

(19)



(11)

EP 4 563 745 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.06.2025 Bulletin 2025/23

(51) International Patent Classification (IPC):
E01B 29/28^(2006.01) B61D 15/00^(2006.01)

(21) Application number: **24208808.6**

(52) Cooperative Patent Classification (CPC):
E01B 29/28; B61D 15/00

(22) Date of filing: **24.10.2024**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(71) Applicant: **Strukton Rail Nederland B.V.**
3542DA Utrecht (NL)

(72) Inventor: **Oostrom, Otto**
p/a 3542DA Utrecht (NL)

(74) Representative: **Assendelft, Jacobus H.W.**
Assendelfts Octrooibureau
Keukenhofdreef 20
2161 AZ Lisse (NL)

(30) Priority: **24.10.2023 NL 2036109**

(54) TRACK WORK WITH THE HELP OF A ROBOTIC ARM AND CARDAN SHAFT

(57) Rail vehicle for carrying out work on a section of a railway, the work may relate to maintenance or new construction, the rail vehicle comprises a chassis frame which is equipped with flange rollers for driving over the two parallel rails of a railway, the rail vehicle delimits an

internal work space, preferably open towards the bottom, which is equipped with a work device for working on the track structure, for example under the rail vehicle, for example for tightening and loosening spring clamps.

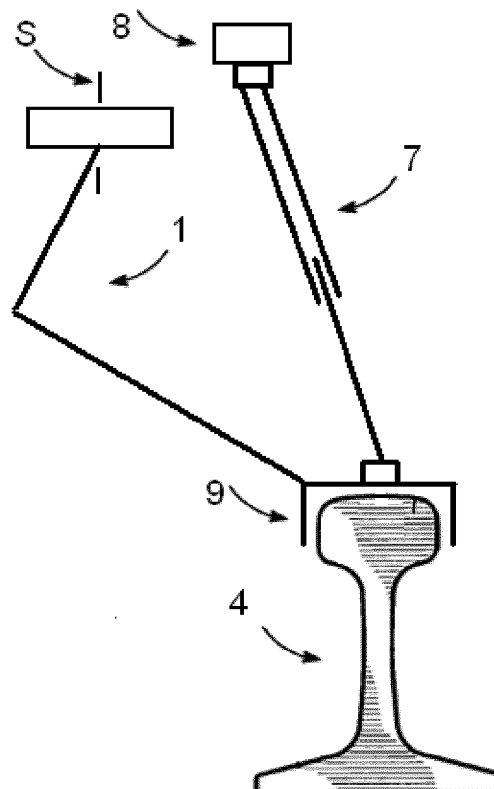


Fig. 6

EP 4 563 745 A1

Description

[0001] The invention relates to a railway vehicle and method for carrying out work on a section of a railway. The work may relate to maintenance or new construction. The railway vehicle comprises a chassis frame which is equipped with flanged rollers for driving over the two parallel rails of a railway. The railway vehicle is equipped with a working device for working on the track structure, for example for tightening and loosening bolts and screws using a motor-driven screw tool, such as a so-called collar screw machine, for example of the rail mounting, such as the spring clamps, on the sleepers. The railway is preferably the public civil railway network and/or intended for passenger and freight transport, such as a train, tram or metro line, preferably with an overhead line above the track for the electrical supply of the train locomotive.

[0002] From FR 2 659 674 or DE 20305569 U1 a manually operated device is known, in which the motor-driven working tools are used for the mounting of spring clamps. During operation, the machine is moved to the next sleeper by pushing against the handles using human muscle power, while driving over the track, while the track worker walks behind it. DE 20 2004 013 732 U discloses a railway vehicle (= mobile workshop) with an internal workspace open at the bottom, located between two side walls that shield the internal workspace from the adjacent environment in order to provide a shielded area within which track workers can work safely.

[0003] Other work devices to which the invention may apply are, for example: sleeper drilling machine; rail surface grinding machine; switch grinding machine.

[0004] This work device must have sufficient performance, low energy consumption, manageability, limited weight, good balancing, low centre of gravity, reproducible tightening force for the nuts or screws. New construction or technical maintenance, in particular in the case of railways, outdoors or in an uncontrolled environment such as the space of railway tunnels, requires the use of powerful working devices that can perform various operations, such as drilling, sawing, machining by sanding (grinding), screwing, moving heavy objects or applying mechanical shocks. These working devices must be movable. There is interest in powerful working devices for new construction or maintenance, which are also suitable for robotisation, so that people are freed from heavy and monotonous work under difficult working and weather conditions. The aim of the invention is to develop a railway vehicle with a working device with a working tool with a, preferably electric, drive motor, for example with which screws, nuts and bolts can be screwed in or out reliably and effectively as much as possible, preferably fully, mechanised, in railway applications, whereby the working device is lightweight and delivers high performance with the desired long-term use, is specifically aimed at the various applications and is constructed safely and reliably with a long service life, low weight, high reliability, low

maintenance costs. The use of a person is limited as much as possible, preferably completely, to controlling and monitoring functions. In the case where a tightening torque has to be supplied by the work device, for example for tightening screws or bolts, a further aim of the invention is that the tightening torque supplied can be supplied accurately and reproducibly in order to be able to guarantee the reliability of the mechanical connection thus realised.

[0005] The implementation of a simple solution is made more difficult in the case of the use of an industrial robot by a significant increase in the weight of the robot as the forces to be exerted by the robot increase. It is therefore necessary, in a context initially defined for the use of a human worker, to apply means to take this circumstance into account.

[0006] To solve these problems, a railway vehicle with a working device is proposed, which working device is equipped with a working tool and associated, preferably electric, drive motor, a robot arm for manipulating the working tool, and a flexible coupling, such as a telescopic cardan shaft, with which the input shaft of a working tool is drivingly coupled to the output shaft of the drive motor. The function of the robot arm can thus be limited to holding and spatially positioning the working tool, and can therefore be constructed in a light weight. The working tool can, thanks to the telescopic cardan shaft, be positioned freely in space by the robot arm.

[0007] The working device preferably has one or more of the following:

- is mounted to the chassis frame of the rail vehicle;
- is mounted to the side of the central longitudinal axis of the rail vehicle, seen in plan view;
- the telescopic cardan shaft has a cardanic coupling at both ends and a telescopic rod in between that can be extended or shortened by telescoping;
- the telescopic cardan shaft is at one end, at a distance, preferably at least 50 centimetres, from the drive motor, cardanically coupled to the working tool via the cardanic coupling;
- the telescopic cardan shaft is at its other end cardanically coupled to the output shaft of the drive motor via the cardanic coupling;
- the length of the fully retracted cardan shaft is at least 25 or 50 and/or a maximum of 150 centimetres;
- the length of the fully extended cardan shaft is at least 75 and/or a maximum of 250 centimetres;
- the work tool is equipped with a device, for example detachable fixing means, such as a clamp, to fix itself to the track structure, for example by clamping to a rail or sleeper or spring clamp;
- the output shaft of the drive motor is oriented vertically;
- the output shaft of the drive motor is located at a level above, preferably at least 25 or 50 centimetres above, the level at which the base of the robot arm is mounted to the rail vehicle;

- the output shaft of the drive motor is located further away, preferably at least 10 or 25 centimetres further away, from the centreline of the rail vehicle and/or the railway than the base of the robot arm, seen in plan view;
- the output shaft of the drive motor is located vertically directly above the straight line connecting the running wheels on the same side of the rail vehicle; - the output shaft of the drive motor is located at a level of at least 25 or 50 or 100 centimetres and/or at most 150 or 200 or 250 centimetres above the level of the bottom of the running wheels of the rail vehicle, in other words the top of the rail head in the event that the running wheel in question rests on the rail head in the typical manner;
- the robot arm and/or drive motor is mounted to the side of the central longitudinal axis of the rail vehicle and/or the railway, viewed in plan view, preferably positioned in the horizontal direction transversely to the central longitudinal axis at a distance, preferably at least 20 or 50 centimetres, from that central longitudinal axis.

[0008] The rail vehicle preferably provides one or more of the following:

- an internal working space open towards the bottom, for example so that the internal working space is provided between two upright side walls of the rail vehicle, from which internal working space access is obtained via the open bottom to the track structure under the rail vehicle;
- a chassis frame formed by tubes or profiles;
- panels fixed to the chassis frame to form walls to form an internal working space protected from the elements;
- the internal working space is essentially a rectangular block with a width of at least 1 or 1.5 metres and a height of at least 1 or 1.5 or 2 or 2.5 metres;
- the internal working space is provided between a front and a rear upright wall;
- the internal working space has a dimension and/or the front and rear upright walls, maintain a distance, measured along the median longitudinal axis of the vehicle and/or the railway, of at least 1 and/or a maximum of 2 or 2.5 or 3 metres;
- designed as a rail/road vehicle;
- light in weight, for example a maximum of 3 or 5 or 10 thousand kilograms to be transported by road as a lorry load.

[0009] For the industrial robot arm, preferably one or more of the following applies:

- of at least 3-axis type, preferably at least or exactly 5-axis or 6-axis type;
- of vertically articulated type;
- contains the following movement axes: S, L, U, R, B,

T (see fig. 6 + 7);

- the maximum rotation angle of one or more of the movement axes is at least 90 degrees;
- for one or more of the characteristic dimensions V, W, X, Y, Z (see fig. 6) the following applies (in millimetres): V minimum 455 and/or maximum 555, such as 505 or minimum 490 and/or maximum 590, such as 540, W minimum 180 and/or maximum 220, such as 200 or minimum 190 and/or maximum 230, such as 210, X minimum 700 and/or maximum 820, such as 760 or minimum 810 and/or maximum 930, such as 870, Y minimum 715 and/or maximum 875, such as 795 or minimum 945 and/or maximum 1105, such as 1025, Z minimum 135 and/or maximum 165, such as 150 or minimum 290 and/or maximum 350, such as 320; - mounted with the S-axis, i.e. the axis of movement of the base, horizontal;
- mounted with the base or the S-axis, i.e. the axis of movement of the base, at a level at least 25 or 50 centimetres and/or at most 150 or 200 centimetres above the level of the bottom of the running wheels of the rail vehicle, in other words the top of the rail head in the event that the relevant running wheel rests on the rail head in the typical manner.

[0010] While the working device is in operation and successively or one after the other treats a number of, for example, at least 3 or 5 or 10, preferably mutually identical, track components, for example spring clamps, with mutual spacing of preferably at least 10 or 20 centimetres, seen in the longitudinal direction of the railway, or according to the pitch of the sleepers, the rail vehicle preferably has a forward speed, for example of at least 5 or 10 or 30 or 100 metres per hour and/or a maximum of 0.5 or 1 or 5 or 10 kilometres per hour, continuously, while the number of track components is treated successively.

[0011] Preferably, the definition of the axes of movement is: S=rotation of the base; and/or S=the shoulder joint; L= pivoting of the upper arm relative to the base; U=pivoting of the forearm relative to the upper arm; and/or U=elbow joint; R=rolling of the forearm around its longitudinal axis; B=pivoting of the free end and/or B=pivoting of the tool holder relative to the forearm; and/or B=wrists joint; T=rolling of the free end and/or T=rolling of the tool holder around its longitudinal axis.

[0012] Preferably, the sequence of the axes of movement, seen along the length of the robot arm, is as follows: S, L, U, R, B, T.

[0013] Preferably, the definition of the characteristic dimensions is: V=distance between L and the bearing surface of the base of the robot arm; W=distance between U and R; X=distance between L and U; Y=distance between U and B; Z=distance between S and L.

[0014] For the axes of movement, preferably one or more of the following applies for the mutual orientation in all positions of the robot arm: B perpendicular to T; U and L parallel; S perpendicular to L and U; R perpendicular to L and U.

[0015] The invention is further explained below by way of non-limiting embodiments, which are shown in the accompanying drawing, which shows in:

Fig. 1-4 an application for mounting or dismounting the rail mounting on the sleepers; 5

Fig. 5 an application for drilling holes in the sleepers;

Fig. 6 a schematic representation; 10

Fig. 7-8 an alternative from the side and above

Fig. 9-10 a side and perspective view of the robot arm type used; 15

Fig. 11 a perspective view of a double railway or track;

Fig. 12 a cross-section of a part of the track of fig. 1-5. 20

[0016] The rail vehicle shown in the drawing is, for example, of the type as disclosed in DE 20 2004 013 732 U or NL1028854C2 or EP3078774A1.

[0017] The rail vehicle is shown in half lengthwise in Fig. 1-5 and in its entirety in Fig. 6-7, and parts of the side wall have been removed to provide a better view of the working device. 25

[0018] Visible are a working device fixed to the chassis frame with a high-power electric drive motor 8, a telescopic cardan shaft 7, a working tool 9 and a robot arm 1. 30

[0019] This working device is designed for mounting rail clamps, with which rails and sleepers of a track are connected to each other. The rail vehicle has a chassis frame that stands on the two rails 4 with flanged rollers 11. 35

[0020] The telescopic cardan shaft is cardanically connected to the working tool at one end at a distance from the drive motor.

[0021] Explanation of the reference symbols used in Fig. 9-10: S-axis rotation of the base (rotation axis is perpendicular to the mounting surface of the base) ; L-axis bending lower arm; U-axis bending upper arm; R-axis rotating upper arm about the longitudinal axis; B-axis wrist bend; T-axis tool coupling rotate about the longitudinal axis. 40 45

[0022] The railway of Fig. 11 is electrified, therefore there are portals (one of which is visible) along it, which carry the contact wire. Fig. 12 shows how the portal leg 6 is founded by a steel-founded prefabricated element 5 next to or in the edge area of the ballast bed 2 which carries the sleepers 3 with the rails 4 on them. 50

[0023] Features of different embodiments disclosed herein can be combined in different ways and different aspects of features are considered mutually interchangeable. All features described or disclosed in the drawing provide the subject matter of the invention on their own or in any combination, also independently of their place in the claims or their reference. 55

Claims

1. Method for carrying out work on a section of a railway, the work may relate to maintenance or new construction, the railway vehicle contains a chassis frame equipped with flange rollers to drive over the two parallel rails of a railway, the railway vehicle delimits an internal work space, preferably open towards the bottom, which is equipped with a work device to work on the track structure, for example under the railway vehicle, for example for tightening and loosening bolts and screws using a motor-driven screw tool, such as a so-called collar screw machine, for example of the rail mounting, such as the spring clamps, on the sleepers.
2. Method according to claim 1, the working device is equipped with the working tool and associated electric drive motor, a robot arm for manipulating the working tool, and a telescopic cardan shaft, with which the input shaft of the working tool is drivingly coupled to the output shaft of the drive motor so that the cardan shaft provides the drive for the working tool for tightening the fastening bolts.
3. Method according to claim 1 or 2, the function of the robot arm remains limited during the method to holding and spatially positioning the working tool, and is lightweight.
4. Method according to one of claims 1-3, the working tool is positioned freely in space by the robot arm due to the use of the telescopic cardan shaft.
5. Method according to one of claims 1-4, one or more of the following applies to the working device:
 - is mounted on the chassis frame of the rail vehicle;
 - is mounted to the side of the central longitudinal axis of the rail vehicle, seen in top view;
 - the telescopic cardan shaft has a cardanic coupling at both ends and a telescopic rod in between that can be lengthened or shortened by telescoping;
 - the telescopic cardan shaft is at one end, at a distance of at least 50 centimetres from the drive motor, cardanically coupled to the work tool via the cardanic coupling;
 - the telescopic cardan shaft is at its other end cardanically coupled to the output shaft of the drive motor via the cardanic coupling;
 - the length of the fully retracted cardan shaft is at least 25 and at most 150 centimetres;
 - the length of the fully extended cardan shaft is at least 75 and at most 250 centimetres;
 - the work tool is equipped with a clamp, with which it temporarily fixes itself in relation to the

track structure, by clamping itself to a rail;

- the output shaft of the drive motor is oriented vertically;

- the output shaft of the drive motor is located at a level at least 50 centimetres above the level at which the base of the robot arm is mounted on the rail vehicle;

- the output shaft of the drive motor is located at least 25 centimetres further away from the centre longitudinal axis of the rail vehicle and the railway than the base of the robot arm, seen in plan view;

- the output shaft of the drive motor is located vertically directly above the straight line connecting the running wheels on the same side of the rail vehicle;

- the output shaft of the drive motor is located at a level at least 50 centimetres and at most 200 centimetres above the level of the bottom of the running wheels of the rail vehicle, in other words the top of the rail head in the event that the running wheel in question rests on the rail head in the typical manner;

- the robot arm and drive motor are mounted to the side of the centre longitudinal axis of the rail vehicle and the railway, seen in plan view, positioned in the horizontal direction transversely to the centre longitudinal axis at a distance of at least 50 centimetres from that centre longitudinal axis.

6. Method according to any of claims 1-5, the rail vehicle provides one or more of the following:

- a downwardly open internal working space, so that the internal working space is provided between two upright side walls of the rail vehicle, from which internal working space access is obtained via the open underside to the track structure under the rail vehicle;

- a chassis frame formed by profiles;

- panels attached to the chassis frame for forming walls to form an internal working space shielded from the weather;

- the internal working space is a rectangular block with a width of at least 1.5 metres and a height of at least 2 metres;

- the internal working space is provided between a front and a rear upright wall;

- the front and rear upright walls maintain a distance, measured along the centre longitudinal axis of the vehicle, of at least 1 and at most 3 metres;

- designed as a rail/road vehicle;

- light in weight, maximum 5 thousand kilograms to be able to be transported on the road as a load from a lorry

7. Method according to any one of claims 1 to 6, for the industrial robot arm one or more of the following applies:

- of precisely 6-axis type;

- of vertically articulated type;

- contains the following axes of movement: S, L, U, R, B, T (see fig. 6 + 7);

- the maximum rotation angle of all six axes of movement is at least 90 degrees;

- for the characteristic dimensions V, W, X, Y, Z (see fig. 6) the following applies (in millimeters): V at least 490 and at most 590, W at least 190 and 230, X at least 810 and at most 930, Y at least 945 and at most 1105, Z at least 290 and at most 350;

- mounted with the S-axis, i.e. the axis of movement of the base, horizontal; - mounted with the base or the S-axis, i.e. the axis of movement of the base, at a level at least 50 centimetres and at most 200 centimetres above the level of the bottom of the running wheels of the rail vehicle, in other words the top of the rail head in the event that the running wheel in question rests on the rail head in the typical manner.

8. Method according to any one of claims 1 to 7, while the working device is in operation and of a number of, for example, at least 10 mutually identical spring clamps, with mutual spacing according to the pitch of the sleepers and directly following each other, viewed in the longitudinal direction of the railway, tightens the fastening bolts by means of the working tool which is held and spatially positioned by the robot arm and driven by the cardan shaft, the railway vehicle moving over the track has a continuous forward speed of, for example, at least 100 metres per hour, while the working tool, by manipulation with the robot arm, in the meantime carries out a movement cycle with respect to the railway vehicle of first moving forward, with a forward speed higher than that of the railway vehicle, to the next fastening bolt and engaging it and then moving backwards while engaging and remaining in the same location with respect to the fastening bolt, until the fastening bolt has been sufficiently tightened and then again forward movement, at a forward speed higher than that of the rail vehicle, to the next attachment bolt of the number.

9. Method according to one of claims 1-10, the rail vehicle is non-articulated.

10. Rail vehicle for carrying out the method according to one of claims 1-9.

11. Rail vehicle according to claim 10, with one or more of the design features according to one of claims 1-9.

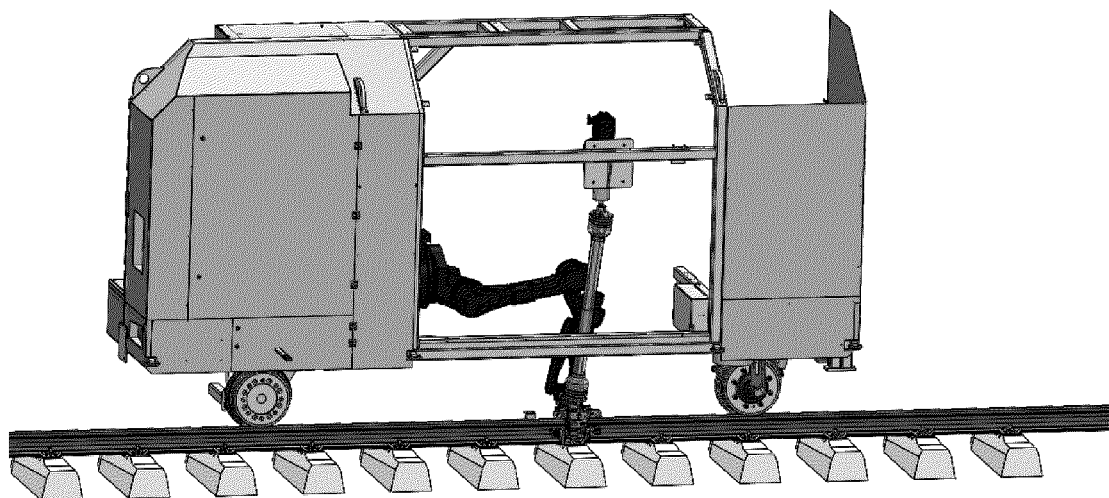


Fig. 1

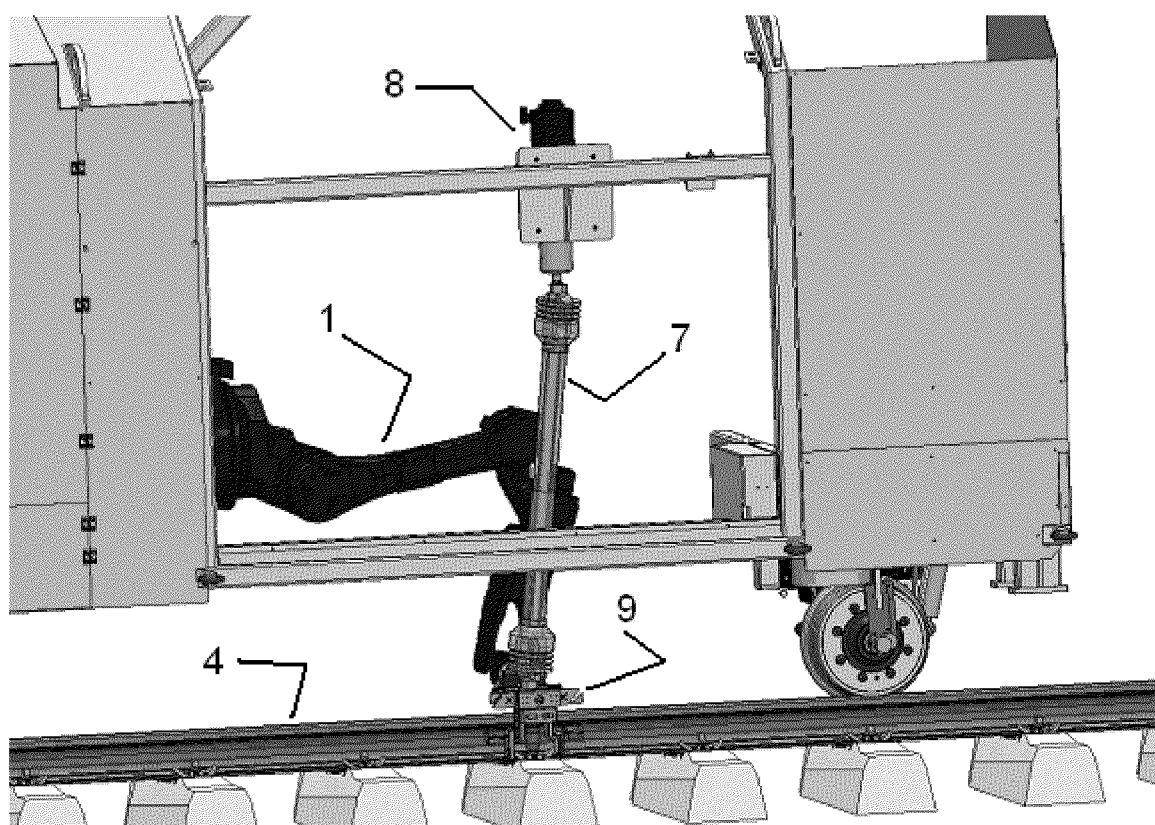


Fig. 2

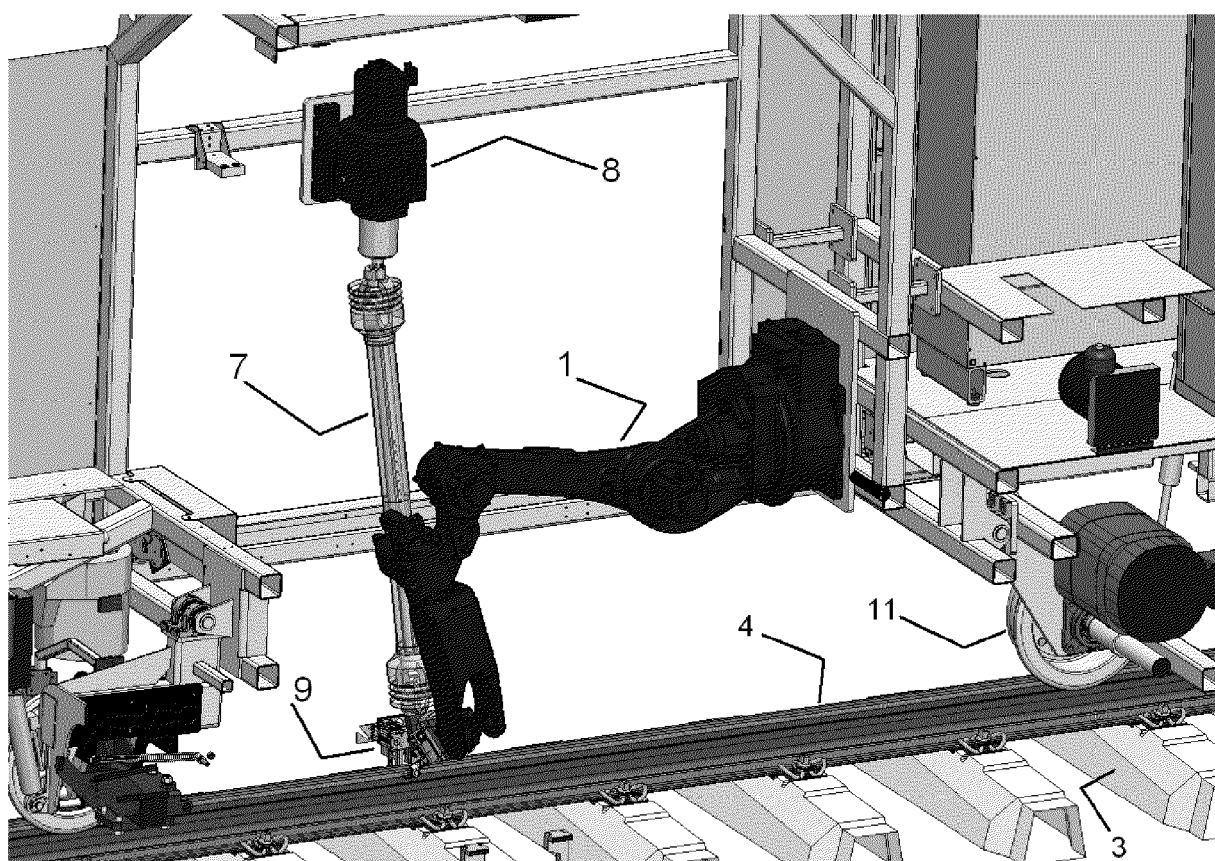


Fig. 3

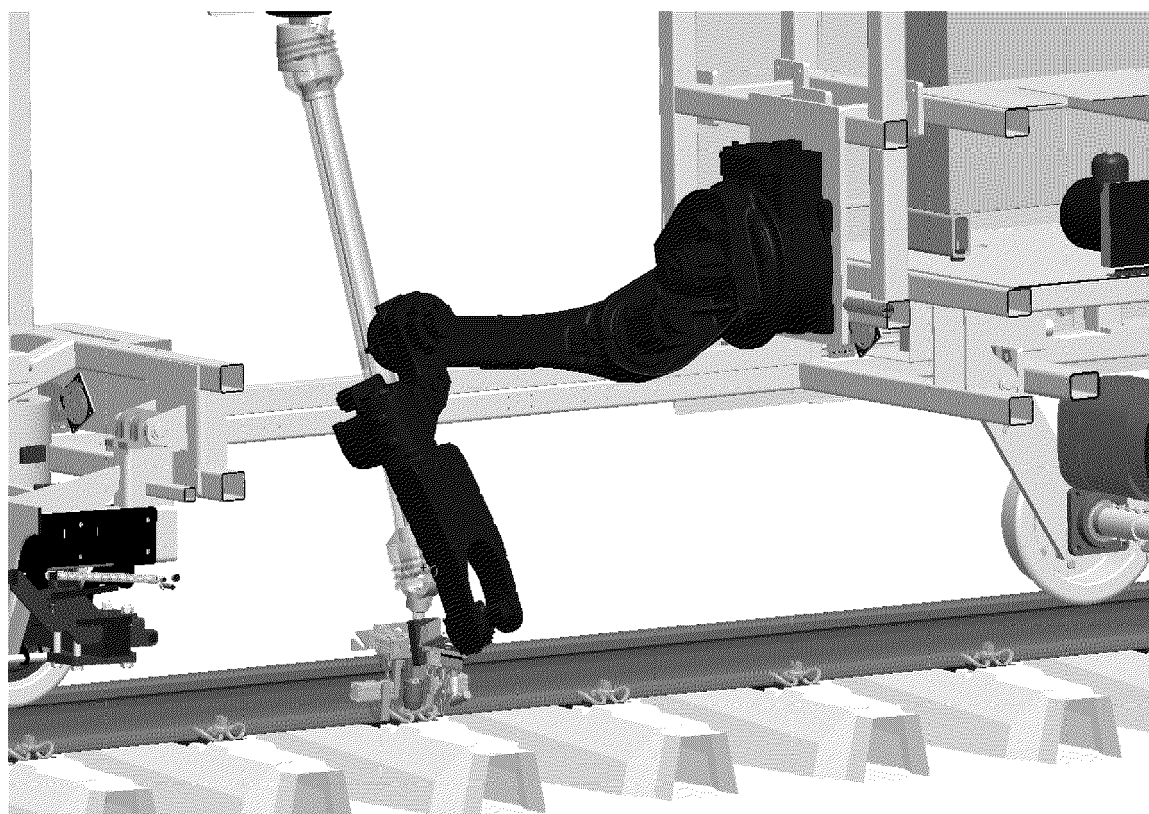


Fig. 4

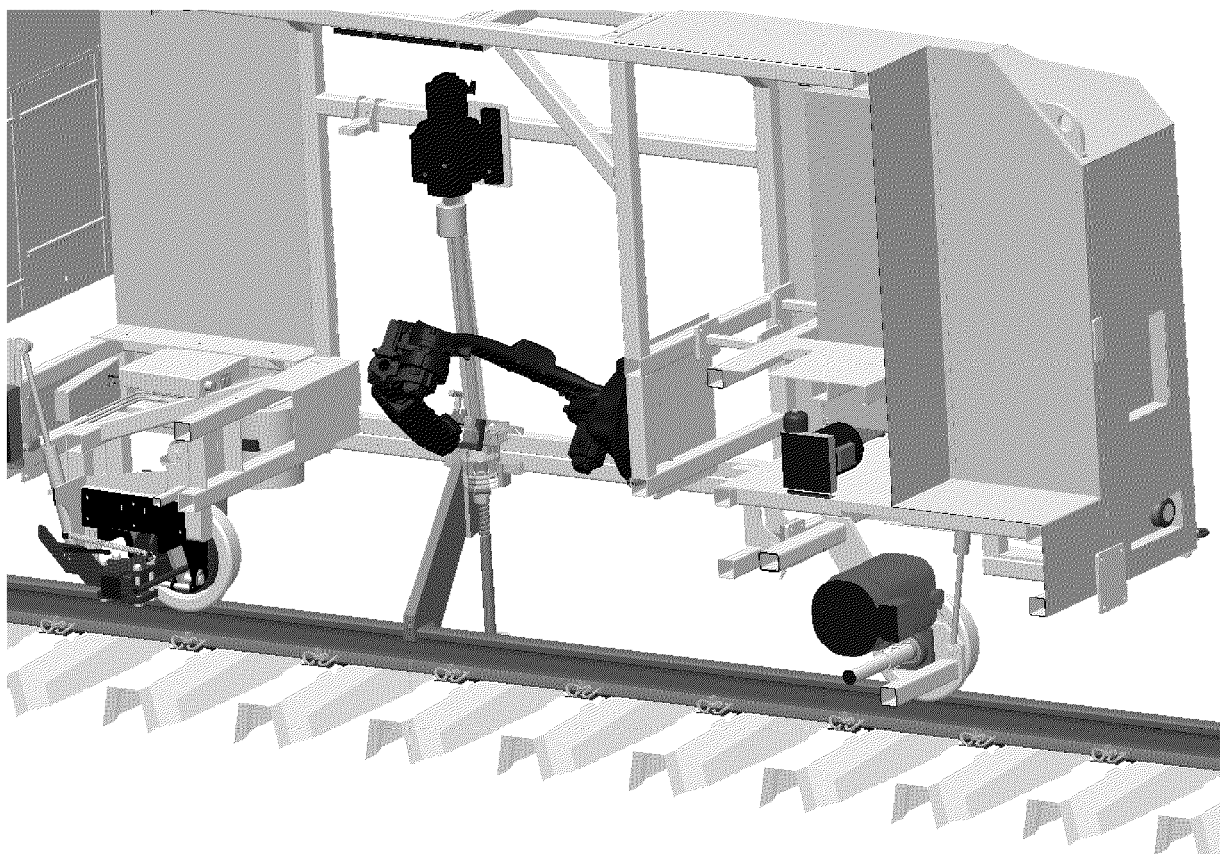


Fig. 5

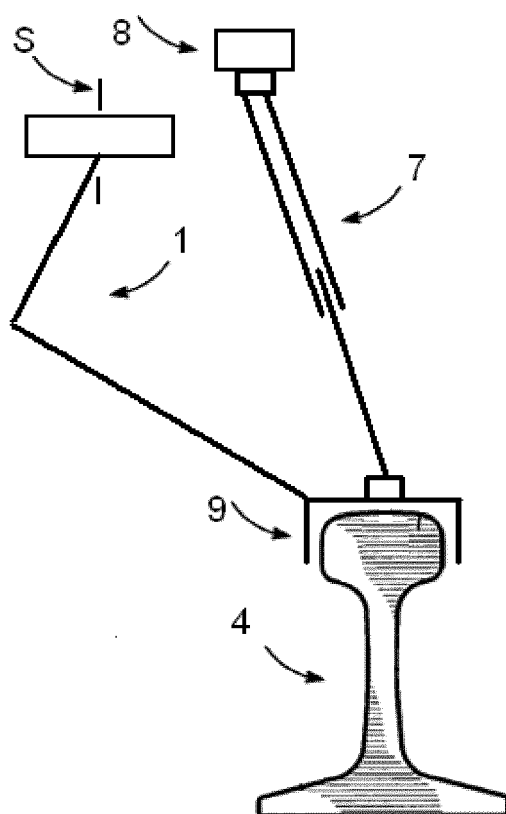


Fig. 6

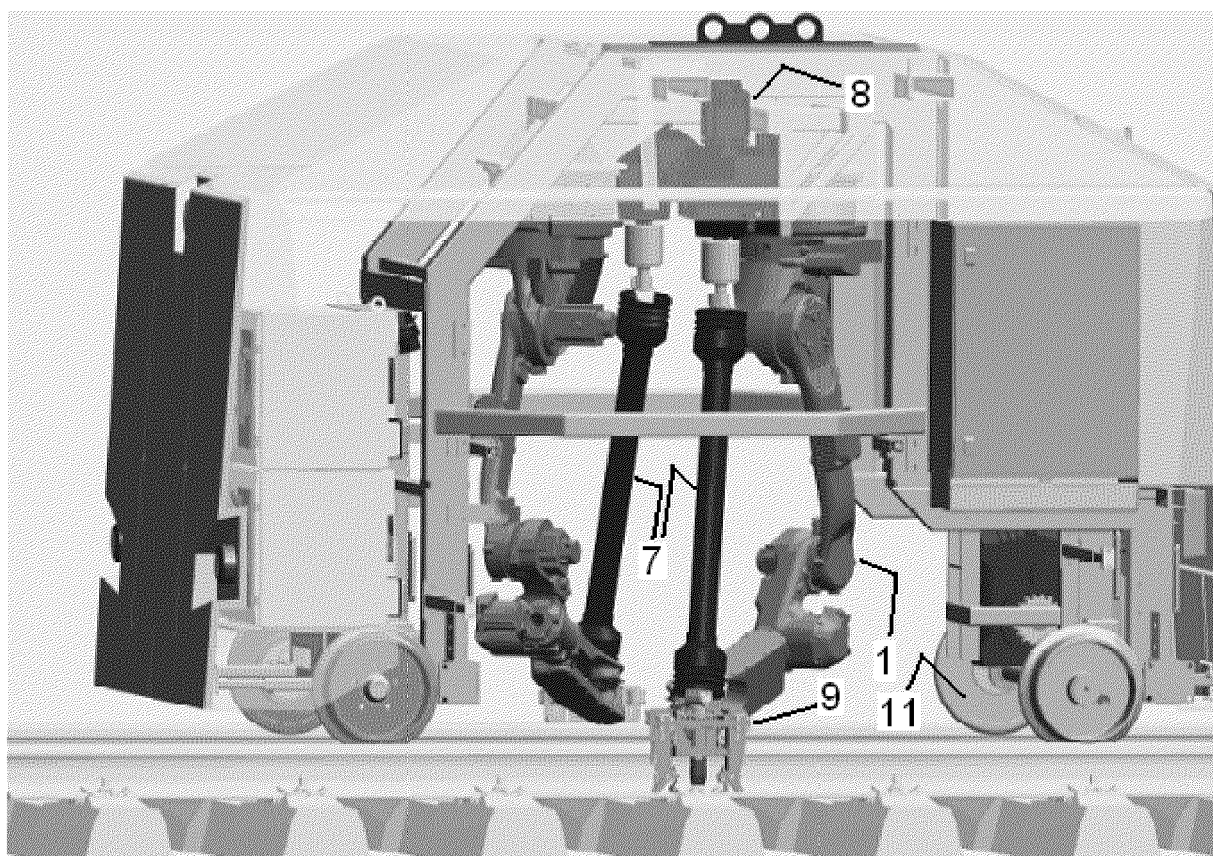


Fig. 7

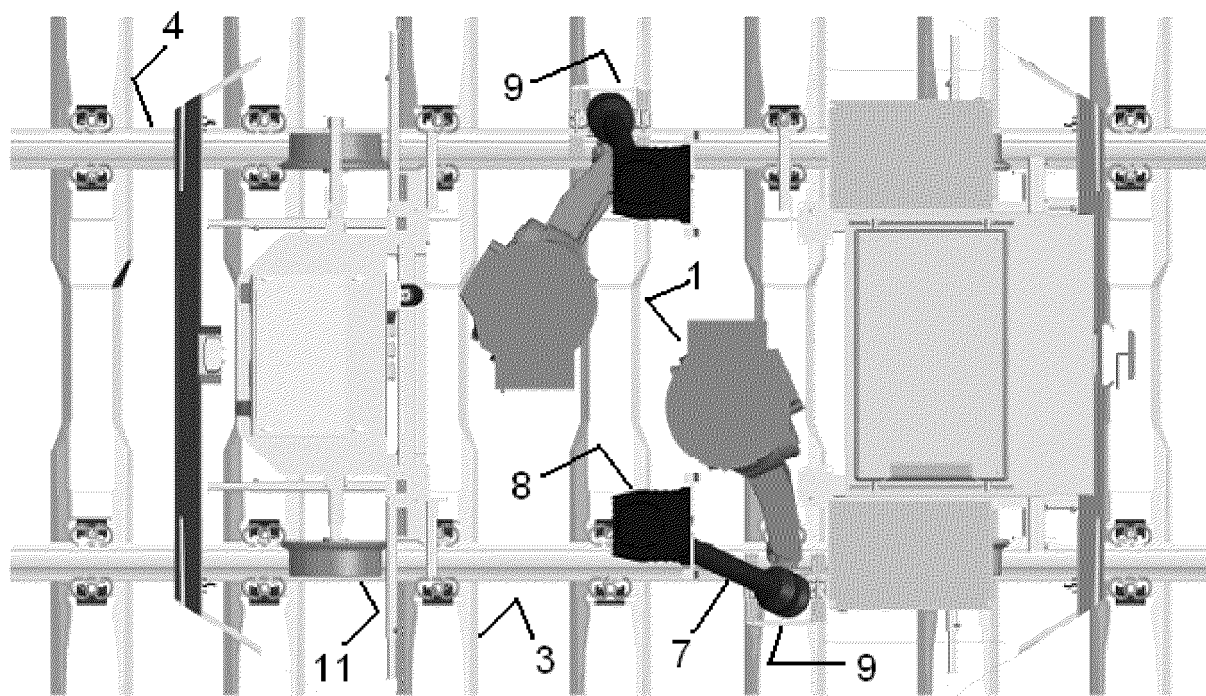


Fig. 8

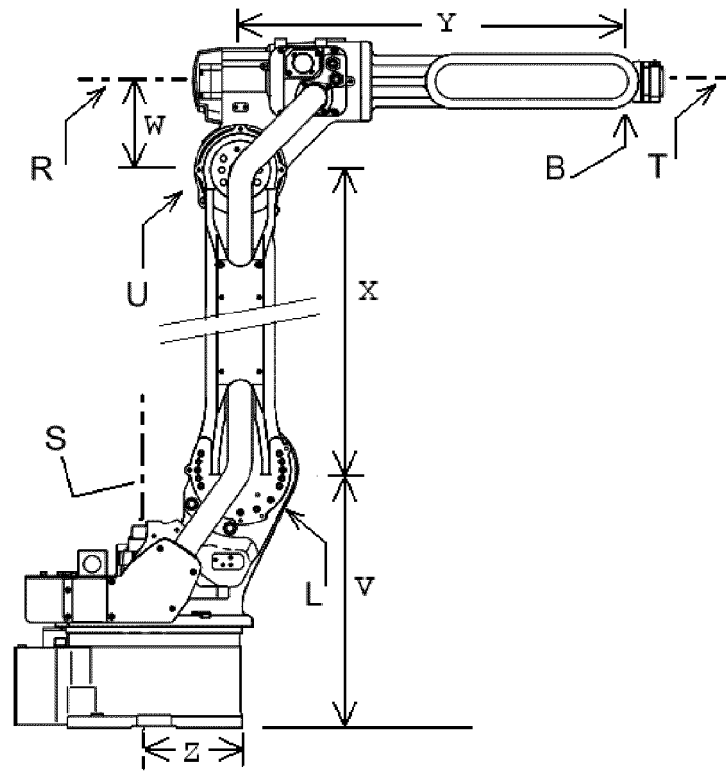


Fig. 9

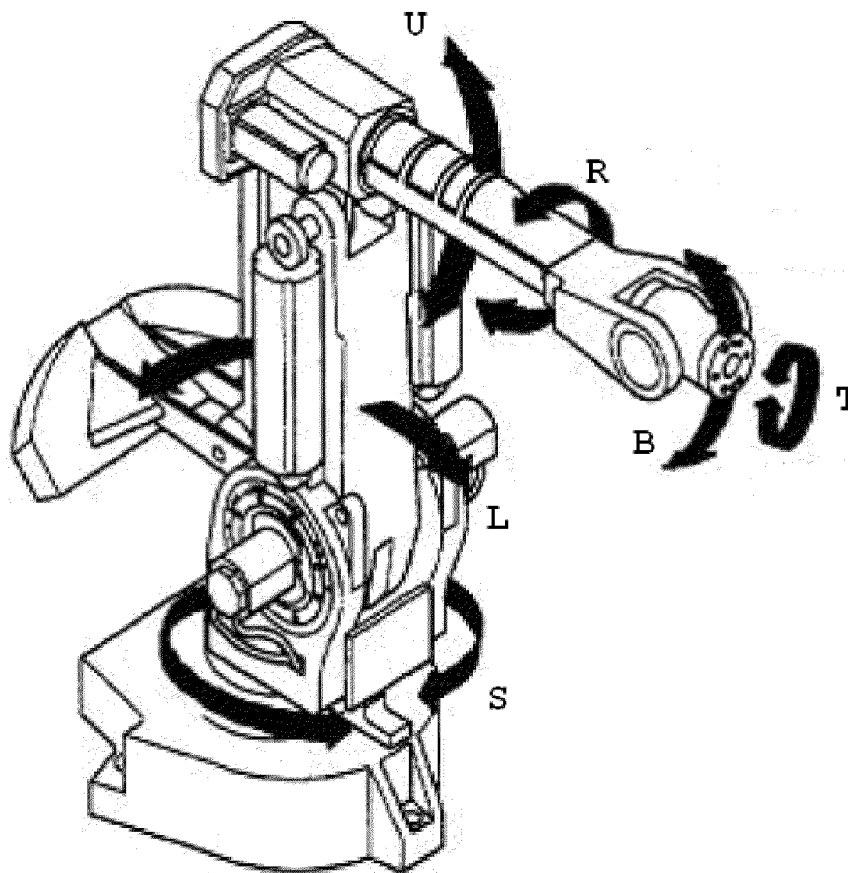


Fig. 10

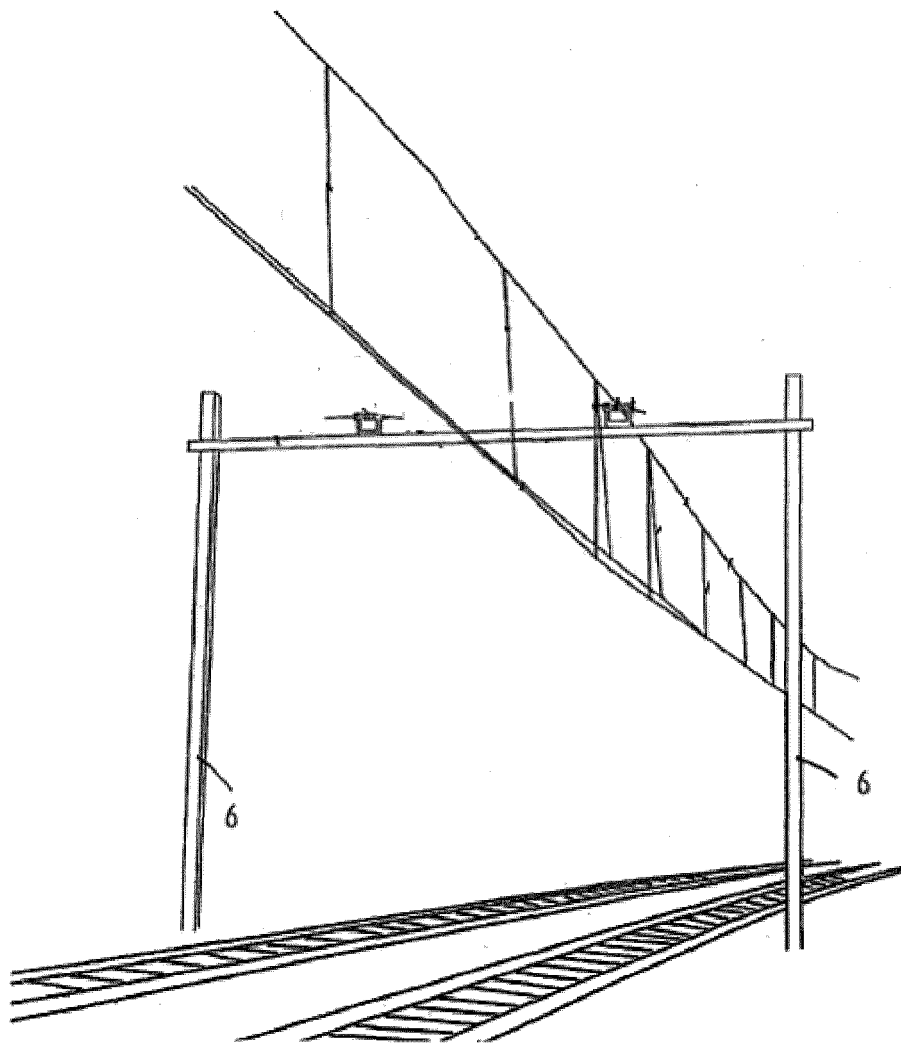


Fig. 11

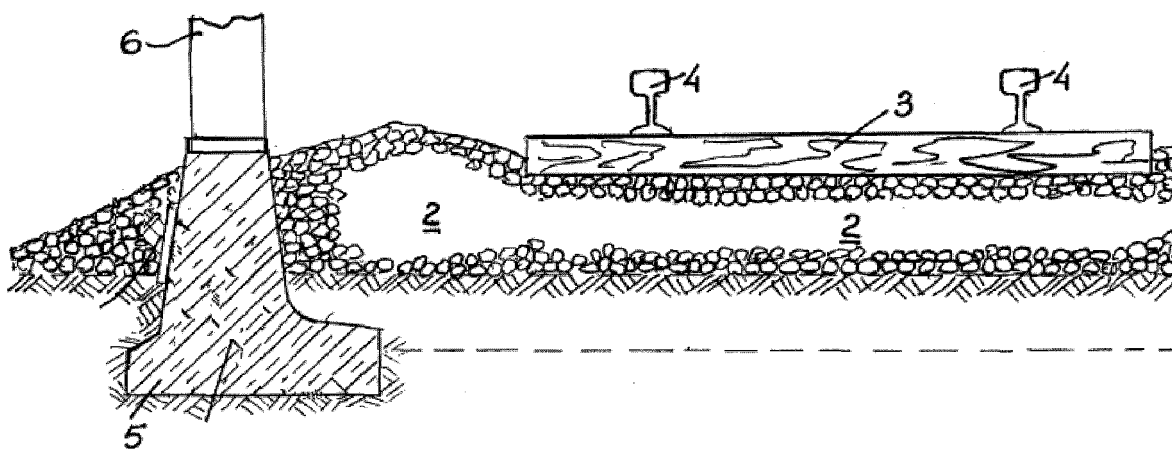


Fig. 12



EUROPEAN SEARCH REPORT

Application Number

EP 24 20 8808

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 85 182 B (MATISA MATERIEL IND SA; CONST MECANQUES SA RENENS) 14 July 1960 (1960-07-14) * the whole document *	1,5,6, 9-11	INV. E01B29/28 B61D15/00
Y	* the whole document *	2-4,7,8	
Y	SU 1 193 201 A1 (SP K B POLIMERNOGO MASH KI PRO [SU]) 23 November 1985 (1985-11-23) * the whole document *	2-4,7,8	
X	DE 22 11 606 A1 (ROBEL & CO G) 20 September 1973 (1973-09-20) * the whole document *	1,10,11	
A	WO 2017/121441 A1 (ROBEL BAHNBAUMASCHINEN GMBH [DE]) 20 July 2017 (2017-07-20) * the whole document *	1-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01B B61K B61D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		5 April 2025	Movadat, Robin
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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

EP 24 20 8808

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-04-2025

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 1085182	B	14-07-1960	NONE
SU 1193201	A1	23-11-1985	NONE
DE 2211606	A1	20-09-1973	NONE
WO 2017121441	A1	20-07-2017	
		AU 2016385836	A1 05-07-2018
		CN 108463388	A 28-08-2018
		CN 110578275	A 17-12-2019
		DE 102016000408	A1 20-07-2017
		DK 3402709	T3 27-04-2020
		EP 3402709	A1 21-11-2018
		ES 2779779	T3 19-08-2020
		HU E049164	T2 28-09-2020
		JP 6910360	B2 28-07-2021
		JP 2019503299	A 07-02-2019
		PL 3402709	T3 15-06-2020
		PT 3402709	T 27-03-2020
		US 2019016350	A1 17-01-2019
		WO 2017121441	A1 20-07-2017

20

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- FR 2659674 [0002]
- DE 20305569 U1 [0002]
- DE 202004013732 U [0002] [0016]
- NL 1028854 C2 [0016]
- EP 3078774 A1 [0016]