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(54) **AUTOMONOUS RAIL VEHICLE MOVING ON THE TRACK WITH ATTENDED OPERATOR SUPERVISION AND METHOD OF RAILWAY MAINTENANCE USING A RAILWAY VEHICLE WITH A WORK DEVICE**

(57) Railway vehicle with a working device, which working device is equipped with a working tool and a robot arm for manipulating the working tool, the rail vehicle being equipped with a control device that ensures that the rail vehicle is brought to a standstill just in front of a track object; and that a human supervisor is notified that

the rail vehicle has come to a standstill just in front of said track object; and the control device only after receiving an authorisation command from the human supervisor gives the command to the propulsion control to resume propulsion so that the rail vehicle continues to drive to the track destination location.

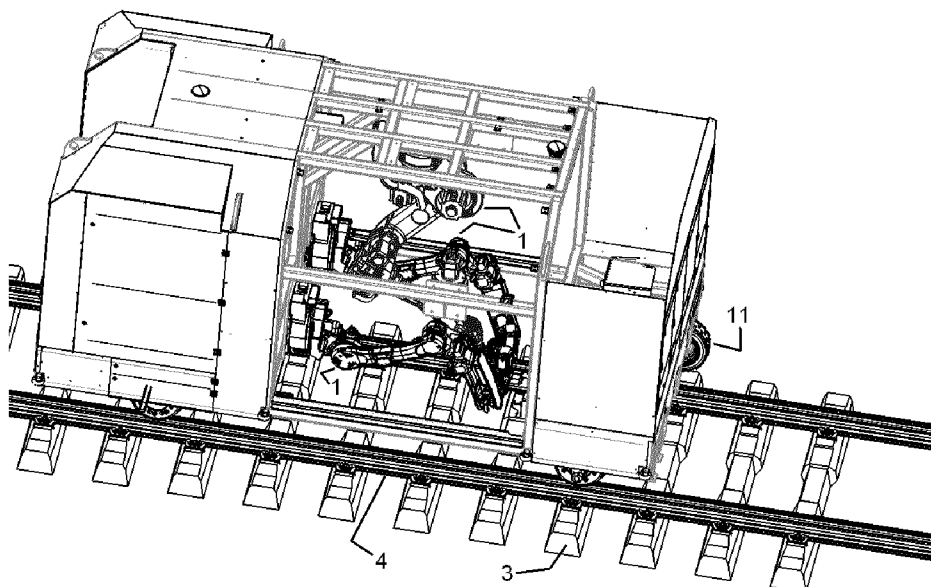


Fig. 1

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Description

[0001] The invention relates to the field of a railway 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. The invention can be embodied in a system and/or a method for allowing the railway vehicle, for example of a rail/road type, to move as autonomously as possible. The railway vehicle is preferably equipped with a working device for carrying out new construction, maintenance or inspection work on the railway structure. 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 is preferably the public civil railway network.

[0002] The new construction or technical maintenance of railways, outdoors or in an uncontrolled environment such as the space of railway tunnels, requires the use of powerful working devices which 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 work equipment for new construction or maintenance, which are also suitable for robotisation, so that personnel are freed from heavy and monotonous work under difficult weather conditions.

[0003] The aim of the invention is to develop a railway vehicle with a work equipment with work tools, which is largely mechanised, so that it can be avoided that a person has to be on or in the immediate vicinity of the railway vehicle during its use. The starting point is that the work equipment is fully robotised, so that the work equipment can function fully without the physical presence of a person. The use of a person is preferably limited to controlling and monitoring functions, which are performed remotely in, for example, an office environment. Incidentally, the invention also includes an embodiment in which a person is close to the railway vehicle, or in or on it.

[0004] The invention is partly based on the insight that this type of railway vehicle does not have to travel particularly large distances over the track to reach the track target location on which the work equipment of the railway vehicle has to work. After all, the intention is to bring the rail vehicle by road as close as possible to the rail destination location, for which the rail vehicle is sufficiently small in size, preferably a maximum length of 5 or 6 metres, and low in weight, preferably a maximum weight of 3 or 7 or 10 thousand kilos, for transport by road as a load of a road vehicle that is permitted for public roads, such as a lorry, or independently by being equipped with a rail/road chassis.

[0005] In order to solve these problems, it is proposed to have a rail vehicle with a work device, which work device is equipped with a work tool and a robot arm for manipulating the work tool, whereby the rail vehicle is equipped with a control device that is linked to: a track map data file (database) that describes the local track

situation, for example using ArcGIS; a localisation system, for example equipped with GNSS, for determining the current geographical location along the track of the rail vehicle; whereby the control device is adapted to continuously access the track map database and the locating system to autonomously decide therefrom that a command must be given to both the propulsion control of the railway vehicle to bring it to a stop; and a human supervisor to determine that the railway vehicle is at a standstill immediately before a railway object belonging to the track over which the railway vehicle is travelling, such as a railway switch, railway bridge, railway crossing, railway level crossing, rail insertion point or buffer stop; and the control device only gives the command to the propulsion control to resume propulsion after receiving an authorisation command from the human supervisor so that the railway vehicle continues to travel to the track destination location and passes the railway object in question.

[0006] The rail vehicle preferably provides one or more of the following:

- a working space open towards the bottom, for example so that the working space is provided between two upright side walls of the rail vehicle, from which working space access is gained via the open bottom to the track structure under the rail vehicle by the robot arm;
- 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 centre longitudinal axis of the vehicle and/or the railway, of at least 1 and/or at most 2 or 2.5 or 3 metres;
- a chassis frame formed by tubes or profiles;
- panels attached to the chassis frame for forming walls to form a weather-protected working space;
- flanged wheels for driving on track or a rail/road chassis;
- propulsion up to 20 or 40 km/h on the track.

[0007] For example, during the movement of the rail vehicle on the track, the control system autonomously determines, by regularly accessing the track map data file, which track it is driving on and what the next stop location is for the rail vehicle because the control system determines from the track map data file that the rail vehicle is approaching a track object belonging to the track in question. The stop location is preferably within a distance of 10 or 5 meters before the track object in question.

[0008] The precise location along the track of the track object is registered in the track map data file (for example ArcGis) and by regularly accessing the track map data file

by the control system, the control system can determine the precise location along the track of the track object.

[0009] The human supervisor is located at a short or large distance from the rail vehicle, for example right next to the rail vehicle or in an office space or the driver's cab of a road vehicle and has a suitable MMI, for example a touch screen. By means of for example a camera on the rail vehicle, the human supervisor receives via the MMI for example an image recording of the rail object made at the stop location in order to carry out a visual inspection in this way.

[0010] The control device, the track map database, the localisation system, the possible camera on board the rail vehicle, the propulsion control and the communication between these components and with the MMI at the human supervisor are implemented by digital computer technology.

[0011] Preferably one or more of the following applies: The robot arm is of a vertically articulated and/or industrial type; the robot arm is of at least or precisely three-, five- or six-axis type; the working device is located inside the internal working space.

[0012] The invention is further explained below on the basis of the scope of protection non-limiting embodiments, which are shown in the accompanying drawing, which shows in:

Fig. 1 a perspective view of a railway vehicle with work device according to the invention

Fig. 2 a perspective view of the robot arms inside the work space of the railway vehicle of fig. 1;

Fig. 3 a cross-section of a part of the track of fig. 1;

Fig. 4 a perspective view of a double railway or track; and

Fig. 5 a cross-section of a part of the track of fig. 1, in which the characteristic dimensions of the track are indicated.

[0013] Parts of the side wall of the railway vehicle shown have been removed to provide a better view of the work device inside the internal work space. The railway vehicle has a chassis frame that stands on the two rails 4 with flanged rollers 11.

[0014] The railway vehicle shown in the drawing is, for example, of the type as disclosed in DE 20 2004 013 732 U or NL1028854C2 or EP3078774A1. The chassis frame is formed by tubes and profiles and panels are attached to it to form walls to form an internal work space shielded from the weather. The work device fixed to the chassis frame is equipped with three robot arms 1.

[0015] A large-sized robot arm is (see Fig. 2) mounted at a high level, seen in plan view, centered on the longitudinal centerline of the rail vehicle, with the bottom of the base facing upwards, in other words this robot arm hangs upside down. Two identical small-sized robot arms are mounted at a low level at a distance on either side of the longitudinal centerline of the rail vehicle, seen in plan view, with the S-axis horizontal and parallel to the long-

itudinal direction of the rail vehicle. Seen in plan view, the base of the large-sized robot arm is located centrally between the bases of the two identical robot arms, the bases of which are located on a straight line perpendicular to the longitudinal centerline of the rail vehicle. The base of the large-sized robot arm is located at a horizontal distance, parallel to the longitudinal centerline of the rail vehicle, of 50 centimeters from the bases of the two identical robot arms, seen in plan view. The railway in Fig. 4 is electrified, therefore there are portals (one of which is visible) along it, which carry the contact wire. Fig. 3 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.

[0016] The characteristic dimensions of Fig. 5 are: 12 horizontal alignment; 13 track symmetry axis; 14 track centre; 15 track width; 16 superelevation (D); 17 vertical alignment/length profile; 18 BS; 19 track axis.

[0017] 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.

Claims

1. Method of railway maintenance using a railway vehicle with a work device, which work device is preferably equipped with a work tool and/or a robot arm for manipulating the work tool, whereby the railway vehicle is equipped with a control device that is digitally connected to:

- a digital track map data file that describes the local track situation of the railway over which the railway vehicle is travelling, using for example ArcGIS;

- a digital localisation system, equipped with for example GNSS, that determines the current geographical location of the railway vehicle along the track;

whereby the control device performs the continuous digital approach to the track map data file and the localisation system and autonomously makes a decision from the data obtained therefrom and thereby gives a digital command to both

- the automatic propulsion control of the railway vehicle that it must be brought to a standstill just before a track object, for example a railway switch, because this has been detected by the control device from the track map data file and the localisation system; and

- a human supervisor, via a human-machine

interface, that the railway vehicle has been brought to a standstill just ahead of the said track object;

- and the control system waits for receipt of a digital authorisation command, via a human-machine interface, from the human supervisor; 5
- and in response to that receipt, issues a digital command to the propulsion control to resume propulsion so that the railway vehicle continues to move towards the track target location, passing the track object; 10
- and, while the railway vehicle continues to move, the control system continues to access the track map database and the locating system in order to decide autonomously from the data obtained therefrom that a further said digital command should be issued to both the automatic propulsion control and the human supervisor. 15

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2. Rail vehicle for carrying out the method according to claim 1, preferably comprising one or more of: a work device, which work device is preferably equipped with a work tool and/or a robot arm for manipulating the work tool, the rail vehicle being equipped with a control device that is coupled to: a track map database that describes the local track situation, for example using ArcGIS; a localisation system, for example equipped with GNSS, for determining the current geographical location along the track of the rail vehicle; the control device being designed to continuously access the track map database and the localisation system in order to autonomously decide therefrom that a command must be given to both the propulsion control of the rail vehicle that it must be brought to a standstill; and a human supervisor that the rail vehicle is standing still just in front of a track object, such as a railway switch, railway bridge, railway crossing, level crossing, rail insertion point or buffer stop; and the control device only after receiving an authorisation command from the human supervisor gives the command to the propulsion control to resume propulsion so that the rail vehicle continues to drive to the track destination location. 25 30 35 40 45

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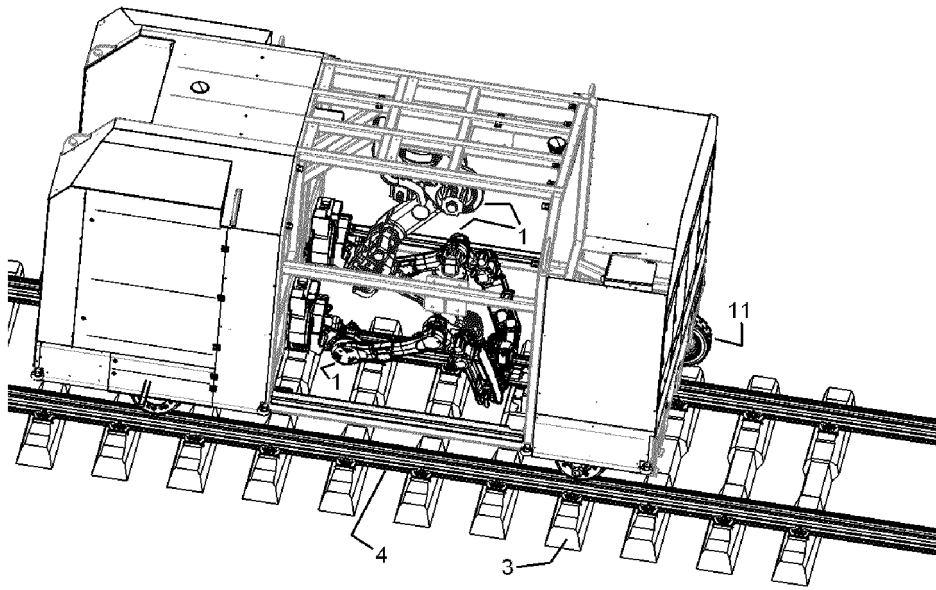


Fig. 1

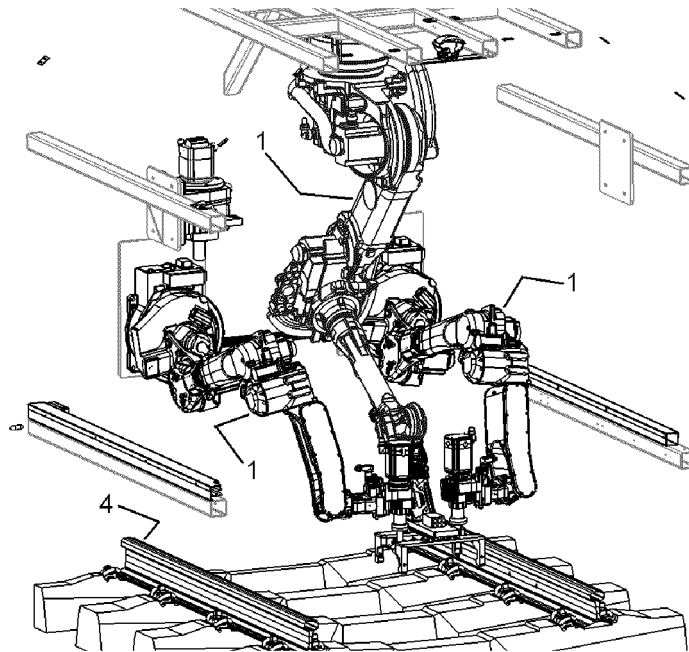


Fig. 2

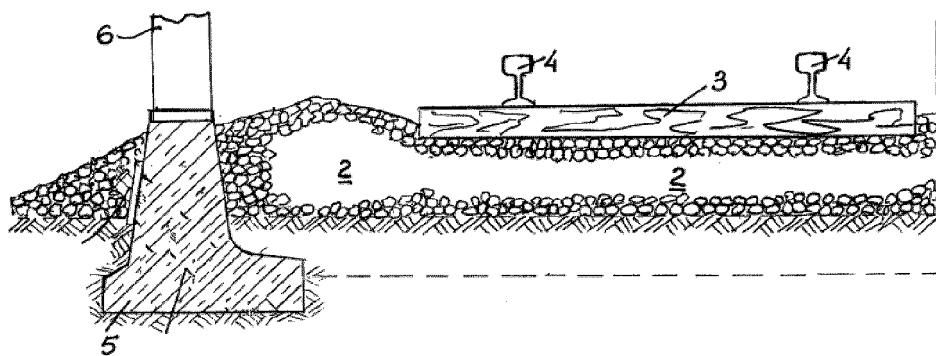


Fig. 3

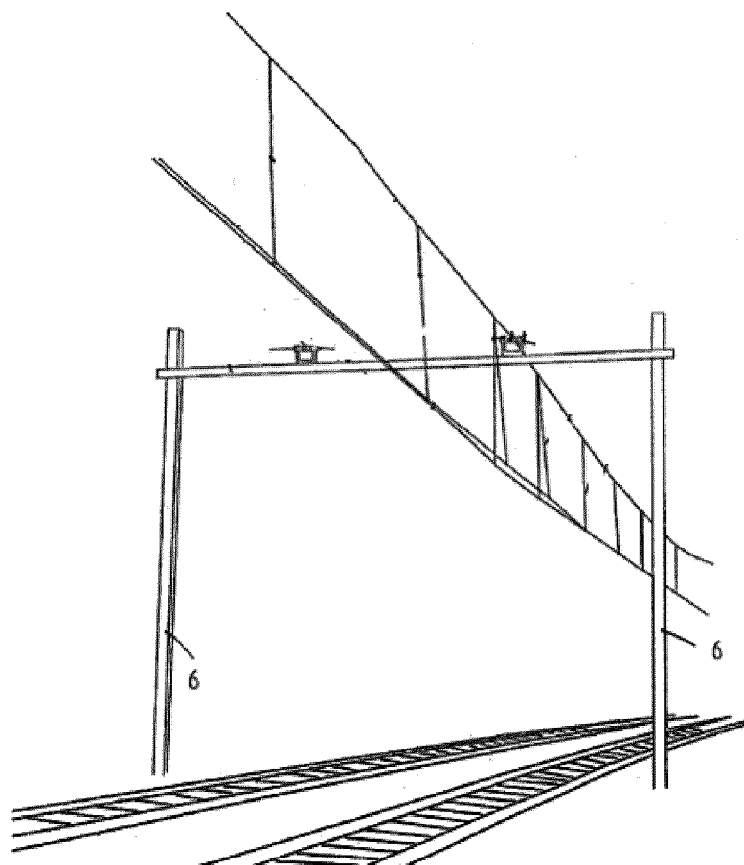


Fig. 4

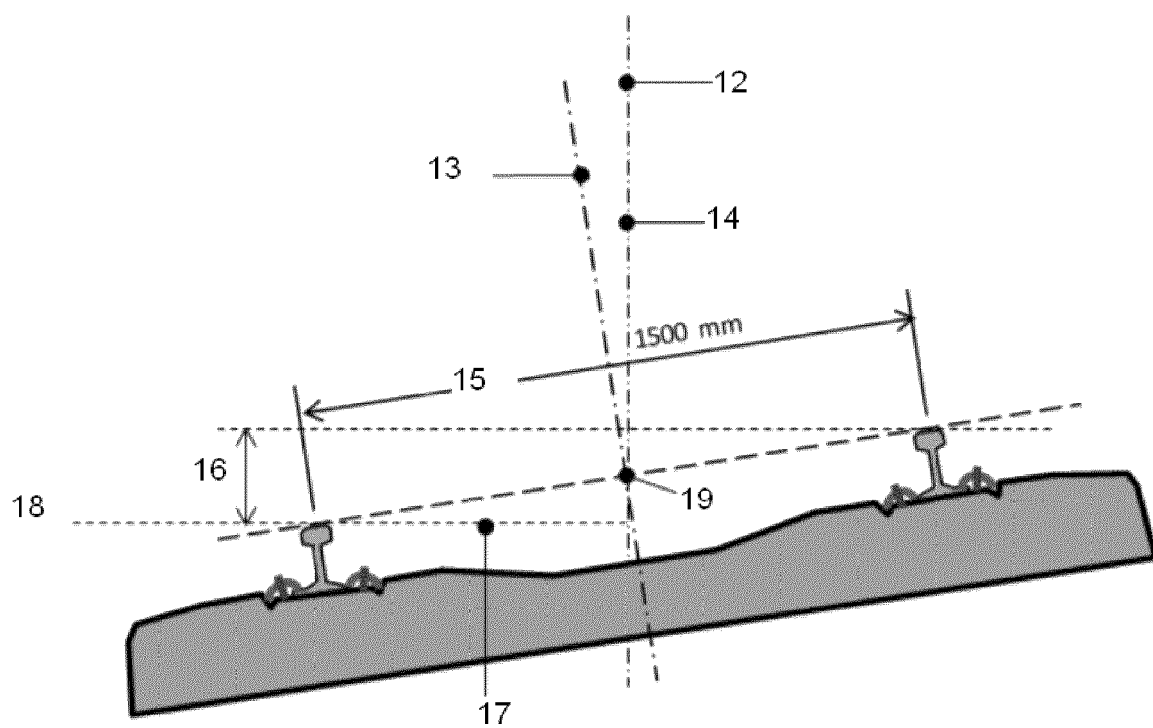


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 24 21 0596

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2010 018064 A (TAKAHAGI JIKO KK; HIGASHI NIPPON RYOKAKU TETSUDO) 28 January 2010 (2010-01-28) * abstract * * paragraph [0004] - paragraph [0009] * * paragraph [0015] - paragraph [0028]; figures 1-4 *	1,2	INV. B61L15/00 B61L23/04 B61L25/02 B61L25/06
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 March 2025	Examiner Pita Priegue, Miguel
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	

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