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Amended claims in accordance with Rule 137(2) EPC.

(54) **METAL ABRASIVE MODULE FOR MACHINING RAILS**

(57) Vehicle for machining a rail (1) by grinding and/or planing, comprising a metal abrasive module (2), an eccentric drive (3) performing an eccentric movement, at least two abrasive blocks (4) connected with the eccentric drive, and a force exerting drive (5) pressing at least one abrasive block onto the rail, wherein the metal abrasive module and/or at least one of the abrasive blocks is individually tiltable around an axis parallel to the rail, and wherein at least one of the abrasive blocks is individually pressable onto the rail. This allows a more effective and improved metal removal and rail shaping capabilities.

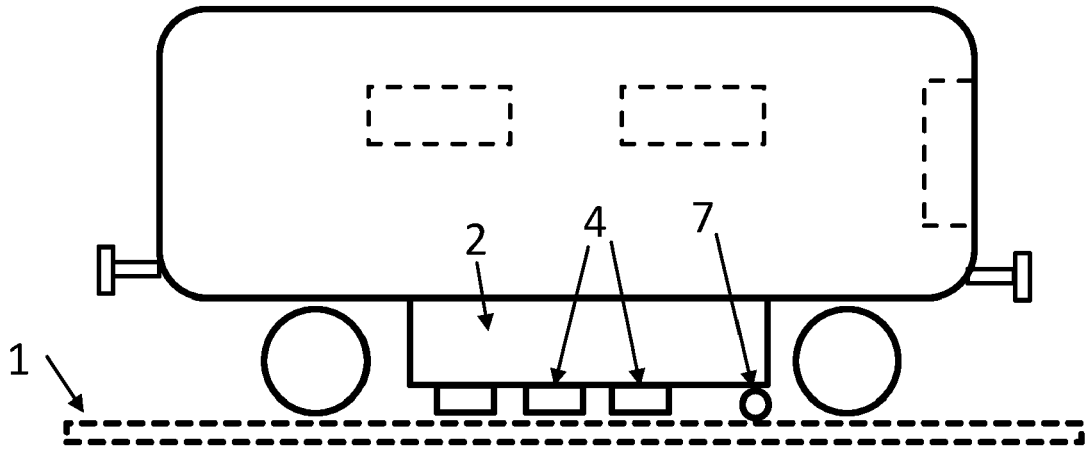

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of mobile treatment of rails with an abrasive rail planning module comprising of one or more abrasive blocks which are in contact with the rail. In particular the present invention relates to the field of mobile rail treatment wherein the abrasive blocks are pressed onto the rails by an eccentric drive. The related technology - for instance integrated into a vehicle or module - allows for removing rail surface irregularities such as corrugations, near surface defects, and millscale.

BACKGROUND OF THE INVENTION

[0002] Steel wheels from trains running on steel rails cause for wear and fatigue damage to both components. Wear and fatigue damage on rails mainly occur on the head and shoulders of the rails. High traction forces, acceleration and/or deceleration and curving of trains all contribute to the occurrence of such wear and rolling contact fatigue damages. For extending the life of rails, a minimization of damages to a related track and/or vehicle components as well as a minimization of noise and vibration, which are issues to passengers and nearby residents, are required. It is therefore necessary that rails are maintained.

[0003] To avoid a replacement of entire rails with surface irregularities such as corrugations, near surface defects and millscale, a maintenance is often performed by on-site treatment of rails. Therefore, often a wagon is equipped with grinding tools which allow metal removal by, for instance, grinding or milling of the rail surface with the help of stones performing movements to remove metal. The related abrasive blocks are usually connected to a drive which performs oscillating movements. Rotational grinding, oscillating block grinding, planing, milling and rotational planing are all common mobile rail treatment methods used to either bring rails in shape or keep rails in shape. Each of these methods have their specific advantages and disadvantages.

[0004] Often ridges and irregularities can be removed from rail head surfaces by means of a travelling on-track planing, shearing and grinding machine with related tool supports. The tool supports provided for each rail are typically pivotally interconnected through spacers adjustable in length transversely of the longitudinal axis of the machine. A set of tools is arranged opposite one another for each rail. The tool support is provided with guide rollers guided firmly along the upper surface and outside of the rail head. The known drives for grinding usually have a relatively small stroke which is often tried to be compensated by higher frequencies or forces with which the abrasive block is pressed onto the rail.

[0005] The machining tools and related machines for rail treatment usually leave the removed metal on or next to the rail. Hence all debris - including a mixture of water, dust, abrasive residue and metal - produced by the existing technologies stays behind on the tracks which requires additional and subsequent cleaning in case of rails surrounded, for instance, by asphalt. In existing grinding machines a relatively short longitudinal or sliding movement of a grinding block is performed due to the nature of the rotational to linear movement mechanism which often means debris remains between stone and rail and is not cleared which in turn results in low metal removal.

[0006] In existing machines often multiple blocks are fitted in a sort of moving ruler or bar and grinding blocks can only be fitted straight, but not angled. This results in low flexibility also in relation to the allowed surface shapes of the rail heads and the way they can be treated. The grinding blocks also cannot be pressed on the rail individually, but only in a fixed series of blocks.

[0007] The existing rail grinding technology only works with the use of significant amounts of water for cooling the stones, typically this technology requires a few thousands of liter water to function, water is sprayed ahead and behind each grinding stone. Hence, significant amounts of water are wasted.

[0008] Rotational to linear movement mechanism is often achieved through gearboxes with excenter mechanisms, for instance a Latest Plasser system via linear horizontal hydraulic cylinders and/or actuators. These are typically used on tramway systems.

[0009] The patent DE3015283A1 describes a travelling on-track machine for removing irregularities from the rail head surface of laid rail tracks and further relates to a method for removing irregularities, such as ridges and laps, from the rail head surface of at least one rail of a laid track using a plane carriage which is pivotally connected to the planing machine and designed to be vertically and laterally guided along the rail head and which is provided with only one planing tool per rail. Hence a significant removal of metal and thus a faster, but also more flexible approach related to the surface shape remains a challenge.

SUMMARY OF THE INVENTION

[0010] It is an object of the invention to provide a method and a related machine for mobile rail treatment with improved characteristics.

[0011] According to the invention, this object is addressed by the subject matter of the independent claims. Preferred embodiments of the invention are described in the sub claims.

[0012] The invention aims inter alia in improving the rail's longitudinal profile combining both high metal removal with leaving a very low residual roughness from the machining process and without leaving any significant dust and/or debris on the track. Further, the invention improves mobile rail treatment by using a method which does not produce any sparks.

[0013] According to the invention a vehicle for machining a rail by grinding and/or planning is provided, comprising a metal abrasive module, an eccentric drive performing an eccentric movement, at least two abrasive blocks connected with the eccentric drive, and a force exerting drive pressing at least one abrasive block onto the rail, wherein the metal abrasive module and/or at least one of the abrasive blocks is - preferably individually - tiltable around an axis parallel to the rail, and wherein at least one of the abrasive blocks is individually pressable onto the rail. The invention also provides a machining technology for mobile rail treatment which is suitable for implementation in a vehicle or train.

[0014] The invention allows for high performance mobile rail treatment suitable for removing rail surface irregularities such as corrugations, near surface defects and millscale. Furthermore, high metal removal capabilities combined with leaving a very low residual machining roughness are achieved by the invention. An abrasive block tiltable around an axis parallel to the rail allows a complex machining of the metal surface and therefore - related to rails - the head and/or shoulder. The metal removal can therefore be performed individually and better adapted to the local form or desired form. This can allow to shape rails to complex forms or profiles with the shape of individual curves.

[0015] In case the abrasive blocks are individually pressable onto the rail, the aforementioned advantages related to the tiltable abrasive blocks apply here as well - the individually pressable abrasive blocks support shaping the rail's surface to an individual form. The invention also provides a machining technology for mobile rail treatment which is suitable for implementation in a vehicle or train.

[0016] The vehicle may also be a wagon or a train car or another mobile service car including those used for trams and/or trains or other rail bound vehicles. The abrasive block may comprise a hard material in form of a stone and/or crystal and/or ceramic and/or a material compound including several materials. The abrasive block can be manufactured by pressing, casting, hot embossing or other methods allowing to produce a block that is hard and/or stable enough for removing metal from a rail by grinding and/or planning. Further, the abrasive block basically can have a relatively simple outer geometry in form of a cuboid, but a free-formed, individually designed geometry can be of advantage especially when considering special forms of the rail surface.

[0017] The eccentric drive usually comprises a drive which is coupled to a turning motor, wherein the eccentric drive transforms the oscillation or other motion of the motor into eccentric movements.

[0018] In one embodiment of the invention, a translational movement component of at least one of the abrasive blocks is longer than the length of said abrasive block. In this way the removed metal, which may often stay between the rail and the abrasive block for several periods of the oscillating movement of the abrasive block, is moved faster to the sides of the abrasive block. Hence the removal rate of the mobile rail treatment is increased since the abrasive block is more in direct contact with the rail surface.

[0019] In one embodiment of the invention, the eccentric movement has a scotch yoke type mechanism. The Scotch Yoke is a reciprocating motion mechanism which transforms the linear motion of a slider into rotational motion or vice versa. The piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The location of the piston versus time typically is a relatively simple harmonic motion, for instance a sine wave having constant amplitude and constant frequency which produces a constant rotational speed. The advantage of a scotch yoke type mechanism can be the realization of a high amplitude - especially of the translational component of the movement - and/or a high acceleration and/or a high pressure and/or a high velocity, which may all contribute to an increased removal rate of metal of the rails.

[0020] In another realization of the invention multiple abrasive blocks are coupled together which can therefore work as a sliding ruler. Typically, every further added abrasive block increases the length of the rail which can be treated simultaneously. However, it is also advantageous to limit the length of each abrasive block so that removed metal is moved more efficient to an outside of an abrasive block. Hence, it is advantageous to limit the overall length of each abrasive block and use multiple abrasive blocks which can also be positioned individually

[0021] In a preferred embodiment of the invention, the eccentric drive is driven by a variable frequency electric motor and/or a hydraulic drive. A variable frequency electric motor allows for adjustment of the power and rounds per minute and hence the rotational speed. Further these can be relatively efficient in power consumption. A hydraulic drive is often already available and therefore, no extra motor or drive is required.

[0022] In a further realization of the invention the abrasive module can be tilted from vertical towards an outer side and/or inner side of the rail. This allows, e.g., for shaping the head and/or the shoulder of a rail. Conventional system in state of the art allow only a fixed angle towards the rail which reduces the possibilities to efficiently reshape rails.

[0023] In a special embodiment of the invention, the vehicle and the abrasive module further comprises a debris suction head in the vicinity of the contact surface of the metal abrasive module with the rail. This allows to remove at least most of the removed metal from the rail and no or only little of the removed metal is left in the vicinity after treatment of the rail.

[0024] Further it is preferred that the invention comprises a guide roller in the vicinity of the metal abrasive module and/or abrasive block, wherein the guide roller is in contact with the rail allowing i. a. for machining rails in tight curves. The guide roller may also contribute to less vibrations of the system and it may also comprise an

opening near the surface of the rail for suction of removed metal.

[0025] In a further realization of the invention at least two abrasive modules are each connected to an individual guide roller. This can significantly improve the quality of the guiding mechanism, improve security measures etc. and hence allow narrow curves.

[0026] It is further preferred that the abrasive module is connected to a guide roller with a - preferably integrated - debris suction head. The suction head can be located in front or in the rear of the guide roller and. It can also be thought of - preferably multiple - suction heads or channels, which - in a special embodiment - may be distributed and/or integrated around the guide roller.

[0027] The invention further comprises a method for machining a rail by grinding and/or planing, comprising the steps of approaching a surface to be machined until contact with a metal abrasive module with at least two abrasive blocks connected with a vehicle, tilting the metal abrasive module and/or at least one abrasive block parallel to a desired surface form, performing eccentric movements with the metal abrasive module while pressing the metal abrasive module onto the rail.

[0028] The method can further comprise the step of suction of debris and/or metal chips in the vicinity of at least one of the abrasive blocks. By this an improved removal of the removed metal can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. Such an embodiment does not necessarily represent the full scope of the invention, however, and reference is made therefore to the claims and herein for interpreting the scope of the invention.

[0030] In the drawings:

Fig. 1 schematically depicts a vehicle on rails having a metal abrasive module according to one embodiment of the invention,

Fig. 2 schematically depicts an embodiment of the metal abrasive module,

Fig. 3 schematically depicts an embodiment of the metal abrasive module with abrasive blocks being positioned in different angles,

Fig. 4 schematically depicts magnified excerpts of each of the three figures in Fig. 3,

Fig. 5 schematically depicts an embodiment of the guide roller,

Fig. 6 schematically depicts the guide roller of Fig. 5 including a mount for attaching to the metal abrasive module,

Fig. 7 schematically depicts one embodiment of the abrasive block and

Fig. 8 schematically depicts the abrasive block in a 3D-view including a channel.

DETAILED DESCRIPTION OF EMBODIMENTS

[0031] Figure 1 schematically shows a vehicle on rails having a metal abrasive module 2 with three abrasive blocks 4, wherein a guide roller 7 is attached to the metal abrasive module 2. The vehicle may also be a wagon or a train car or a service or maintenance car and allows to carry the metal abrasive module 2 to the place where a treatment of the rails is required.

[0032] In Fig. 2 one embodiment of the metal abrasive module 2, which can be attached to a chassis or a frame of the vehicle, with three abrasive blocks 4 and a guide roller 7 is shown. Further, the force exerting drive 5 for pressing the abrasive blocks 4 is depicted, which has the form of a hydraulic cylinder. The hydraulic cylinder presses also the part of the metal abrasive module 2 downwards in direction of the rails 1, which performs the eccentric movements.

[0033] The metal abrasive module 2 is schematically depicted in Fig. 3 with abrasive blocks 4 being positioned in different angles in a.), b.) and c.) towards the head of the rail 1 and with magnified excerpts of each of the three shown cases in Figs. 4 a.), b.) and c.). By tilting the abrasive blocks 4, an adapted or optimized treatment of the profile form of the rails can be realized.

[0034] In Fig. 5 one embodiment of the guide roller 7 is shown in more detail from a side perspective. The guide roller 7 is illustrated with a debris suction head 6 adjacent to the guide roller 7. It can also comprise a channel for a vacuum and can have a separate suspension. The roller is usually made of steel, but can be of any other material which is adequate to a specific application.

[0035] In Fig. 6 schematically depicts the guide roller 7 of Fig. 5 in a perspective which is 90 degrees turned. Also shown is a mount in the middle of Fig. 6 for attaching the guide roller 7 to the metal abrasive module 2. In the left part of Fig. 6 a hydraulic cylinder is depicted that exerts force onto the lower part of the guide roller 7.

[0036] Figure 7 schematically depicts two side views a.) and b.) of one embodiment of the abrasive block 4 which can substantially have the form of a cuboid. A recess 10 on one or two upper portions may serve for mounting the abrasive block 4 onto a rail system or another mounting or clamping mechanism or systems for holding the abrasive block 4. Figure 8 basically depicts the abrasive block of Fig. 7 in a 3D-view.

[0037] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the

invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope. Further, for the sake of clearness, not all elements in the drawings may have been supplied with reference signs.

REFERENCE SYMBOL LIST

[0038]

Rail	1
Metal abrasive module	2
Eccentric drive	3
Abrasive block	4
Force exerting drive	5
Debris suction head	6
Guide roller	7
Mobile chassis	8
Recess	9

Claims

1. Vehicle for machining a rail (1) by grinding and/or planing,

comprising a mobile chassis (8) and a metal abrasive module (2) for grinding and/or planning a rail, the metal abrasive module (2) comprising

- an eccentric drive (3) performing an eccentric movement,
- at least two abrasive blocks (4) connected with the eccentric drive (3), and
- a force exerting drive (5) pressing at least one abrasive block (4) onto the rail (2),

wherein the metal abrasive module (2) and/or at least one of the abrasive blocks (4) is tiltable around an axis parallel to the rail, and
wherein at least one of the abrasive blocks (4) is individually pressable onto the rail.

2. Vehicle according to claim 1, wherein a translational movement component of at least one of the abrasive blocks (4) is longer than the length of said abrasive block (4).

3. Vehicle according to any of the preceding claims, wherein the eccentric movement has a scotch yoke type mechanism.

4. Vehicle according to any of the preceding claims, wherein multiple abrasive blocks (4) are coupled together.

5. Vehicle according to any of the preceding claims, wherein the eccentric drive (3) is driven by a variable frequency electric motor and/or a hydraulic drive.

6. Vehicle according to any of the preceding claims, wherein the abrasive module (2) can be tilted from vertical towards an outer side and/or inner side of the rail.

7. Vehicle according to any of the preceding claims, further comprising a debris suction head (6) in the vicinity of the contact surface of the metal abrasive module (2) with the rail (1).

8. Vehicle according to any of the preceding claims, further comprising a guide roller (7) in the vicinity of the metal abrasive module (2) and/or abrasive block (4), wherein the guide roller (7) is in contact with the rail (1).

9. Vehicle according to any of the preceding claims, wherein at least two abrasive modules (4) are each connected to an individual guide roller (7).

10. Vehicle according to any of the preceding claims, wherein the abrasive module (4) is connected to a guide roller (7) with a debris suction head (6).

11. Method for machining a rail (2) by grinding and/or planing, comprising the steps of

- approaching a surface to be machined until contact with a metal abrasive module (2) with at least two abrasive blocks (4) connected with a vehicle (1),
- tilting the metal abrasive module (2) and/or at least one abrasive block (4) parallel to a desired surface form,
- performing eccentric movements with the metal abrasive module (4) while pressing the metal abrasive module (4) onto the rail (2).

12. Method according to the precedent claim, further comprising the step of suction of debris and/or metal chips in the vicinity of at least one of the abrasive blocks (4).

Amended claims in accordance with Rule 137(2) EPC.

1. Vehicle for machining a rail (1) by grinding and/or planing,

comprising a mobile chassis (8) and a metal abrasive module (2) for grinding and/or planning a rail, the metal abrasive module (2) comprising

- an eccentric drive (3) performing an eccentric movement,
- at least two abrasive blocks (4) connected with the eccentric drive (3), and
- a force exerting drive (5) pressing at least one abrasive block (4) onto the rail (2),

wherein the metal abrasive module (2) and/or at least one of the abrasive blocks (4) is tiltable around an axis parallel to the rail, and
wherein at least one of the abrasive blocks (4) is individually pressable onto the rail.

2. Vehicle according to any of the preceding claims, wherein the eccentric movement has a scotch yoke type mechanism.

3. Vehicle according to any of the preceding claims, wherein multiple abrasive blocks (4) are coupled together.

4. Vehicle according to any of the preceding claims, wherein the eccentric drive (3) is driven by a variable frequency electric motor and/or a hydraulic drive.

5. Vehicle according to any of the preceding claims, wherein the abrasive module (2) can be tilted from vertical towards an outer side and/or inner side of the rail.

6. Vehicle according to any of the preceding claims, further comprising a debris suction head (6) in the vicinity of the contact surface of the metal abrasive module (2) with the rail (1).

7. Vehicle according to any of the preceding claims, further comprising a guide roller (7) in the vicinity of the metal abrasive module (2) and/ abrasive block (4), wherein the guide roller (7) is in contact with the rail (1).

8. Vehicle according to any of the preceding claims, wherein at least two abrasive modules (4) are each connected to an individual guide roller (7).

9. Method for machining a rail (2) by grinding and/or planing, comprising the steps of

- approaching a surface to be machined until contact with a metal abrasive module (2) having at least two abrasive blocks (4) connected with a vehicle (1),
- tilting the metal abrasive module (2) and/or at least one abrasive block (4) parallel to a desired surface form,
- performing eccentric movements with the metal abrasive module (4) while pressing the metal abrasive module (4) onto the rail (2).

10. Method according to the precedent claim, further comprising the step of suction of debris and/or metal chips in the vicinity of at least one of the abrasive blocks (4).

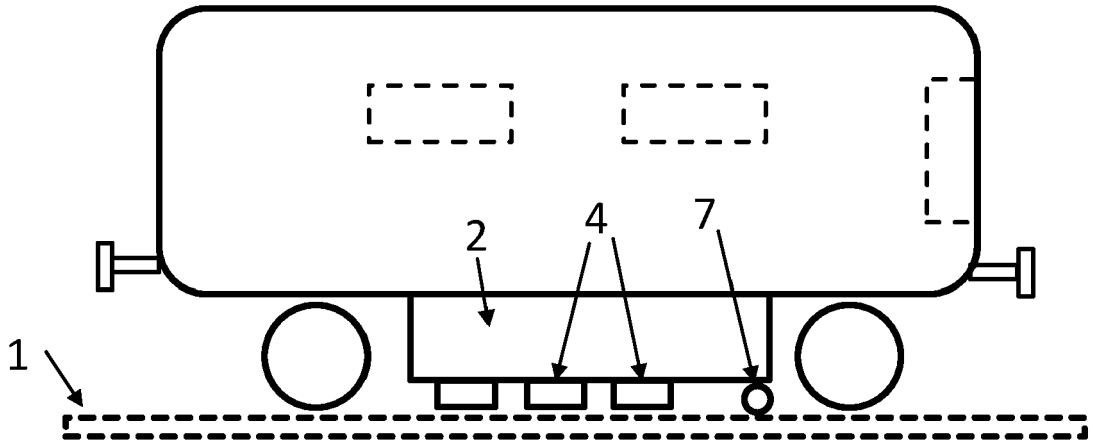

Fig. 1

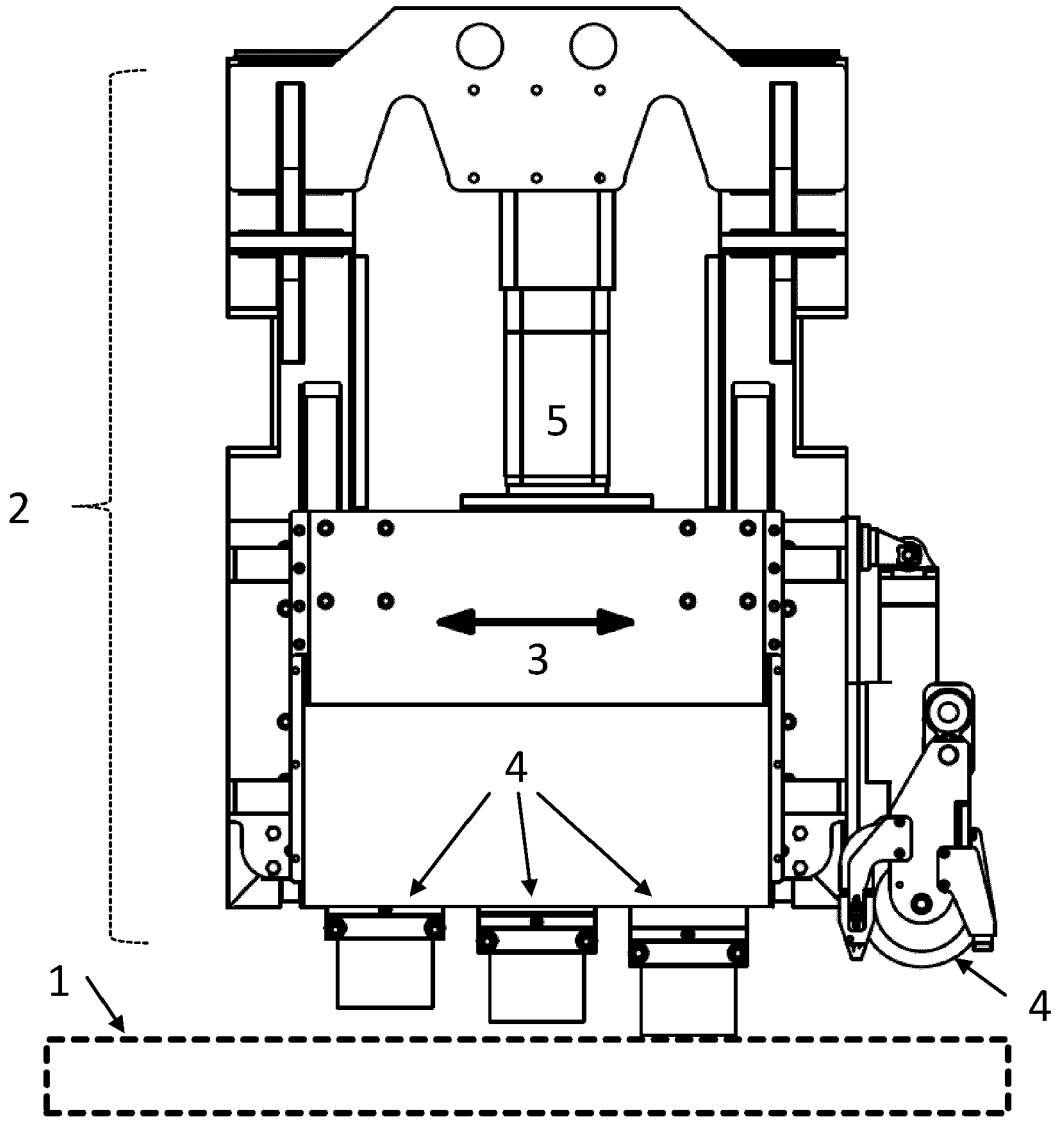

Fig. 2

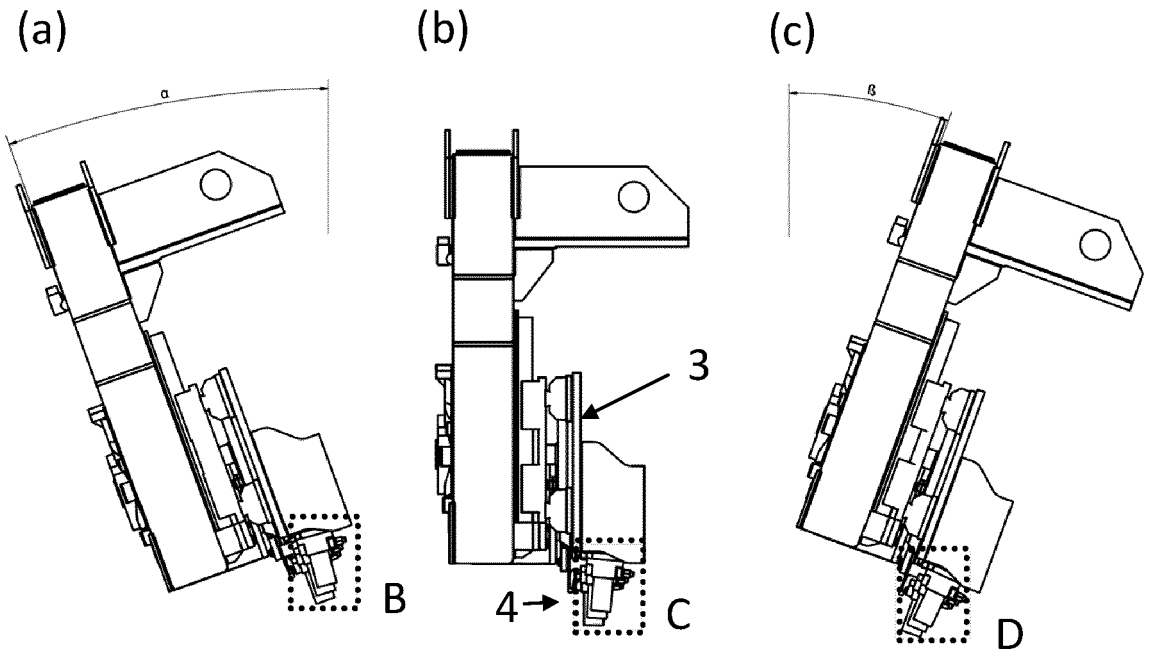

Fig. 3

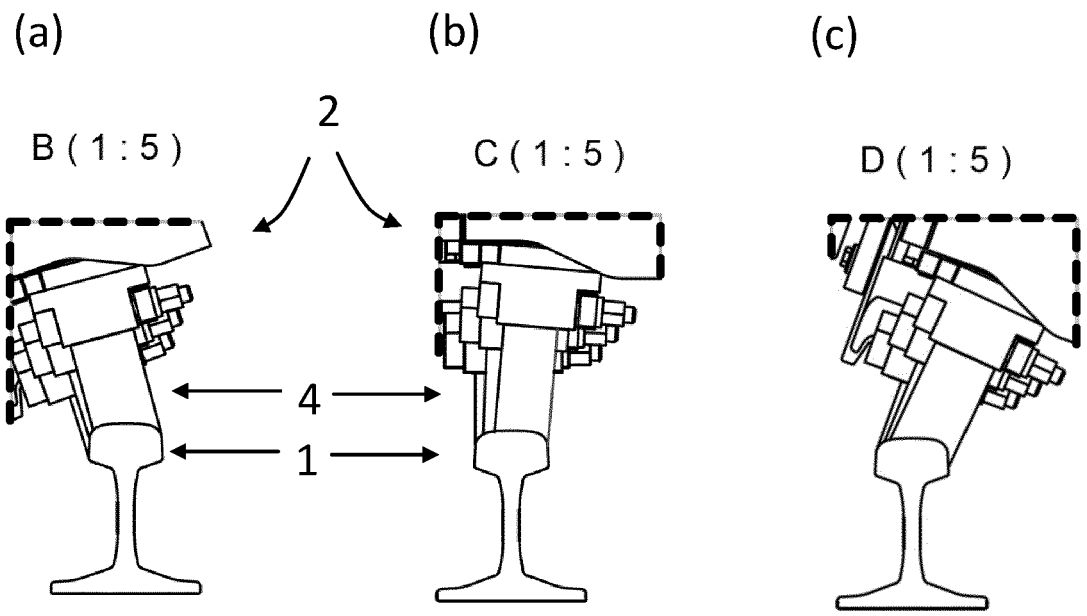

Fig. 4

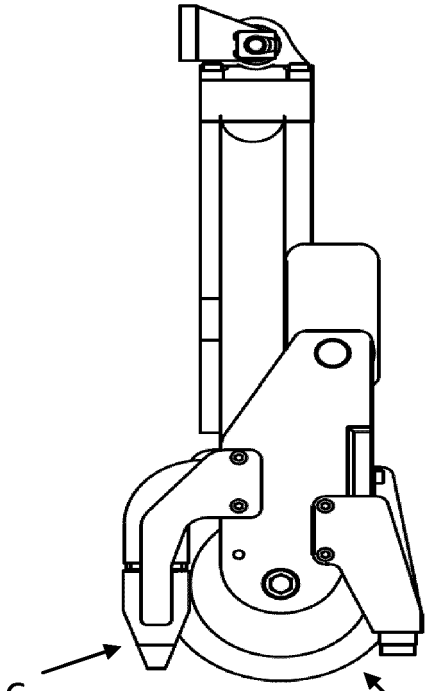

Fig. 5

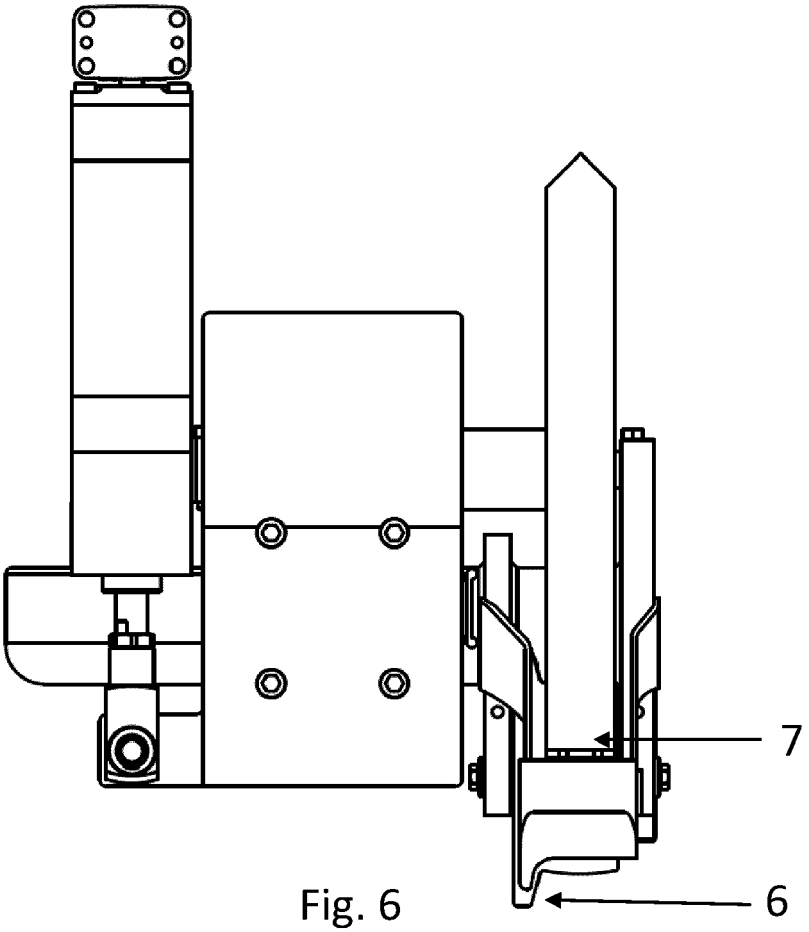

Fig. 6

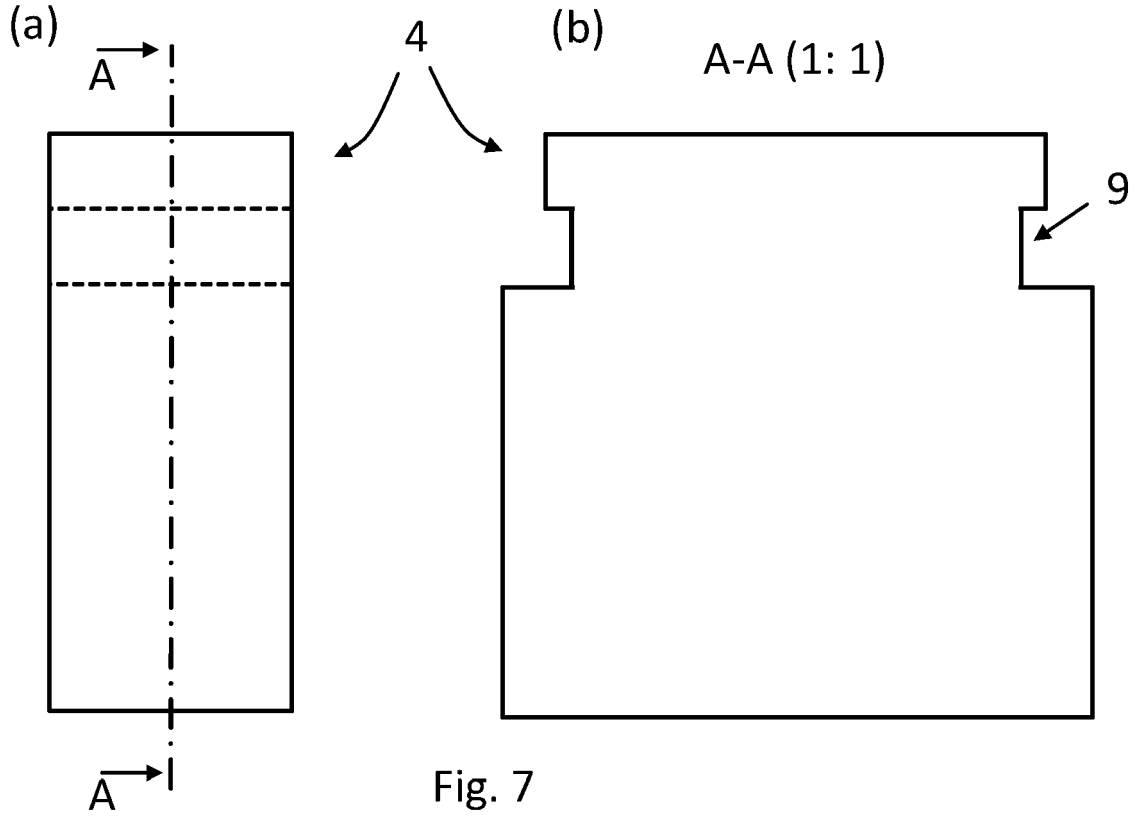

Fig. 7

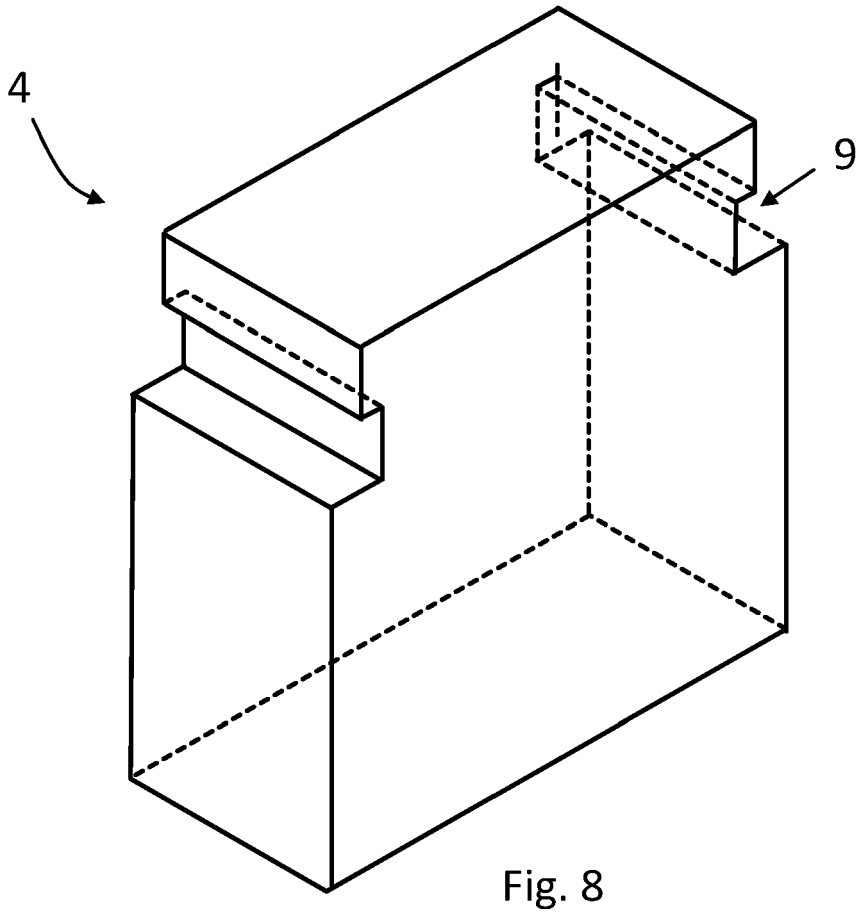

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 0485

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

E01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 November 2023	Klein, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 18 0485

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