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(71) Applicant: **ALSTOM Transport Technologies**
93400 Saint-Ouen (FR)

(72) Inventor: **FAROOQUI, Asghar**
560065 Bangalore (IN)

(74) Representative: **Lavoix**
2, place d'Estienne d'Orves
75441 Paris Cedex 09 (FR)

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(54) **SENSING BAR FOR A BOGIE OF A RAILWAY VEHICLE**

(57) Sensing bar (2) for a railway bogie (1) of a railway vehicle running on a railway track, said sensing bar (2) comprising a plurality of sensors placed on a bar (6)

fixed to the bogie (1) and arranged to measure values of parameter related to the operating conditions of the bogie (1)

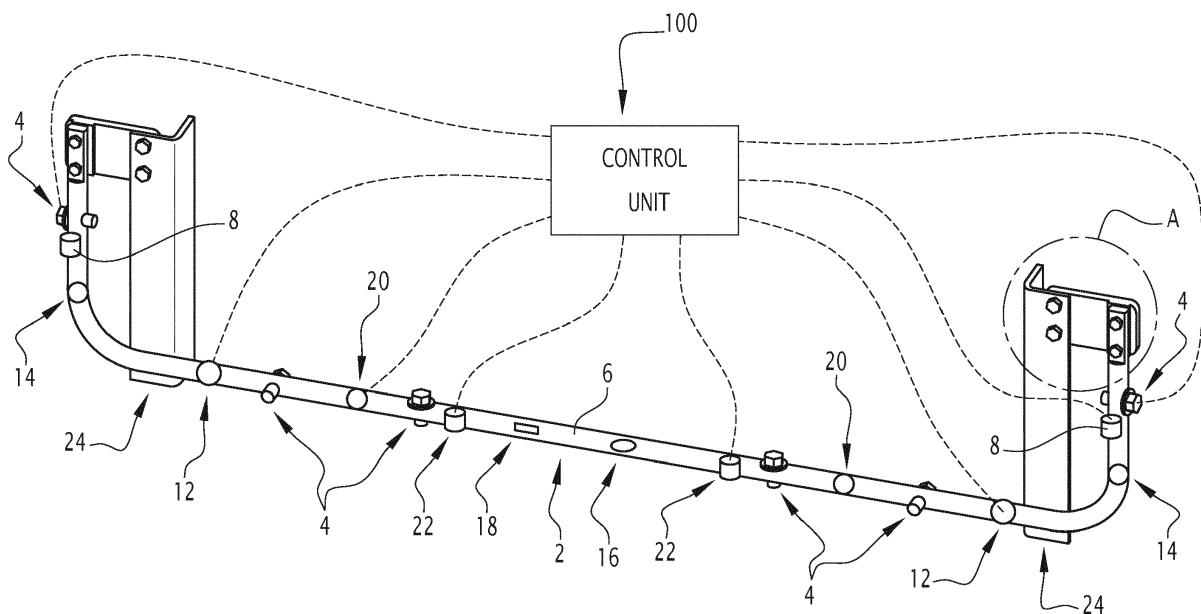


FIG.2

Description

[0001] The present invention concerns a sensing bar for a bogie of a railway vehicle.

[0002] There is the need to have a device for monitoring bogie operating conditions, which is capable of measuring a plurality of data relating to a bogie in order to detect any deviation from a standard.

[0003] There is also the need to have a device which can be easily installed on existing bogies of railway vehicles.

[0004] These and other objects are fully achieved by virtue of a sensing bar for a bogie of a railway vehicle having the characteristics defined in independent claim 1, and by a railway vehicle as defined in claim 10.

[0005] Preferred embodiments of the invention are specified in the dependent claims, whose subject-matter is to be understood as forming an integral part of the present description.

[0006] Further characteristics and advantages of the present invention will become apparent from the following description, provided merely by way of a non-limiting example, with reference to the enclosed drawings, in which:

- Figure 1 shows a perspective view of a bogie to which a sensing bar according to the present invention is fixed;
- Figure 2 shows an enlarged view of the sensing bar of figure 1;
- Figure 3 shows an enlargement of the zone A of figure 2; and
- Figure 4 shows a railway vehicle including the sensing bar of figure 2.

[0007] The sensing bar for a bogie according to the present invention is a bar arranged to be fixed to a bogie of a railway car of a railway vehicle running on a railway track. The bar is provided with many sensors, arranged to collect a plurality of data related to the operating conditions of the bogie.

[0008] The collected data allows performing conditioned based maintenance of the bogie, because these data can be immediately used to plan an intervention on the railway bogie.

[0009] In addition, these collected data can be used for post processing and analysis, to precisely identify the cause of a failure or to predict the life of a component or occurrence of incidents.

[0010] The elaboration of the collected data is performed in a manner known per se by a control unit connected to said sensors, and it will not be disclosed in detail in the following.

[0011] The sensing bar according to the present invention carries all the sensors on a single member, it is easy to be installed on existing bogies, and it is easy to maintain.

[0012] The sensing bar is provided with a single con-

necter, capable of acquiring data coming from a plurality of channels, preferably eighteen channels, associated with the respective sensors. These data are then sent, through the connector, to the control unit.

[0013] The sensing bar can be used on existing railway cars, for monitoring functions and for predictive maintenance.

[0014] The sensing bar according to the present invention allows performing ten monitoring functions. Different parameters are monitored, continuously or conditionally (because all the sensors placed on the sensing bar are suitable for condition based monitoring and maintenance strategy). The measured data, signals representative of said parameters or values of said parameters, are sent to the control unit connected to the sensing bar, this control unit being arranged to elaborate said data to monitor the bogie operating conditions.

[0015] The parameters are the followings:

- axle box temperature profile: this parameter indicates the lubrication health of the axle box of the bogie, and the behavior of the bearings of wheels of said bogie;
- wheel rail interface: these data relate to the wheel flange wear pattern, its life and different failures that can occur on it;
- track conditions / comfort: errors or anomalies on the wheel of a railway car are a reflection of errors or anomalies on the rail on which the railway vehicle is running. Thanks to the sensing bar of the present invention is it possible to collect enough data of a rail to identify any issues on the wheels of a railway vehicle, and also any deviations in comfort that may occur;
- wheel flange wear characterization: these are measures performed by vibration sensors (accelerometers mounted on the sensing bar) and anomalies identified thanks to the elaboration of noise and images acquired in proximity of the bogie. These measures and anomalies show, in combination, the trend of different wear zones, with their relative intensity. This information allows understanding the wear pattern and making proposal on corrective and preventive actions to be taken for enhancing the wheel life;
- conicity: the safety of the rail with respect to derailment or lateral oscillations of the railway vehicle is a function of conicity of the wheel. This parameter can be monitored and wheel re-profiling could be planned accordingly;
- primary suspensions: primary suspensions in railway vehicles have several issues like creep and plastic deformation. By capturing random pictures of the primary suspensions at predetermined time intervals, it is possible to appreciate the evolution of the primary suspensions themselves. The variation of the height of a suspension from an initial reference value, identified thanks to comparison of subsequent images of the primary suspensions taken in different

time instants, provides information on how a creep is occurring;

- gearbox temperature profile: this parameter indicates the lubrication health of the gearbox of the railway vehicle;
- motor temperature profile: this parameter relates to the bearings of the motor;
- environment temperature: this parameter allows understanding the rise in environment temperature;
- GPS: this measure allows locating the bogie in real-time and identify the anomalies during processing of co-relation studies.

[0016] Figure 1 shows a perspective view of a bogie 1 of a railway vehicle, to which a sensing bar 2 according to the present invention is fixed.

[0017] Figure 2 shows an enlarged view of the sensing bar 2.

[0018] The sensing bar 2 is preferably mounted on a leading bogie. As an alternative, the sensing bar 2 is mounted on any other bogie, intermediate or end bogies.

[0019] In the following of the description, firstly the sensing bar 2 with its components will be disclosed, then, details of the functions of each component are provided.

[0020] All the components here below disclosed are connected, in a manner known per se, with an energy source for energy supply and with a control unit 100 arranged to collect the data coming from the sensors and to elaborate them to get the information of interest. The control unit is advantageously part of a data acquisition system of the railway vehicle.

[0021] The cables for connection of the sensors to the control unit are usually 4-5 mm thick in diameter and they carry both power and data. Cables are not shown in the pictures and preferably half of the cables run on the right side of the sensing bar 2, and half run on the left side of the sensing bar 2.

[0022] The sensing bar 2 comprises six single-axes accelerometers 4 mounted on a bended solid bar 6 which has a U-shape, to sense accelerations of the bogie 1 along three perpendicular directions X, Y and Z of a Cartesian reference system. The accelerometers 4 output vibration signals.

[0023] Two first cameras 8 are mounted at the end of the bar 6, in the vertical parts of the U-shape of the bar 6, and they are arranged to acquire respective images of primary suspensions associated with wheels 10 of the bogie 1. Each camera 8 acquires images of right and left primary suspensions of the bogie 1, respectively.

[0024] The sensing bar 2 further includes at least one microphone 12, preferably two.

[0025] The sensing bar 2 further includes two first pyrometers 14 mounted towards the end of the bar 6 and arranged to measure the respective temperature of axle boxes of bearings associated with the wheels 10.

[0026] The sensing bar 2 further comprises one temperature sensor 16 for measuring the environment temperature.

[0027] The sensing bar 2 further comprises one GPS sensor 18 for positioning measurements.

[0028] The sensing bar 2 further includes two second pyrometers 20, one arranged to measure the temperature of bearings of a gearbox of the railway vehicle, and the other arranged to measure the temperature of a motor of the railway vehicle.

[0029] The sensing bar 2 further includes two second cameras 22 arranged to acquire respective images of second-axle wheels of the bogie 1 (not shown in the picture), and to study the dynamics, creep and failure evolution of the primary suspensions.

[0030] In the sensing bar 2, there are preferably two accelerometers 4 for each direction of sensing, i.e. the X, Y and Z direction, for redundancy reasons and to ensure consistency of the measurements. As an alternative, only one accelerometer 4 for each direction is provided.

[0031] The bar 6 is advantageously 3.5 meter long and all the sensors above disclosed are connected, as above indicated, to a control unit and represent, altogether, an eighteen channel data acquisition system.

[0032] The ends of the bar 6 are fixed to a frame 24. Figure 3 shows an enlargement of the zone A of figure 2 wherein it is shown the end of the bar 6 fixed to a plate 28 arranged to be fixed, through the frame 24, to a supporting structure of the bogie 1, as shown in figure 1.

[0033] A DAQ (Data AcQuisition) system of known type can be installed on the bar 6, connected to the sensors, for standard checks and to elaborate the accelerations measured by the accelerometers 4 along the three axes.

[0034] Among the accelerometers 4, the second and fifth accelerometer 4 starting from the right side of the bar 6 act as obstacle sensors, while the third and fourth accelerometer 4 act as derailment sensors, as here below detailed. As an alternative, only one sensor acts as obstacle sensor or derailment sensor.

[0035] The sensing bar 2 according to the present inventions allows performing many different functions, described here below in detail.

[0036] A first function is the detection of an obstacle on the railway track. In this case, an impact force having a value above a predetermined threshold, preferably of 1KN, on the bar 6 generates a first obstacle signal coming from the second and/or the fifth accelerometer 4. This signal is used by the control unit 100 to trigger an alarm signal, to an emergency brake circuit of the railway vehicle.

[0037] A second function is the detection of a derailment of the railway car, which corresponds to the wheels 10 throwing off rails of the railway track. When the wheels 10 jump down the rail, the bar 6 is pushed upwards by the rail itself, and this impact generates a signal coming from the third and/or the fourth accelerometer 4, which is used by the control unit to trigger an alarm signal to the emergency brake circuit.

[0038] The sensing bar 2 allows taking videos or pictures of the space around the sensing bar 2.

[0039] The first cameras 8 acquire respective images

of the primary suspensions of the wheels 10, the second cameras 22 are mounted facing the second-axle wheels, and this enables to take pictures whenever there is abnormal vibration on the front axle, assuming that a similar trend follows also on the following wheel set. The vibration is measured by the accelerometers 4, which output a corresponding vibration signal.

[0040] Depending on the speed of the railway vehicle, videos are taken in place of pictures.

[0041] Since the cameras 8 and 22 constantly vibrate, due to the vibration of the bar 6, the videos acquired are post processed in a manner known per se by the control unit 100. Anomalies detected by the control unit 100 in the videos are used to trigger corresponding alarm signals.

[0042] Similarly, images with anomalies are specific frames having differences compared with reference images in idle situation. Images are important to study the evolution of the components and anomalies.

[0043] Another function possible thanks to the sensing bar 2 is capturing noises through the microphones 12 and co-relating them, in a manner per se known in the control unit 100, with the images of the cameras 8 and 22 and the vibration signals of the accelerometers 4, to trigger a wheel flange lubricator disclosed here below and to reduce these anomalies in the following wheels.

[0044] Furthermore, the two first pyrometer 14, which are preferably laser-based temperature sensors, measure the temperature of the axle boxes of bearings associated with the wheels 10, as above indicated. This allows monitoring the axle bearings for a condition based maintenance plan.

[0045] Similarly, the second pyrometers 20 measure the temperature of bearings of the gearbox and of the engine, as above cited. Usually, the rotating components are subjected to wear and tear.

[0046] Alternatively, the pyrometers 14, 20 can measure the temperature at different locations.

[0047] Furthermore, the first and the sixth accelerometer 4 produce a smooth sinusoidal wave-like reference signal when the wheel 10 is well contained on the rail, without rubbing on the flange, which is an extended lip shaped edge of the wheel which is a guide running along the inside of the rail. This helps to retain the train on rails during navigation of curves. When there is a severe wear and the flange engages with the rail, a vibration output signal is obtained. This vibration output signal helps analysing wear zones of the railway track and quantifies their values.

[0048] When the railway track is not well maintained and there is a tendency of derailment, a combination of the vibration signals coming from the first and sixth accelerometers 4, and from the second to fifth accelerometers 4, allows identifying if the wheels 10 are partially climbing the rail.

[0049] Another function possible thanks to the sensing bar 2 relates to behaviour, vertical displacement and failure evolution, of the primary suspensions. The first cam-

eras 8 focus on the primary suspensions, recording the displacements during running of the railway vehicle and taking/records pictures at defined intervals, or when there is a deviation observed with respect to a predetermined parameter. These displacement data, in correlation with accelerations of the railway vehicle measured by the accelerometers 4, allow characterizing the primary suspensions. The difference between two consecutive pictures provides information about the evolution of the suspension, thus allowing prediction of life of the bogie 1.

[0050] The GPS sensor 18 allows a precise location of the bogie 1 to plan any intervention.

[0051] The temperature sensor 16 allows detecting high temperatures, which affect the primary suspension, the gear box, the motor and axle bearing temperatures, etc. This is the referent to understand the relative behaviour of all these elements.

[0052] The vibration and noise data (and, advantageously, also the images) coming from the sensors above disclosed are used by the control unit 100 to trigger a wheel flange lubricator of the railway vehicle.

[0053] The wheel flange lubricator is a unit, which pumps a lubricant (mineral oil) onto the rails of the railway track, to ease the contact abnormalities between the wheels 10 and the rail by reducing wear and friction.

[0054] Thanks to the sensing bar 2 of the present invention, a combined correlation between vibration signals (coming from the accelerometers) and anomalies (detected by the cameras 8, 22 and by the microphone 12) is obtained, and this is used to trigger the wheel flange lubricator to dispense the required amount of lubricant.

[0055] Figure 4 shows a railway vehicle 100 having a plurality of railway cars, wherein at least one bogie of a railway car is provided with a sensing bar 2 as above disclosed.

[0056] The main advantage of the sensing bar 2 of the present invention is the integration of all the sensors useful for monitoring the bogie operating conditions in a single component, easy to mount and well connected to the data acquisition system of the railway vehicle 100.

[0057] Clearly, the principle of the invention remaining the same, the embodiments and the details of production can be varied considerably from what has been described and illustrated purely by way of non-limiting example, without departing from the scope of protection of the present invention as defined by the attached claims.

Claims

1. Sensing bar (2) for a railway bogie (1) of a railway vehicle running on a railway track, said sensing bar (2) comprising a plurality of sensors placed on a bar (6) fixed to the bogie (1) and arranged to measure values of parameter related to the operating conditions of the bogie (1).
2. Sensing bar (2) according to claim 1, wherein said

sensors are connected to a control unit arranged to receive said values coming from the sensors and to elaborate them to monitor the operating conditions of the bogie.

3. Sensing bar (2) according to claims 1 or 2, wherein said sensors comprise sensors chosen among the following:

- a plurality of accelerometers (4) arranged to sense accelerations of the bogie (1) along three perpendicular directions (X, Y, Z) of a Cartesian reference system;
- at least one first camera (8) arranged to acquire images of primary suspensions associated with wheels (10) of the bogie (1) or respective images of axle wheels of the bogie (1);
- at least one temperature sensor (14) arranged to measure the temperature of axle boxes of bearings associated with the wheels (10) or for measuring an environment temperature or for measuring the temperature of bearings of a gearbox of a railway vehicle associated with the sensing bar (2), or the temperature of a motor of said railway vehicle;
- at least one GPS sensor (18) arranged to measure the position of the sensing bar (2);
- at least one microphone (12) arranged to capture noises to be co-related with the images of each camera (8, 22) and signals outputted from the accelerometers (4).

4. Sensing bar (2) according to any of the preceding claims, wherein the bar (6) has a U-shape and is fixed to a support structure of the bogie (1).
5. Sensing bar (2) according to claim 3, wherein at least one first accelerometer (4) acts as obstacle sensors so that an impact force, having a value above a pre-determined threshold, on the bar (6) generates a first obstacle signal coming from said accelerometer.
6. Sensing bar (2) according to claim 3, wherein at least one second accelerometer (4) acts as derailment sensors, so that when the wheels (10) jump down a rail of the railway track, the bar (6) is pushed upwards and this impact generates a signal coming from said second accelerometer 4.
7. Sensing bar (2) according to claim 3, wherein each camera (8, 22) acquires images or videos and the control unit is arranged to identifies anomalies in said images or videos and to trigger corresponding alarm signals.
8. Sensing bar according to claim 3, wherein at least one accelerometer (4) is configured to produce a smooth sinusoidal wave-like reference signal when

the wheel (10) is well contained on a rail of the railway track, and when there is a wear and a flange engages with said rail, a different output vibration signal is produced, this output vibration signal being used by the control unit to analyze wear zones of the railway track.

9. Sensing bar (2) according to any of the preceding claims, wherein the values coming from the sensors are used to trigger a wheel flange lubricator of the railway vehicle.
10. Railway vehicle (100) having at least one bogie provided with a sensing bar (2) according to any of the preceding claims.

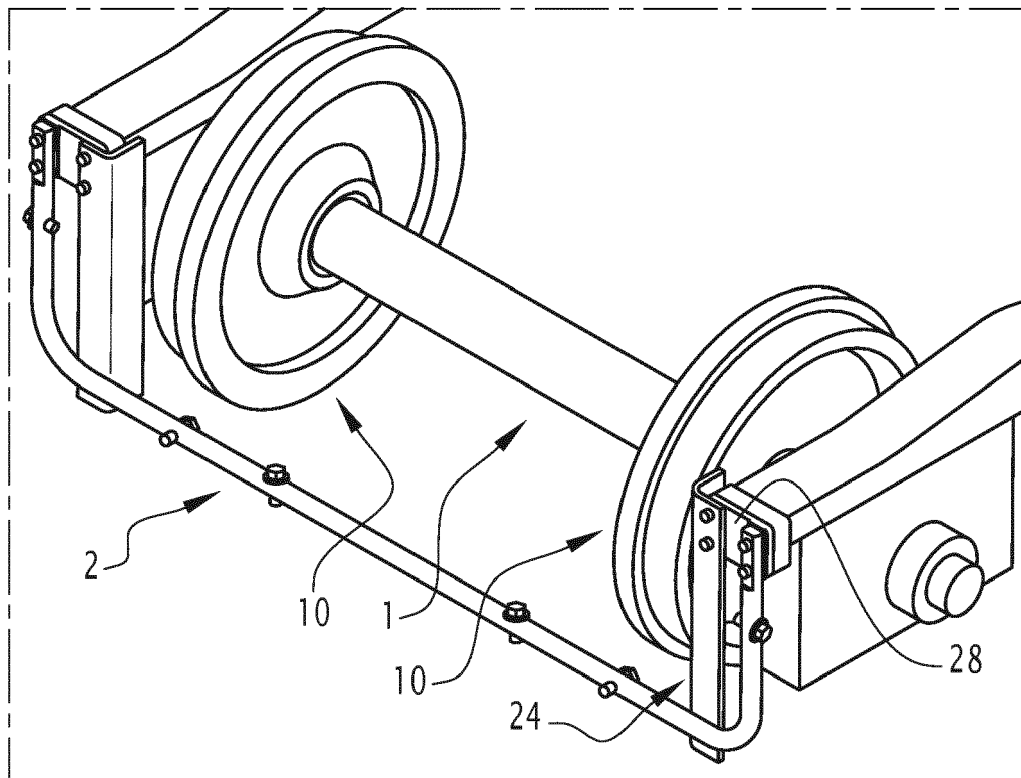


FIG.1

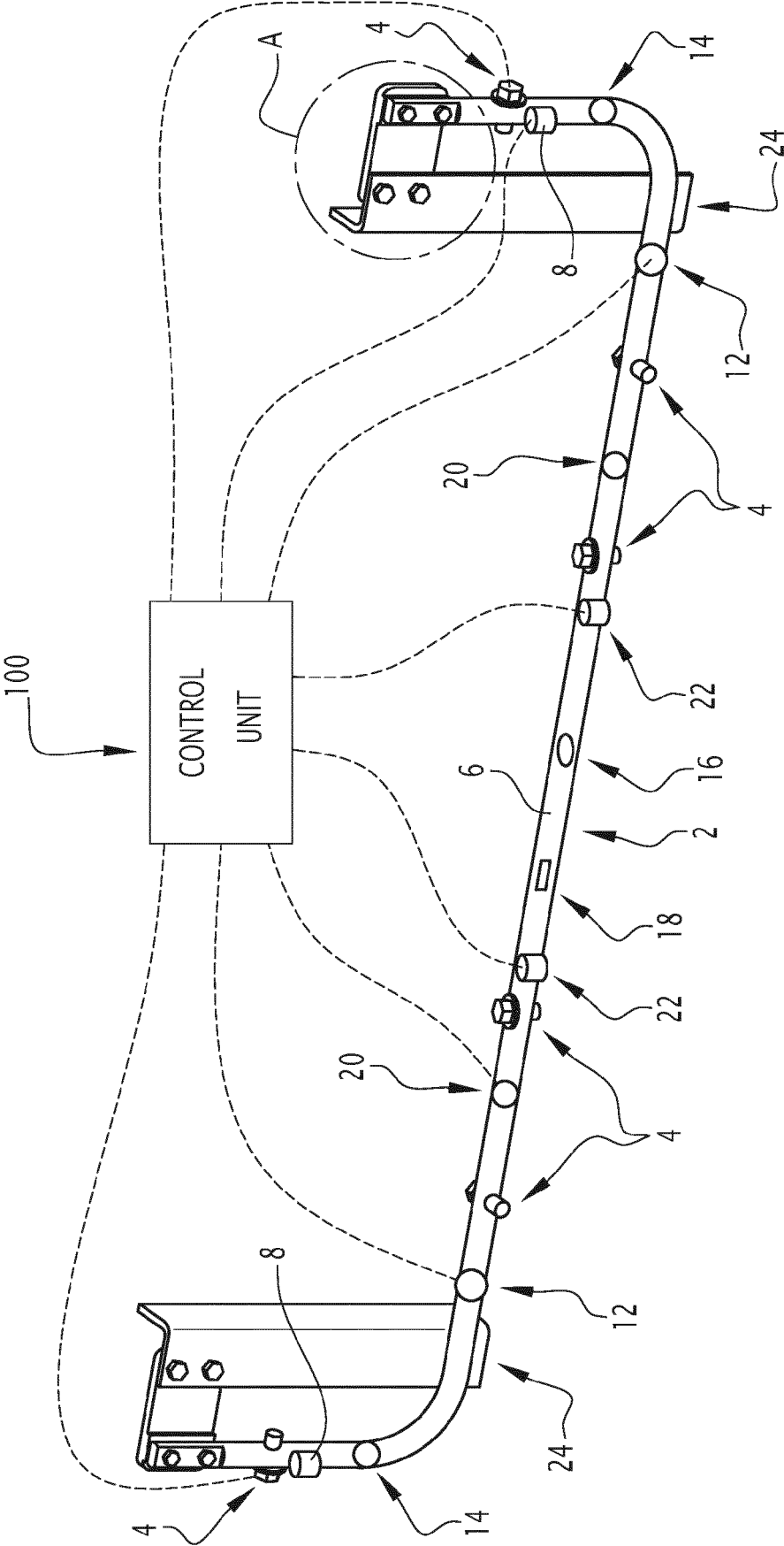


FIG.2

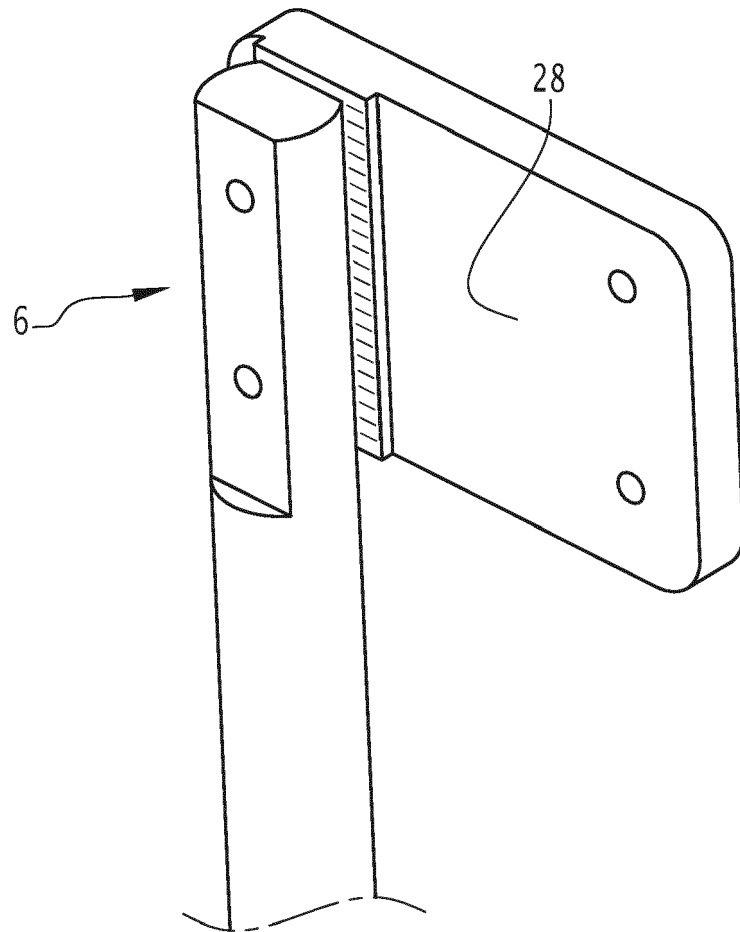


FIG.3

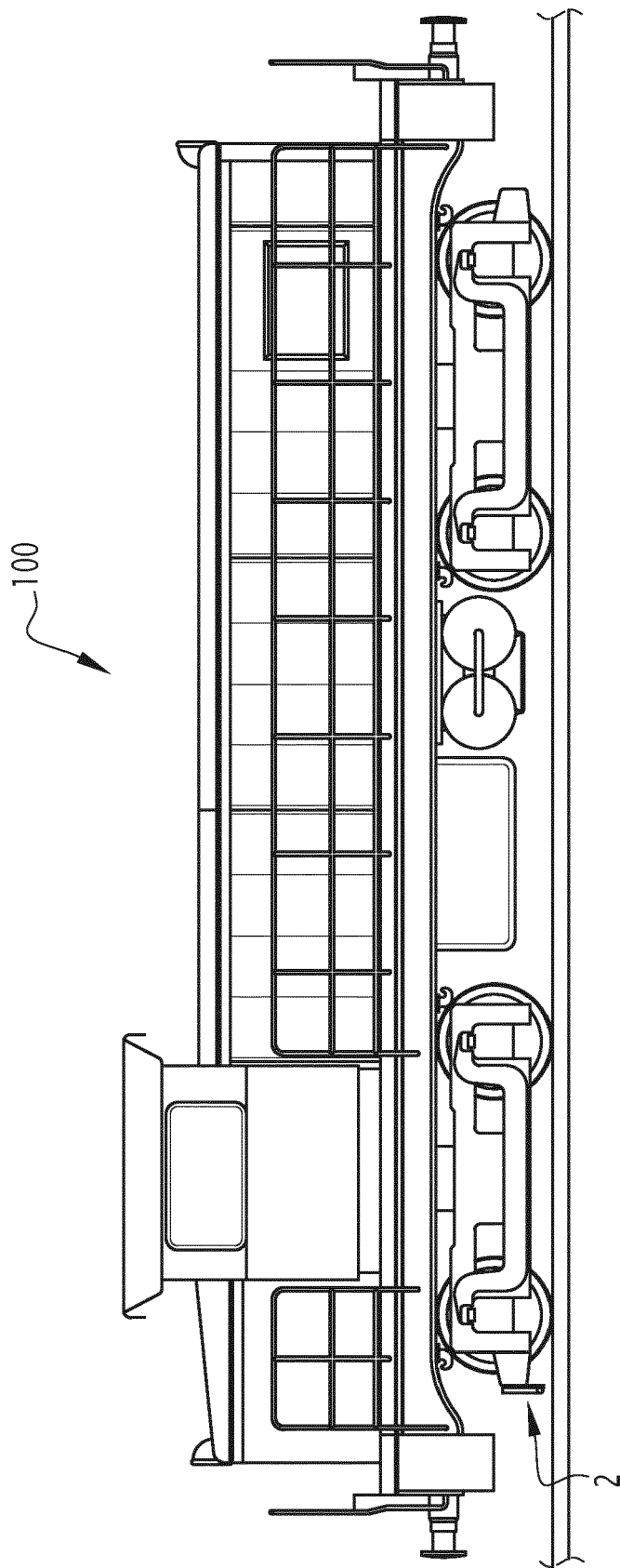


FIG.4



EUROPEAN SEARCH REPORT

Application Number
EP 20 19 4240

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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	US 2004/244637 A1 (SCHNEIDER CHAD [US] ET AL) 9 December 2004 (2004-12-09)	1,2,4,10	INV. B61F3/00 B61K9/00 B61F9/00
Y	* the whole document *	9	
X	KR 2010 0082162 A (HYUNDAI ROTEM CO [KR]) 16 July 2010 (2010-07-16)	1,2,4,10	
Y	* the whole document *	9	
A	US 2018/339720 A1 (SINGH SAMEER [GB]) 29 November 2018 (2018-11-29)	1-10	
A	EP 2 784 540 A1 (SYSTEM7 RAILSUPPORT GMBH [AT]) 1 October 2014 (2014-10-01)	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			B61F B61K
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 January 2021	Examiner Awad, Philippe
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