practical implementation and arrangement of discrete load-bearing elements 4, in accordance with the proposed technical solution, the required saving of materials, improvement of manufacturability and stability of the rail cord 3 throughout the track structure of the transport system are achieved.

[0075] Considering all possible alternative and non-excluding combinations, including the above-mentioned variants and parameters of the design of discrete load-

bearing elements 4 of the rail cord 3, plenty of embodiments of the proposed transport system by Yunitski are possible, which, in general, ensure the installation on the foundation 1, directly along the profile of the route, of supports 2 and 6 with spans 8 in accordance with the design option (see Figs. 1 and 13). At least one rail cord 3, tensioned above foundation 1, is fastened on supports 6. Hereby, the rail cord 3 is made of at least three discrete load-bearing elements 4, which are prestressed in longitudinal direction by tensioning thereof and fastening between anchor 2 supports.

[0076] At the same time, it is significant that rail cord 3 is made bodiless and equipped with discrete (distributed) rolling surface N.

[0077] According to the present technical approach, the required result is achieved thanks to the reduction of materials consumption of the proposed rail cord 3 in comparison with the known technical solutions. At the same time, the embodiment of the rail cord 3 of the structure claimed in this technical solution provides the required strength of the track structure, since the entire load on the rail cord, from the self-powered wheeled vehicle 9, is accumulated by its discrete load-bearing elements 4, which are prestressed in the longitudinal direction. In addition, it is possible to assemble the rail cord 3 in the field conditions, using high-tech equipment delivered directly to the place of installation of the transport system. At the same time, component materials (for example, wire, or cables) can be delivered to the place of installation of the transport system in a compact form, for example, in the form of coils and/or rolls, which helps to reduce materials intensity, labor capacity, transport costs, the cost of manufacturing and installation of track structure with improvement of manufacturability of production of such transport system.

Industrial applicability

[0078] The geometrical parameters of the rail cord 3 optimized as a result of empirical studies and the characteristics of the discrete load-bearing elements 4 forming it, for various embodiments of the proposed transport system by Yunitski, make it possible to create a track structure of the transport system with the specified operational parameters and ensure an increase in its specific bearing capacity.

[0079] The proposed transport system by Yunitski can be implemented in the field conditions with lower costs relative to the known structures of track structures and is a high-tech solution.

[0080] The diagram presented above in a simplified form illustrates one of the possible manufacturing options for the transport system by Yunitski according to the proposed technical approach.

[0081] The transport system by Yunitski of the described structure operates in the following manner.

[0082] When the wheels 10 of the self-powered wheeled vehicle 9 move along the rail cord 3, the latter,

with its continuous rolling surface N, experiences and accommodates, from the wheels 10 of the self-powered wheeled vehicle 9, the load concentrated on the contact surface K, leading to its elastic deformation. The deformation wave, moving together with the wheels 10 of the self-powered wheeled vehicle 9 along the rolling surface N, is evenly redistributed into the discrete load-bearing elements 4, tensioned between the anchor 2 supports.

[0083] The transport system by Yunitski of the described structure, thanks to the "bodiless" design of the rail cord 3, with high manufacturability and reduced quantity and cost of components required for its manufacture, in accordance with the combination of all the essential features which define its advantages, allows to achieve a significant increase in the specific bearing capacity of the track structure, as well as reduce the cost of construction of the transport highway, including by saving up the materials intensity and labor capacity, while increasing the manufacturability of its production and simplifying the processes of delivery of components and installation thereof in real conditions.

Information sources

[0084]

1. Patent RU № 2464188, IPC B61B 3/02, publ. 20.10.2012 (analog).
2. Patent RU № 2179124, IPC B61 B 13/00, publ. 10.02.2002 (analog).
3. Patent RU № 2374102, IPC B61B 3/02, publ. 27.11.2009 (analog).
4. Patent RU № 2475387, IPC B61B 3/00, publ. 20.02.2013 (analog).
5. Patent RU № 2325293, IPC B61B 3/02, publ. 27.05.2008 (analog).
6. Patent RU № 2204639, IPC E01B 5/08, 25/00, B61B 3/02, 5/00, 13/04, publ. 20.05.2003 (analog).
7. Patent RU № 2080268, IPC B61B 5/02, B61B 13/00, E01B 25/22, publ. 27.05.1997 (prototype).

Claims

1. Transport system, which includes at least one rail cord, tensioned above foundation between anchor supports, which contains at least three discrete load-bearing elements, prestressed in longitudinal direction and positioned on the same line in the cross section of the rail cord, fixed resting on the caps of intermediate supports, wherein each discrete load-bearing element contains contact surface, continuous along the entire length of the rail cord, configured with the possibility of forming, in totality, by all discrete load-bearing elements, of the rolling surface of

the rail cord for self-powered wheeled vehicle, whereby the width S , m, of the rail cord is related to the height H , m, of its discrete load-bearing elements by the ratio:

$$3 \leq S/H \leq 50,$$

whereas the gap δ , m, between the adjacent discrete load-bearing elements is described by the dependence:

$$0 \leq \delta/H \leq 5$$

2. Transport system according to claim 1, **characterized in that** the gap δ , m, between the adjacent discrete load-bearing elements is described by the dependence:

$$0 \leq \delta/H \leq 2$$

3. Transport system according to claims 1 and 2, **characterized in that** the gap δ , m, between the adjacent discrete load-bearing elements is described by the dependence:

$$0 \leq \delta/H \leq 1$$

4. Transport system according to claim 1, **characterized in that** the rail cord is tensioned up to the force, defined by the ratio:

$$10 \leq T/(Mg + mg) \leq 200,$$

where: T , N - tensile force of the rail cord;

M , kg - total calculated weight of self-powered wheeled vehicles, positioned simultaneously on the rail cord in span between the adjacent supports;

m , kg - weight of the rail cord in span between the adjacent supports;

g , m/sec² - acceleration of gravity.

5. Transport system according to claim 1, **characterized in that** the profile of the tread surface of wheels mates with the profile of the rolling surface of the rail cord in places of its fastening on the caps.

6. Transport system according to claim 1, **characterized in that** the caps of the intermediate supports are embodied in the form of saddles.

7. Transport system according to claim 1, **characterized in that** the load-bearing elements are fastened

on the caps of the intermediate supports with use of cross bulkheads.

8. Transport system according to claim 1, **characterized in that** the discrete load-bearing elements, in spans between intermediate supports, are connected to each other by cross bulkheads.

9. Transport system according to any of claims 7 and 8, **characterized in that** the cross bulkheads are equipped with retainers of lateral displacement of discrete load-bearing elements.

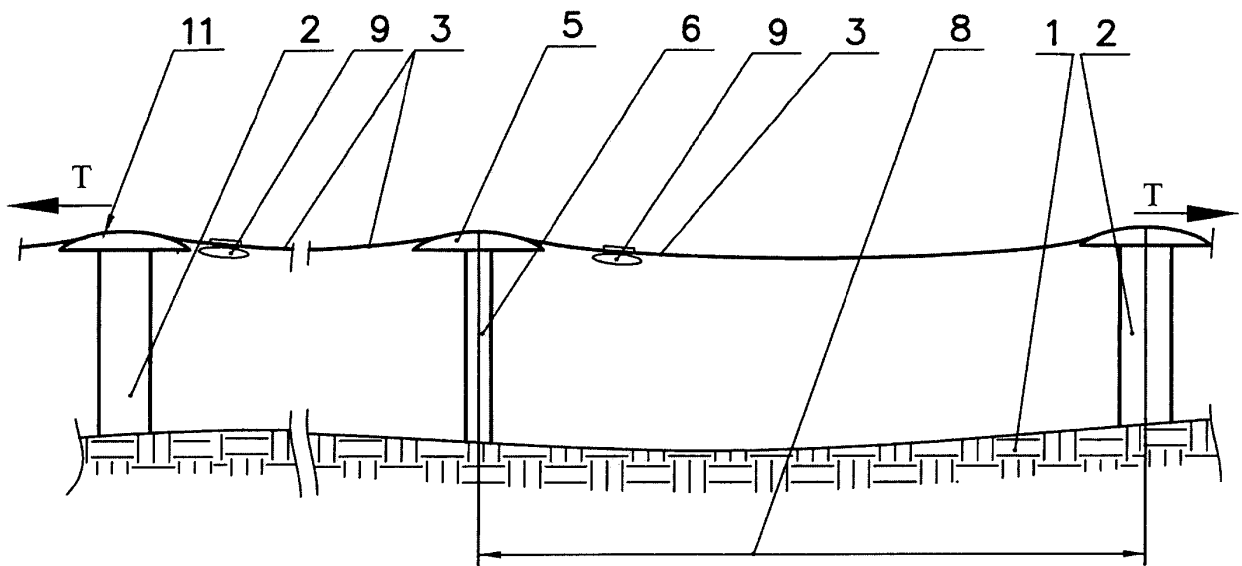


Fig. 1

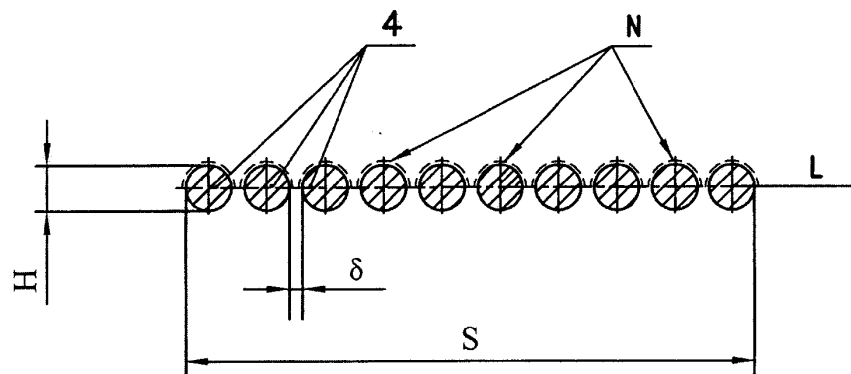


Fig. 2

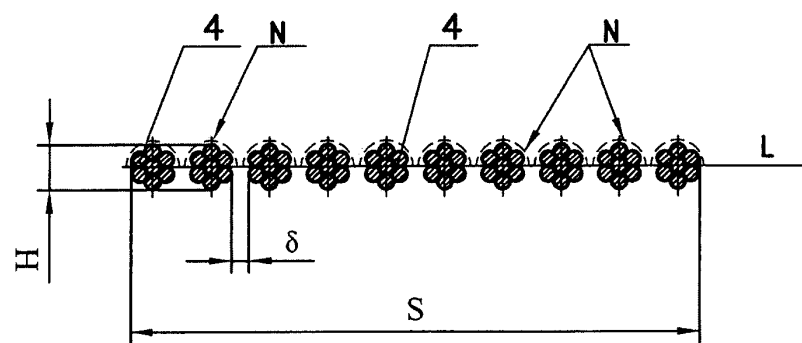


Fig. 3

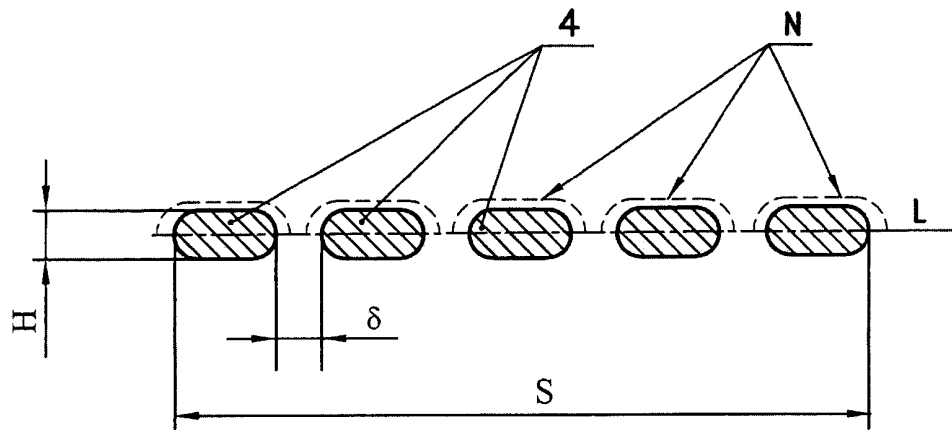


Fig. 4

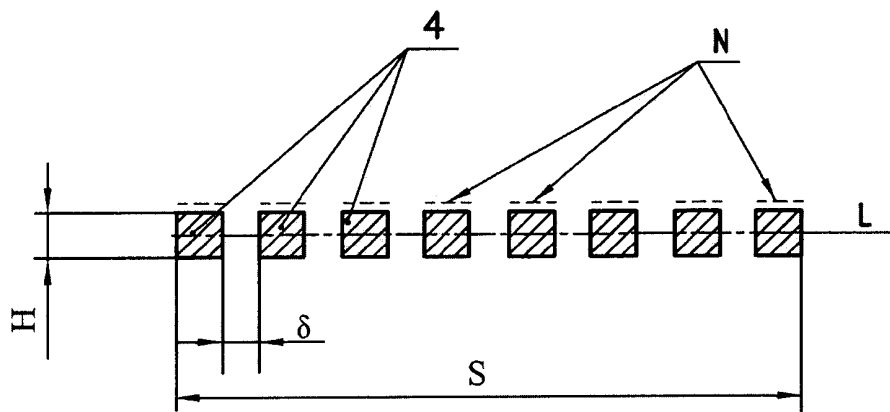


Fig. 5

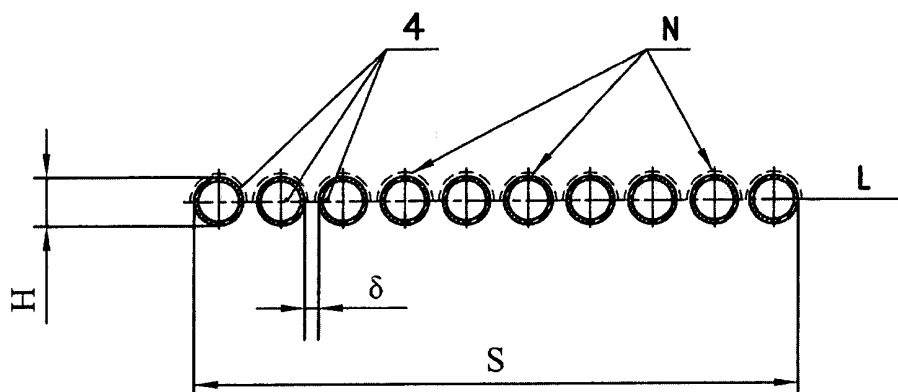


Fig. 6

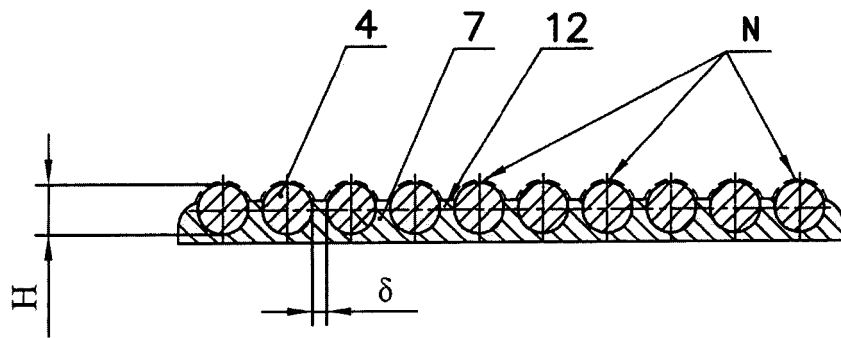


Fig. 7

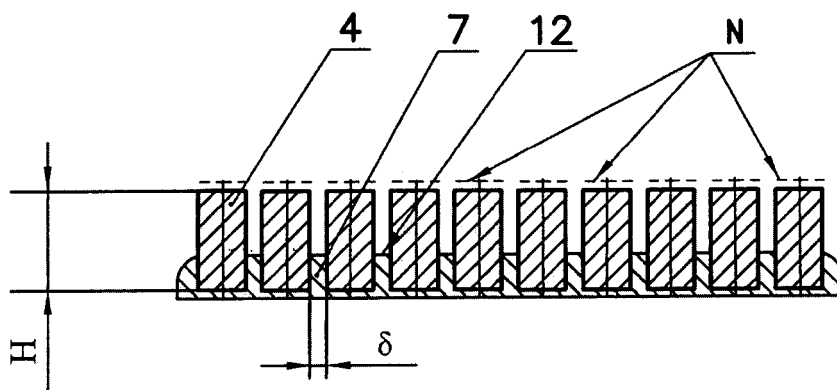


Fig. 8

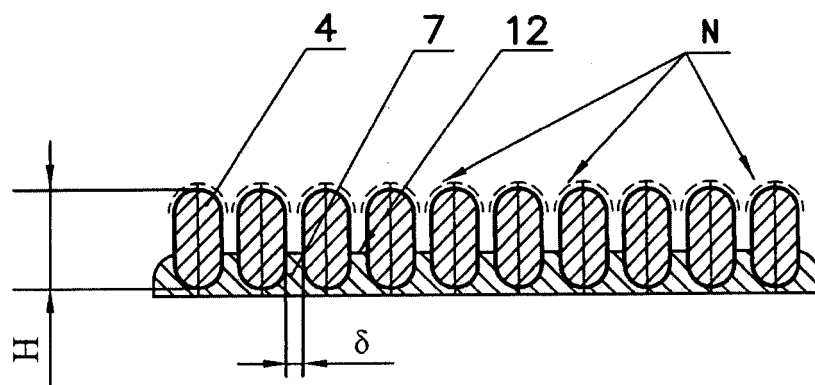


Fig. 9

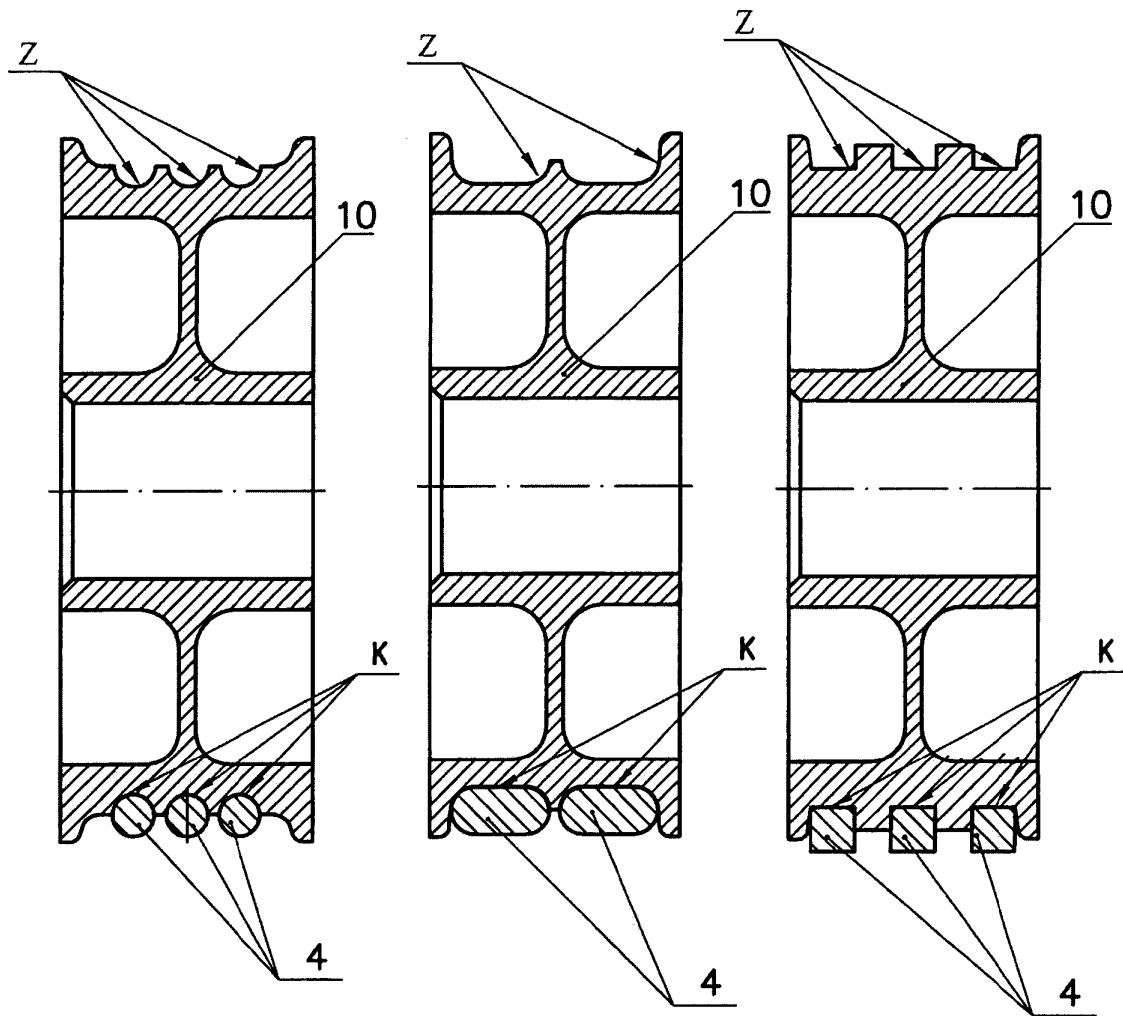


Fig.10

Fig.11

Fig.12

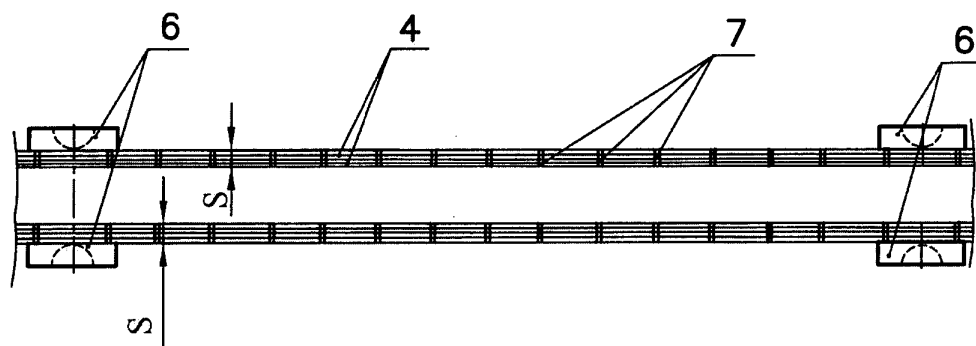


Fig.13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BY 2020/000014

A. CLASSIFICATION OF SUBJECT MATTER		
<i>B61B 3/02 (2006.01)</i> <i>B61B 13/00 (2006.01)</i> <i>B61B 5/02 (2006.01)</i> <i>E01B 25/22 (2006.01)</i>		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
B61B 1/00, 1/02, 3/00, 3/02, 5/00, 5/02, 13/00, 13/04, 13/06, 15/00, E01B25/00, 25/22, 25/24, 26/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
PatSearch (RUPTO Internal), USPTO, PAJ, Espacenet, Information Retrieval System of FIPS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2224064 C1 (JUNITSKY ANATOLY EDUARDOVICH et al.) 20.02.2004, the claims, abstract, fig. 1-126	1-9
A	RU 2623786 C1 (SAVELEV ALEKSANDR SERGEEVICH) 29.06.2017, the claims, abstract, fig. 1-13	1-9
A	RU 2439236 C2 (SAVELEV ALEKSANDR SERGEEVICH) 10.01.2012, the claims, abstract, fig. 1-13	1-9
A	DE 4240785 A1 (PERDOLT GOTTFRIED) 20.01.1994, the claims, abstract, fig. 1-11	1-9
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 16 February 2021 (16.02.2021)		Date of mailing of the international search report 25 February 2021 (25.02.2021)
Name and mailing address of the ISA/ RU		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)