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(54) SPRING ROD-SHAPED CLIP FASTENER FOR RAIL FASTENING

(57) The invention relates to a design of a track structure for railways, namely to a design of a spring rod-shaped clip fastener for a use in intermediate rail fastenings for pressing a rail against a rail support. The spring rod-shaped clip fastener for a rail fastening is made of a resilient rod bent to form a single B-shaped part in the projection onto a horizontal plane, which is symmetrical relative to the transverse axis and consists of sections radially mated therebetween in the projection onto a horizontal plane, said sections comprising a section of resting on a rail, which is rectilinear in the projection onto a horizontal plane and changes on two opposite sides along rounding radii into side sections located perpendicularly to a track centerline and being rectilinear in the projection onto a horizontal plane, said side sections change into radial, in the projection onto a horizontal plane, sections of resting on a thrust member of the rail fastening, which change into end sections directed with their ends towards the section of resting on the rail and rectilinear in the projection onto a horizontal plane; the section of resting on the rail is made, in its longitudinal profile, convex radially with two edge points of resting on the rail; the sections of resting on the thrust member of the rail fastening are made radially concave in their longitudinal profile, and the side sections and the end sections are made radially convex in their transverse profile; and a value of an inner radius of the side sections in the transverse profile of the clip fastener is less than a value of an inner radius of the end sections. The technical effect is a higher stability of a force of pressing a rail against a rail support provided by the spring rod-shaped clip fastener due to its designed having complex spatial geometry, which reduces its stiffness, while maintaining its pressing force, due to an increased resilient motion of the clip fastener, and, simultaneously, provides the possibility of reducing stress concentration and raise the efficiency of using the material of the clip fastener owing to making a greater length of the rod operable.

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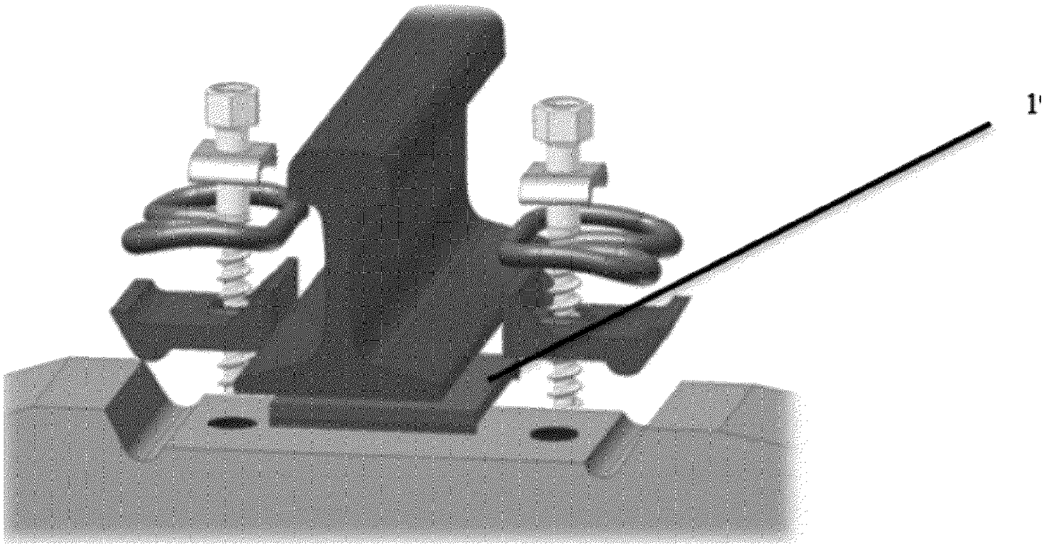

Fig. 1

Description

Field of the Invention

[0001] The invention relates to a design of a track structure for railways, namely to a design of a spring rod-shaped clip fastener for a use in intermediate rail fastenings for pressing a rail against a rail support.

[0002] The clip fastener should provide a force sufficient for pressing a rail against a rail support.

Description of Prior Art

[0003] The RU 2767807 C1 information source of 22.03.2022 (an analogous solution) is known in the art, wherein a structure of a clip fastener for rail fastening is disclosed; the structure is made of a resilient rod bent to form a rectilinear on-rail section smoothly changing first into side lengthy sections and then into abutting each other on-sleeper arched sections and end sections bent inward the clip; each of the side lengthy sections is formed by a part of a circumference with a center lying on the crossing of a longitudinal axial line of the rectilinear on-rail section and a straight line passing through a point of support of the on-sleeper arched section by a sleeper and a point of force application on an end section.

[0004] As disadvantages of this technical solution, its structural features may be mentioned that are associated with excessive stiffness of the clip structure, which cannot ensure stability of a force of pressing a rail against a rail support in the process of rail fastening operation due to a decreased thickness of an under-rail pad (due to its wear and/or plastic deformations). In consequence of a pad decreased thickness, a force of pressing a rail against a rail support is reduced, the clip cannot compensate for this reduction since it has relatively flat spatial geometry (such geometry may be arranged in a plane allowing for disregard of one of the geometrical parameters, since its numerical value is small with relation to the other spatial geometrical parameters). The stiffness (mechanical), according to information available in the art, should be understood as the capability of a body to resist deformation at a given load value (Blum E. E. - Dictionary of Main Metal Science Terms. Yekaterinburg, 2002).

[0005] Furthermore, one more disadvantage of this clip is primarily local nature of stress distribution, i.e., in the process of loading the clip by an external load individual sections of the claims become overloaded (a high level of stress concentration appears therein), which leads to formation of fractures and shortens the life time of the clip.

[0006] The above disadvantages of this clip are conditioned primarily by the absence of complex spatial geometry of the clip structure, i.e., the clip is relatively flat, which results in that the clip primarily works as a torsion bar.

[0007] Information source RU 170573 U1 of 28.04.2017 (an analogous solution) is known in the art, wherein a clip structure for rail fastening is disclosed; the structure is made as a single part shaped mirror-symmetrically relative to its longitudinal axis and comprising a rectilinear on-rail section changing on two opposite sides on rounding radii into clip side sections bent upward archwise and deflected outward that are continued in arched, in the projection on a horizontal plane, sections changing into free peripheral sections directed with their ends toward the position of the rectilinear on-rail section of the clip, said free peripheral sections of the clip being made rectilinear and being located below the maximum rise level of the side sections of the clip, and the clip being made, in the projection onto a horizontal plane, smoothly extended with its side sections towards location of the on-rail section.

[0008] A disadvantage of this technical solution is also excessive stiffness of the clip structure, though the structure of this clip has side sections with complex spatial geometry.

[0009] In the structure of this clip, the section resting on a rail is made rectilinear, both in the projection on a horizontal plane, and in the longitudinal profile; and, due to this, principally contact stresses appear on this section under a load (in the clip-rail contact area). This section remains unloaded.

[0010] The closest analog to the proposed invention is the RU 174600 U1 information source, 23.10.2017 (the closest prior art), wherein the structure of a spring rod-shaped clip fastener for a rail fastening is disclosed that is B-shaped in the plan view (in the projection on a horizontal plane) and that comprises the following sections radially abutting each other in the plan view: a rectilinear section resting on a rail, intermediate sections located at a right angle thereto that are rectilinear in the plan view and radially convex in their profile (in the projection onto a vertical plane), sections resting on a thrust member of a rail fastening, and end sections that are radial in the plan view, radially convex in their profile (in the projection onto a vertical plane) and directed toward the sections resting on the thrust member of the rail fastening; wherein values of inner radii of the intermediate and end sections are equal in the profile, and, in the free state, the clip profile is a figure which closed contour consists of two semicircumferences with the radius equal to the bar radius and two arcs connecting them, a difference between their radii being not greater than a bar diameter value.

[0011] Disadvantages of this technical solution (the closest prior art) are structural features conditioned by excessive stiffness of this clip fastener, which are due to the absence of complex spatial geometry in its structure (the clip fastener is relatively flat); which cannot provide for a stable force of pressing a rail against a rail support in the process of thinning an under-rail pad.

[0012] Furthermore, a clip fastener of this structure (a relatively flat clip) is characterized by localized nature of stress distribution (i.e., a high stress concentration factor).

[0013] It is worth mentioning that such clip fasteners are highly practically feasible due to their simple shape, but lose their pressing force significantly when a pad height is decreased.

[0014] Thus, with due regard to information found in the art, the following disadvantages are identified in the art: in the process of operation, the structural members of an intermediate rail fastening are subject to wear, a resilient under-rail pad becomes progressively thinner in the course of time, which leads to a change of its thickness resulting in rail sagging, and a force of pressing a rail against a rail support is reduced.

[0015] These circumstances are mostly conditioned by the fact that structures of the clip fasteners known in the art do not have complex spatial geometry (they have a relatively flat shape), due to which they do not have sufficient compliance to provide a stable force of pressing a rail against a rail support when the pad thickness is reduced, i.e., as a result of making a clip fastener having a structure lacking complex spatial geometry, the possibility of compensating for a reduction in the force of pressing a rail against a rail support is not provided due to a decrease in a pad thickness.

[0016] Furthermore, clip fastener structures (relatively flat) known in the art do not provide distribution of stresses appearing in operation over the entire clip fastener, which leads to stress localization on certain clip fastener sections, thus overloading them and resulting in shortening the life time of such clip fasteners in general.

Summary of the Invention

[0017] The object of the proposed invention is to eliminate the disadvantages existing in the prior art.

[0018] The technical effect achievable when the proposed invention is implemented is higher stability of a force of pressing a rail against a rail support by the spring rod-shaped clip fastener due to its structure having complex spatial geometry, which has enabled to reduce its stiffness owing to increasing a resilient motion of the clip fastener and, at the same time, reduce stress concentration and raise efficiency of using the material of the clip fastener due to making a greater length of the rod operable.

[0019] The essence of the technical solution proposed by this invention is that a spring rod-shaped clip fastener for a rail fastening is made of a resilient rod bent to form a single B-shaped part in the projection onto a horizontal plane that is symmetrical relative to the transverse axis and consists of sections radially mated therebetween in the projection onto a horizontal plane, said sections comprising a section of resting on a rail, which is rectilinear in the projection onto a horizontal plane and changes on two opposite sides along rounding radii into side sections located perpendicularly to a track centerline and being rectilinear in the projection onto a horizontal plane, said side sections change into radial, in the projection onto a horizontal plane, sections of resting on a thrust member of the rail fastening, which change into end sections directed with their ends towards the section of resting on the rail and are rectilinear in the projection onto a horizontal plane; the section of resting on the rail is made, in its longitudinal profile, convex radially with two edge points of resting on the rail; the sections of resting on the thrust member of the rail fastening are made radially concave in their longitudinal profile, and the side sections and the end sections are made radially convex in their transverse profile; and a value of an inner radius of the side sections in the transverse profile of the clip fastener is less than a value of an inner radius of the end sections.

[0020] Novel in the proposed invention is the structure of the clip fastener having a shape with a complex spatial geometry, as compared to the technical solutions known in the art, due to which a radially convex shape of the clip fastener is obtained both in the longitudinal profile, and in the transverse profile.

[0021] Such sections include a section of resting on a rail, side sections perpendicular to the track centerline, end sections that contact a fastening means (a bolt, screw, etc.), thus providing a point of force application.

[0022] The longitudinal profile and the transverse profile should be understood in this invention as a front view and a side view, respectively.

[0023] Owing to the section of the clip that is made radially convex and contacts a rail (the section of resting on a rail), additional bending compliance around the transverse axis of the clip fastener is provided.

[0024] The presence in the structure of the clip fastener of side vertical sections that are radially convex in their transverse profile and directed perpendicularly to the track centerline provides higher bending compliance around the longitudinal axis of the clip.

[0025] The proposed structural transformations of the technical solution of the prior art, a number of which sections have been redeveloped, eventually provide a structure of a spring rod-shaped clip for a rail fastening which has higher compliance and ensures stress distribution over a greater area of the clip.

[0026] In otherwise equal operating conditions of the proposed clip fastener and the clips known in the art, loads acting on the clips and having similar numerical values will be sustained mostly by certain sections of the structure (the sections of resting on a thrust member), overloading them, which leads to reduction in fatigue resistance of these sections and to failures of such clips.

[0027] However, in the structure of the proposed clip fastener, stresses will be distributed more uniformly over the length of the clip fastener's rod, which is achieved owing to higher compliance of the clip fastener due to complex spatial geometry of the structure of the clip fastener; as a result, stress concentration in individual clip sections will be reduced, e.g. in the section of resting on a thrust member of the rail fastening of the proposed clip fastener.

[0028] In the proposed clip fastener, the section of resting on a rail, which is radially convex in the transverse profile, bends when receiving an acting load.

[0029] The side sections of the clip, which are located perpendicularly to the track centerline, are rectilinear in the projection onto a horizontal plane and radially convex in the transverse profile, are subject to bending and twisting when receiving an external load, but are more compliant due to their complex spatial geometry (as compared to the clip fastener of the closest prior art) relative to the clip fastener longitudinal axis, which enables the clip fastener to provide better stability of the rail pressing force.

[0030] The end sections of the clip fastener, when subject to an external load, bend. Their structural design enables to provide a required resilient motion of the clip fastener, which, in its turn, enables to provide a required rail pressing force when the clip fastener is tightened by a fastening means (a bolt, screw, etc.).

[0031] The resilient motion of the clip fastener should be understood as a value of its vertical movement in the point of contact with the fastening means tightened until a required rail pressing force is reached.

[0032] Thus, the proposed structure of the clip fastener has higher compliance and, at the same time, has stress distribution over a greater area of the structure of the clip fastener due to its complex spatial geometry.

Brief Description of the Drawings

[0033] The essence of the proposed invention is explained in the below description and the accompanying drawings, wherein:

Fig. 1 shows a general view of a rail fastening wherein the resilient clip known in the art is used (the closest prior art).

Fig. 2 shows the general view (isometric) of the proposed clip fastener.

Fig. 3 shows the proposed clip fastener, projections onto a horizontal plane (front view, top view, sectional view, isometric view).

Figs. 4.1 and 4.2 show results of equivalent stress distribution calculations (von Mises) for the clip of the closest prior art, top view and bottom view, respectively, made with the use of the "ABAQUS" software package.

Figs. 5.1 and 5.2 show results of equivalent stress distribution calculations (von Mises) for the proposed clip fastener, top view and bottom view, respectively, made with the use of the "ABAQUS" software package.

Carrying Out the Invention

[0034] Figure 1 chows the rail fastening wherein the resilient clip of the closest prior art is used, owing to which a rail is pressed against a rail support; the rail base is positioned on a resilient under-rail pad (1) serving for reducing dynamic loads on an under-rail foundation.

[0035] When a rail fastening assembly is mounted, the resilient clip is secured with a fastening means (a bolt, screw, etc.), and a force of pressing the rail to the rail support is generated in the course of tightening the fastening means.

[0036] However, in the process of decreasing the thickness of the under-rail pad (1) (due to its wear and/or plastic deformation), the force of pressing the rail against the rail support is reduced.

[0037] A reduction in the pressing force may lead to an insufficient force of fastening rail lengths, loss of temperature conditions of fastening rail lengths, displacement of track. The above deviations from normal maintenance of a railway track may lead to an increase in man-hours required for the operating the track.

[0038] Figures 2 and 3 show the proposed clip fastener in different views that show the sections of the proposed clip fastener forming complex spatial geometry.

[0039] Thus, the proposed spring rod-shaped clip fastener for the rail fastening is made as a single part having a symmetrical B-shape in the projection onto a horizontal plane.

[0040] This implementation is realized by bending a rod of a resilient material in preset points to form the sections of the clip fastener, namely, a section (2) of resting on a rail, which is radially convex in the longitudinal profile with the formation of two points (6) of support, two side sections (3) radially convex in the transverse profile and directed perpendicularly to the permanent way axis, sections (4) of resting on a thrust member, end sections (5) (see Fig. 2).

[0041] Also, Figure 2 shows the longitudinal axis (7) and the transverse axes (8) of the proposed clip fastener.

[0042] The most preferable type of material used for making the proposed clip fastener is steel.

[0043] Figure 3 shows the proposed resilient clip fastener in a front view, a top view, a sectional side view (A section) and an isometric view in order to better explain the structural differences helping to achieve the claimed technical effect.

[0044] It can be seen on the views presented in Figure 3, Section A, that a value of an inner radius of the side sections in the transverse profile is less than a value of an inner radius of the end sections; owing to this, the structure of the proposed clip fastener has a different geometrical shape in its different sections, in particular, the side sections may compensate for a reduction in a force of pressing a rail due to its sagging as a result of a decreased pad thickness, and the end sections provide a force of pressing a rail when the clip fastener is tightened with fastening means.

[0045] Moreover, on the basis of the isometric view of the clip fastener in Figures 2, 3 and the views presented in Figure 3, a conclusion may be drawn that the proposed clip has complex spatial geometry, which makes it more compliant and enables to maintain stability of pressing a rail against a rail support without significant reduction in pressing force due to wear of the pad.

[0046] Furthermore, this implementation provides sufficiently uniform stress distribution over the mated sections of the resilient clip.

[0047] To confirm the above information, calculations were conducted on a computer with the use of the "ABAQUS" software package (hereinafter, the "ABAQUS" SP).

[0048] The calculation results for the prototype clip and the proposed clip are presented in Figures 4.1 - 4.2 and 5.1 - 5.2, respectively.

[0049] Since these clips have the symmetrical shape, to simplify the information presented herein and the calculations made on the computer with the use of the "ABAQUS" SP, it will be sufficient to describe only one symmetrical half of the clips.

[0050] The calculations simulated the process of tightening the fastening means (as one of the calculated cases of loading the clip) for loading the clip to the point of pressing of a rail with the force equal to 12.5 kN per one of the two fastening clips.

[0051] Also, for the calculation purposes, as the material for each of the calculation objects (the prototype clip and the proposed invention) the properties of one and the same material (spring steel) were used.

[0052] The calculations were made with the use of the "ABAQUS" SP in a non-linear quasi-static setting with due regard to physical and geometrical nonlinearities as well as contact interaction. Three-dimensional hexahedral elements of first order were used in the clip models; the contact through "surface-surface" pairs was used for absolutely stiff contact surfaces.

[0053] Thus, Figures 4.1 and 4.2 show the calculation results on distribution of equivalent stresses for the prototype clip, a top view and a bottom view, respectively; and the non-linear calculation step was selected that corresponded to the clamping force of 12.5 kN (for one clip).

[0054] The pattern of distribution of equivalent stresses relates to a qualitative type (the calculation results comprise graphic information on clip areas with different levels of equivalent stresses without indicating numerical values of these stresses).

[0055] Thus, according to the calculation results obtained with the use of the "ABAQUS" SP, the areas of the proposed clip and the clip of the prior art subject to different stresses are presented in different color-graphic imaging.

[0056] The areas with the lowest stress values are shown in blue color, the areas with medium stress values are shown in blue, green, yellow, and orange colors according to increases in stresses, respectively, and the areas with the highest stress values are shown in red color.

[0057] It can be seen from the calculation results that the highest maximum equivalent stresses appear on the inner portion of the section of resting on the thrust member of the prototype clip (the zone of highest stresses are marked in red in Figures 4.1 and 4.2).

[0058] Also, according to data from Figures 4.1 and 4.2, it can be seen that medium values of equivalent stresses are distributed over the side section of the clip and in the zone of radial mating with the section of resting on the rail (the medium stress zones are marked in orange, yellow and green colors).

[0059] The lowest equivalent stresses appear on the prototype clip section of resting on the rail, as well as on the ends of the clip end sections (blue and deep blue zones in Figures 4.1 and 4.2).

[0060] Furthermore, equivalent stresses on the clip of the prior art show a localized distribution character (red color in Figures 4.1 and 4.2).

[0061] Another pattern of stress distribution is shown in Figures 5.1 and 5.2, since they show the results of calculating equivalent stress distribution for the proposed technical solution, a top view and a bottom view, respectively; the non-linear calculation step is selected that corresponds to the clamping force of 12.5 kN (for one clip).

[0062] Figures 5.1 and 5.2 present equivalent stress distribution plots showing that the maximum stress zone is located on the inner portion of the section of resting on the thrust member (the highest stress zone is marked in red in this Figure). However, unlike the prototype clip, this zone in the proposed clip has smaller dimensions, which enables to draw a conclusion that equivalent stresses are distributed over the length of the rod of the proposed clip fastener more uniformly. The proposed solution enables to lower the stress concentration level, which increases the life time of the clip fastener.

[0063] It can be seen in Figure 5.2 (bottom view) that orange color dominates on the lower portion of the side section of the proposed clip fastener; whereas it can be seen in the bottom view of the clip of the closest prior art (Figure 4.2) that medium stress distribution has a less pronounced character (orange color is extended only to the middle of the side section of the clip of the closest prior art). Consequently, a greater loading of the side section enables the clip to be more compliant, and, therefore, maintain stability of the pressing force in contrast to the clip of the closest prior art.

[0064] Unlike the clip of the closest prior art, the section of resting on the rail of proposed clip has equivalent stress distribution with medium values (green color in Figures 5.1 and 5.2), which enables to draw a conclusion that the section of resting on the rail works when the clip is loaded.

[0065] This section of the clip of the closest prior art is not loaded, which reduces efficiency of use of the material (efficiency of accumulating elastic energy).

[0066] And, similarly to the clip of the prior art, the lowest equivalent stresses appear on the clip end sections (zones of blue and deep blue colors in Figures 5.1 and 5.2).

[0067] An analysis of the calculation results for the proposed clip fastener shows the possibility of achieving greater compliance of the clip fastener owing to complex spatial geometry of the side sections (3) and the section (2) of resting on the rail of the clip fastener, which increases stability of pressing the rail by the clip fastener during an inevitable wear of the resilient under-rail pad.

[0068] Furthermore, the obtained results on equivalent stress distribution for the prototype clip and the proposed clip fastener, which are shown in Figures 4.1 - 4.2 and 5.1 - 5.2, respectively, enable to draw a conclusion that the proposed structure of the clip fastener has better stress distribution than the prototype clip; and this enables to ensure a greater life time of the proposed clip fastener in the process of its operation.

[0069] Thus, according to the calculation results obtained, the conclusion may be drawn that the proposed technical solution, namely the spring rod-shaped clip fastener for a rail fastening having the shape with complex spatial geometry provides increased stability of the rail pressing force by increasing the clip structure compliance simultaneously with providing stress distribution over a greater portion of the clip structure.

Claims

1. A spring rod-shaped clip fastener for a rail fastening made of a resilient rod bent to form a single B-shaped part in the projection onto a horizontal plane, which is symmetrical relative to a transverse axis and consists of sections radially mated therebetween in the projection onto a horizontal plane, said sections comprising a section of resting on a rail, which is rectilinear in the projection onto a horizontal plane and changes on two opposite sides along rounding radii into side sections located perpendicularly to a track centerline and being rectilinear in the projection onto a horizontal plane, said side sections change into radial, in the projection onto a horizontal plane, sections of resting on a thrust member of the rail fastening, which change into end sections directed with their ends towards the section of resting on the rail and rectilinear in the projection onto a horizontal plane, **characterized in that** the section of resting on the rail is made, in its longitudinal profile, convex radially with two edge points of resting on the rail; the sections of resting on the thrust member of the rail fastening are made radially concave in their longitudinal profile, and the side sections and the end sections are made radially convex in their transverse profile; wherein a value of an inner radius of the side sections in the transverse profile of the clip fastener is less than a value of an inner radius of the end sections.

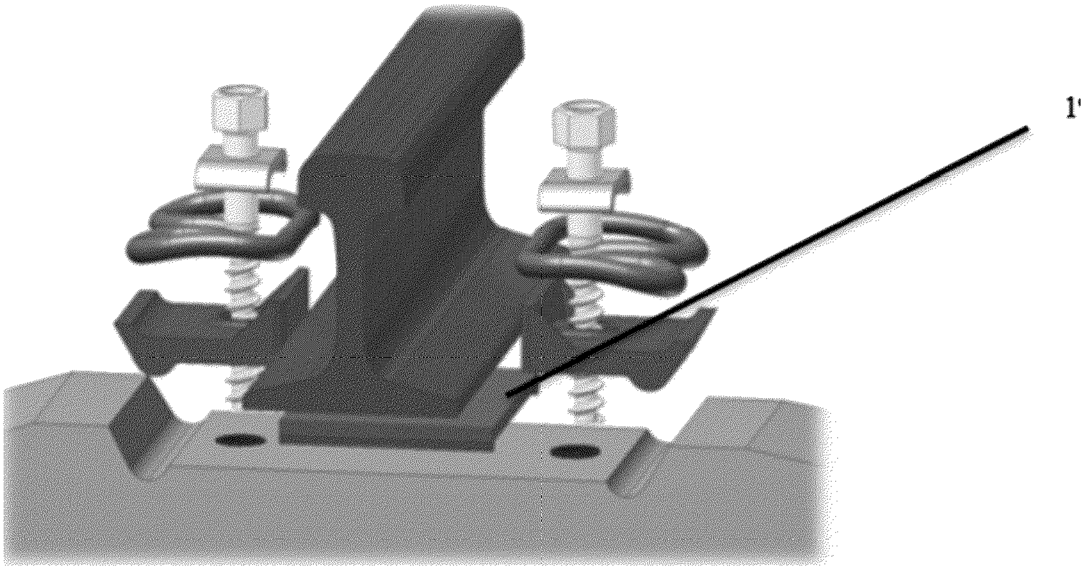

Fig. 1

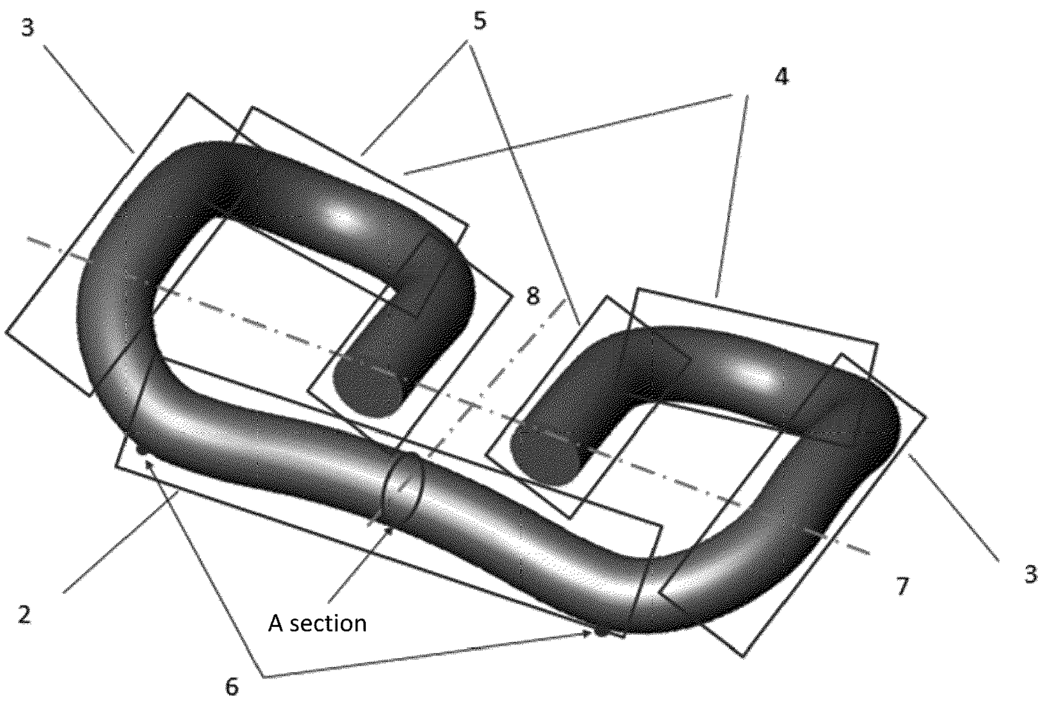

Fig. 2

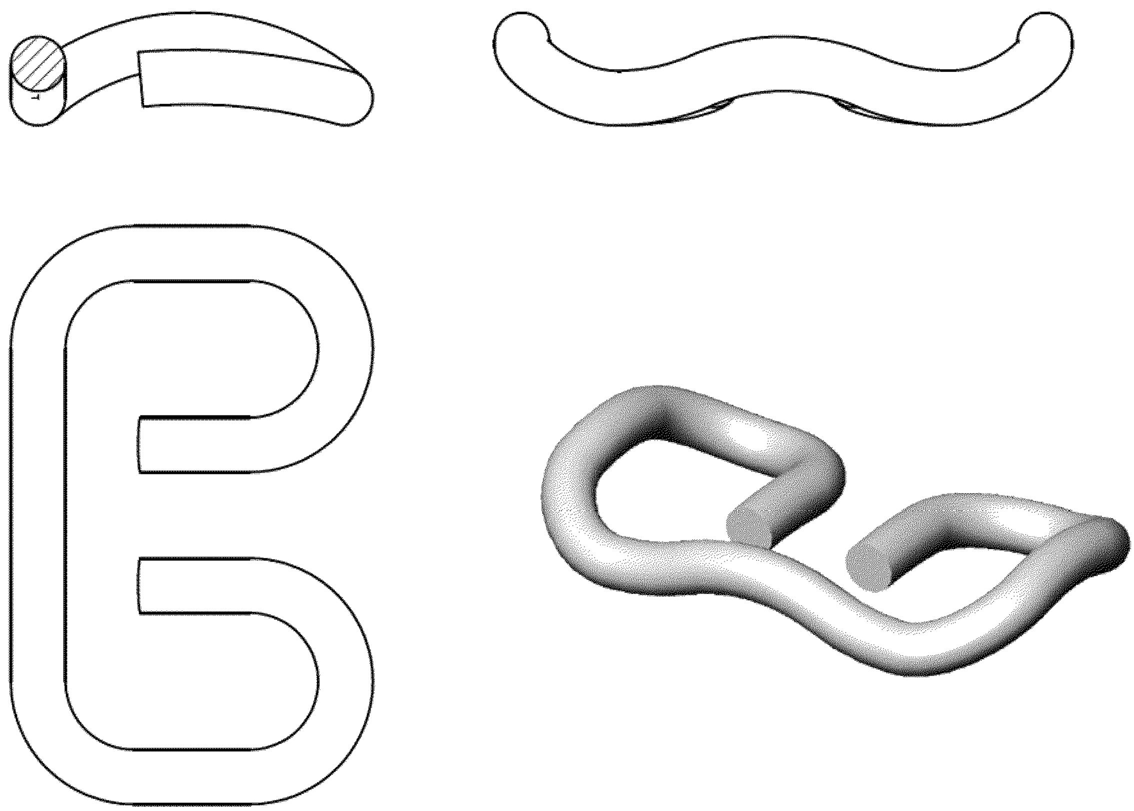

Fig. 3

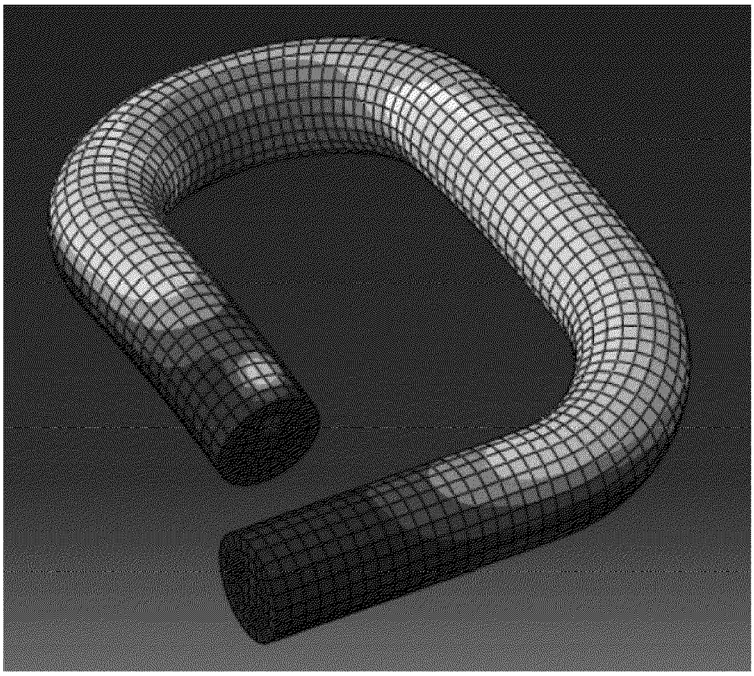

Fig. 4.1

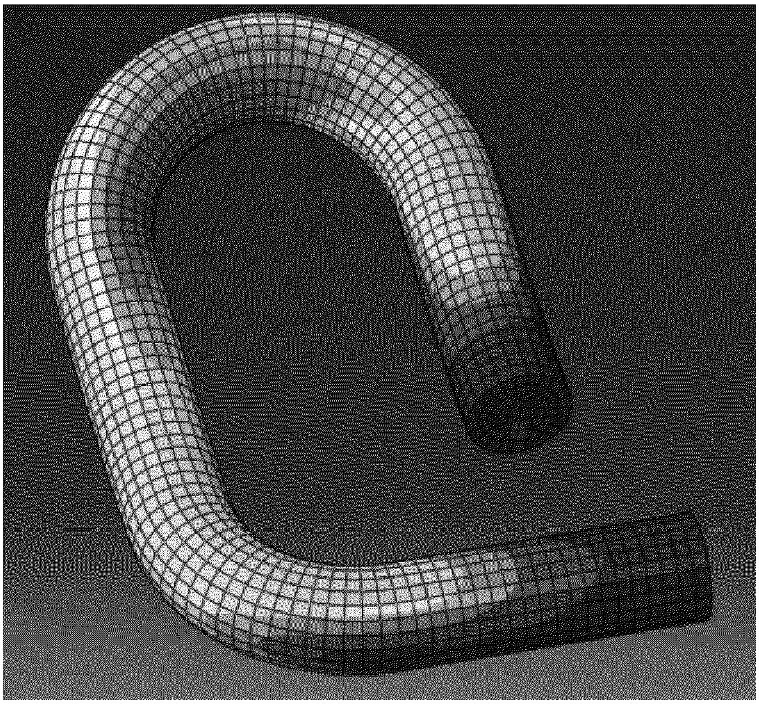

Fig. 4.2

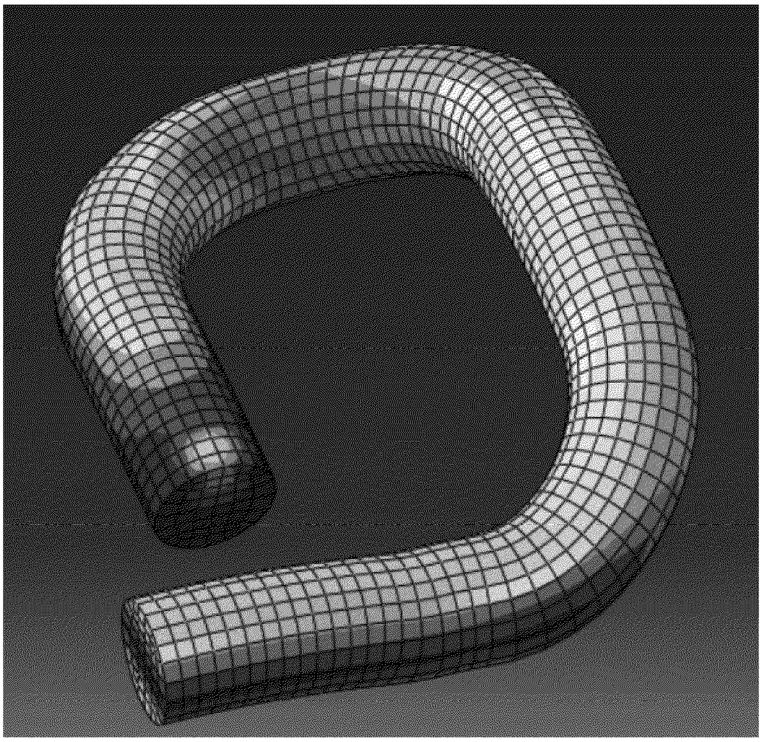

Fig. 5.1

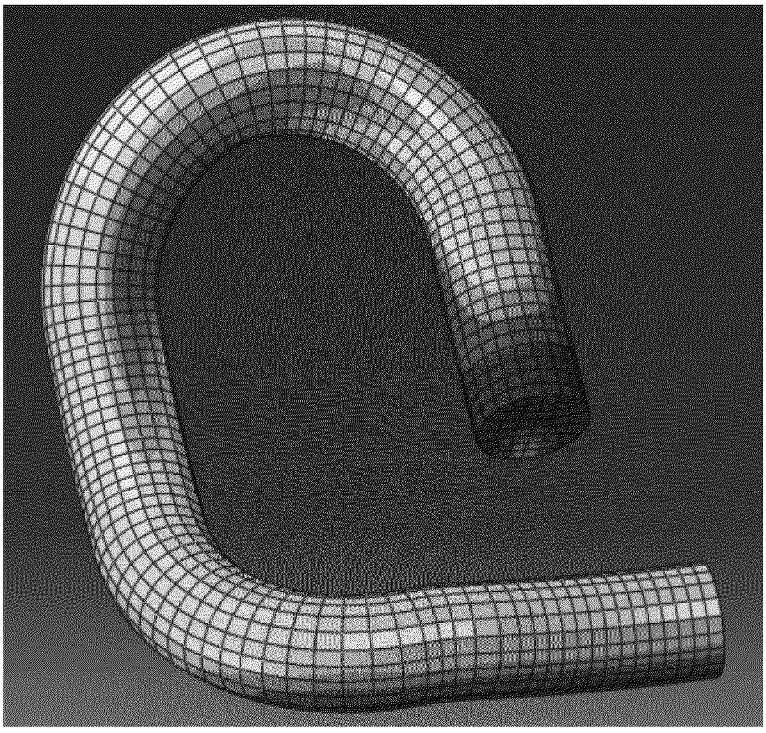

Fig. 5.2

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EUROPEAN SEARCH REPORT

Application Number
EP 23 02 0340

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	RU 174 600 U1 (OPEN JOINT STOCK COMPANY "RUSSIAN RAILWAYS") 23 October 2017 (2017-10-23) * the whole document * -----	1	INV. E01B9/30
A,D	RU 170 573 U1 (GVIDONSKY DMITRY VITALIEVICH , POLITOV ALEXEY MIKHAILOVICH) 28 April 2017 (2017-04-28) * the whole document * -----	1	
A	DE 27 40 144 A1 (PORTEC INC) 15 March 1979 (1979-03-15) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

E01B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	7 March 2024	Kremsler, Stefan

CATEGORY OF CITED DOCUMENTS

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07-03-2024

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
RU 174600	U1	23-10-2017	NONE	
RU 170573	U1	28-04-2017	NONE	
DE 2740144	A1	15-03-1979	NONE	

EPO FORM P0459

REFERENCES CITED IN THE DESCRIPTION

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