



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.01.2019 Bulletin 2019/05

(51) Int Cl.:
B61L 1/16 (2006.01) B61L 27/00 (2006.01)

(21) Application number: **18460044.3**

(22) Date of filing: **19.07.2018**

(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 MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **Bulawa, Mariusz**
81-743 Sopot (PL)
• **Lehner, Guenther**
4722 Bruck-Wassen (AT)

(74) Representative: **Poplawski, Czeslaw**
BIURO PATENTOWE
ul. Piecewska 18A/30
80-288 Gdansk (PL)

(30) Priority: **27.07.2017 PL 42236817**

(71) Applicant: **voestalpine SIGNALING Sopot Sp. z
o.o.**
81-859 Sopot (PL)

(54) **WHEEL SENSOR AND SENSOR ENVIRONMENT MONITORING METHOD AND A SYSTEM
EXECUTING SUCH A METHOD**

(57) A wheel sensor monitoring method, and a method of monitoring sensor environment using measurements and recording of working conditions of the sensors used to form a set of diagnostic information variable over time, used to form a diagnostic signal sent to an evaluation system, which also receives a wheel presence signal, characterised in that according to the invention that the evaluation system (UO) receives simultaneously and automatically, in constant or variable intervals $T_d(i)$ the diagnostic signal (SD) and the wheel presence signal (X) such that the diagnostic signal (SD) is sent using a frequency band higher than the frequency band used by the wheel presence signal (X), wherein the diagnostic signal (SD) and the wheel presence signal (X) are added to obtain the resulting signal (Y).

A wheel sensor monitoring system including a wheel

detection system, a wheel sensor interior monitoring system including preferably sensors detecting temperature, vibrations, humidity and a wheel sensor environment monitoring system and an evaluation system, characterised in that it includes a voltage-current conversion system (KUI) with a wheel detection system (UDK) connected to its input via the first resistor (R1) and a wheel sensor interior monitoring system (UMC) connected via the second resistor (R2) and via a converter (K1). The system output (KUI) is connected with the top bandwidth filter system (FGP) and with the bottom bandwidth filter system (FDP), wherein the top bandwidth filter system (FGP) is connected with a monitoring evaluation system (UM_UO) via a converter (K2). The bottom bandwidth filter system (FDP) is connected with a wheel detection evaluation system (UDK_UO).

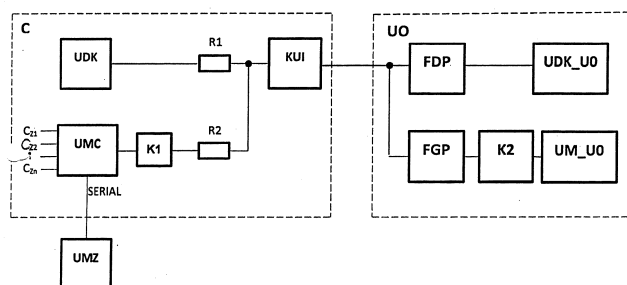


fig. 2

Description

[0001] This Invention is related to a wheel sensor monitoring method and to a sensor environment monitoring method and a to a system executing such a method.

[0002] There are known methods of measurement sensor monitoring, including railway vehicle wheel sensors and methods of sensor environment monitoring including measurement and recording of sensor working conditions, such as internal temperature, vibrations inside the sensor and relationships between electric signals inside the sensor, as well as conditions in the environment of the sensor, such as ambient temperature and relative humidity.

[0003] There are also known evaluation systems evaluating information provided by the sensor, resulting in information about the technical condition of the sensor and about its working conditions, useful for forecasting the technical condition of the sensor and for its remaining lifetime.

[0004] There are known evaluation methods used to detect wheel presence and to monitor the technical condition of the wheel sensor, which independently receive the wheel presence signal and a signal reflecting technical condition of the sensor.

[0005] This invention is related to development of a solution which ensures quasi-continuous monitoring that allows to observe working conditions of a wheel sensor. This objective was achieved through simultaneous sending signals from measurement sensors which detect the observed parameters and from the wheel sensor to an evaluation system. The system monitors the wheel sensor and its environment including measurement and recording of wheel sensor working conditions, it is used to form a set of diagnostic information variable, which over time is used to create a diagnostic signal that is sent to the evaluation system. This system also receives the wheel presence signal. It is characterised in that according to the invention a diagnostic signal and a wheel presence signal are sent simultaneously and automatically to the evaluation system, in constant or variable intervals. A frequency band higher than the frequency band used by the wheel presence signal is used to send the diagnostic signal. Then the diagnostic signal and the wheel presence signal are added together to form a resulting signal.

[0006] Potential, mutual interference of the diagnostic signal and the wheel presence signal is eliminated by adding these signals only at times t_i , when the frequency band used by the output signal at time t_i is significantly lower, preferably 10 times lower, than the lower boundary of the frequency band used by the signal at time t_i . The resulting signal is then sent through the current loop to the evaluation system and the resulting signal is decomposed using top bandwidth filtration and bottom bandwidth filtration. We thus obtain a separate secondary wheel presence signal, and the secondary diagnostic signal is sent to the diagnostic module, while the secondary

wheel presence signal is sent to the wheel detection module. The separated signals are then analysed using a known method. Permitted frequency bands are controlled during the signal adding operation. If the wheel presence signal exceeds the permitted frequency band, this is detected on the basis of identification of a momentary wheel presence signal change that is faster than the momentary signal change corresponding to the permitted frequency band; this prevents the signals from being added together.

[0007] Preferably, the sensor vibration levels indicating train travel in direct vicinity of the sensor are also controlled, in order to eliminate interferences during the signal adding.

[0008] A wheel sensor monitoring system including a wheel detection system, a wheel sensor interior monitoring system with sensors for, preferably, temperature, vibration, humidity and a wheel sensor environment monitoring system and an evaluation system is characterised in that it also includes a voltage/current conversion system. The wheel detection system is connected to an input of the voltage/current conversion system through the first resistor. The wheel sensor interior monitoring system is also connected to an input of the voltage/current detection system, through the second resistor and through a converter, preferably a modem.

[0009] The output of the voltage/current conversion system is connected with the top bandwidth filter system and with the bottom bandwidth filter system. The top bandwidth filter system is connected with the wheel sensor monitoring evaluation system through a converter, preferably a modem. The bottom bandwidth filter system is connected with the wheel detection evaluation system.

[0010] An external wheel sensor environment monitoring system is preferably connected to the wheel sensor interior monitoring system using a serial interface, preferably using galvanic separation.

[0011] Use of the invention ensures quasi-continuous monitoring of sensor technical condition, its working conditions and conditions of its environment in order to forecast the future technical condition of the sensor, thus improving safety of railway traffic and the availability of traffic control equipment. Automatically obtained information can also be used in railway line maintenance based on prevention.

[0012] The invention is better explained using a description of an embodiment and using a drawing, in which Fig. 1 presents the general diagram of the method and Fig. 2 presents a general diagram of the system.

Example 1

[0013] As Fig. 2 shows, the wheel sensor monitoring system includes a wheel detection system UDK, a wheel sensor internal monitoring system UMC and sensors: C_{Z1} for temperature measurements, C_{Z2} for vibration measurements, C_{Zn} for humidity measurements and an evaluation system UO.

[0014] The system also includes a voltage/current conversion system KUI with wheel detection system UDK, which is connected to its input via the first resistor R1, and a wheel sensor Interior monitoring system UMC connected via the second resistor R2 and via converter K1 comprising a modem.

[0015] The output of the voltage/current conversion system KUI is connected to the top bandwidth filter system FGP and the bottom bandwidth filter system FDP. The top bandwidth filter system FGP is connected with the monitoring evaluation system UM_UO via converter K2, comprising a modem K2. The bottom bandwidth filter system FDP is connected with the wheel detection evaluation system UDK_UO.

[0016] Working conditions of the wheel sensor are measured and recorded automatically, in constant intervals T_{di} , using the following sensors: for temperature measurements C_{Z1} , for vibration measurements C_{Z2} and for humidity measurements C_{Zn} . The obtained measurement results are used to form a set of diagnostic information ZDTi in the wheel sensor internal monitoring system UMC.

[0017] The set of diagnostic information ZDTi is used to form a diagnostic signal SD that is sent to the evaluation system UO as shown in Fig. 1, with the evaluation system also receiving the wheel presence signal X from the wheel detection system UDK. The diagnostic signal SD is sent using a frequency band higher than the frequency band used to send the wheel presence signal X and the diagnostic signal SD is added to the wheel presence system X to obtain the resulting signal Y.

[0018] Potential mutual interference of the diagnostic signal SD with the wheel presence signal X is eliminated in such a way that these signals are added only at times t_i , namely when the frequency band used by the output signal Y at time t_i is 10 times lower than the bottom boundary of the frequency band used by the diagnostic signal SD.

[0019] The resulting signal Y is sent further using a current loop to the evaluation system UO, and this resulting signal Y is decomposed using top bandwidth filtration FG and bottom bandwidth filtration FD.

[0020] We obtain a separate secondary diagnostic signal $SD_UO \sim SD$ and a separate secondary wheel presence signal $X_UO \sim X$. The secondary diagnostic signal $SD_UO \sim SD$ is sent to the diagnostic module MD and the secondary wheel presence signal $X_UO \sim X$ is sent to the wheel detection module MW.

[0021] The separated signals are further analysed in a known manner and diagnostic information useful in forecasting of sensor technical condition and its remaining lifetime is obtained. Additionally, the obtained information may be used to evaluate degradation of railway infrastructure manifesting through increased vibration levels recorded in the sensor.

Example 2

[0022] The system is executed as in Example 1 with the exception that an external wheel sensor environment monitoring system UMZ is connected to the wheel sensor internal monitoring system UMC which uses a serial interface with galvanic separation. It enables access to diagnostic information related to the track infrastructure, for example about increased track temperature, related to technical condition of equipment installed within the tracks, for example incorrect junction and junction drive operation, as well as related to the environment of the track infrastructure, as relative humidity and temperature requiring the junction to be heated. This information does not require any additional expenses for dedicated transmission infrastructure thanks to the use of the wheel sensor and its connection with the evaluation system.

Claims

1. A wheel sensor monitoring method, and a method of monitoring sensor environment using measurements and recording of working conditions of the sensors used to form a set of diagnostic information variable over time, used to form a diagnostic signal sent to an evaluation system, which also receives a wheel presence signal, **characterised in that** the evaluation system (UO) receives simultaneously and automatically, in constant or variable intervals $T_{d(i)}$ the diagnostic signal (SD) and the wheel presence signal (X) such that the diagnostic signal (SD) is sent using a frequency band higher than the frequency band used by the wheel presence signal (X), wherein the diagnostic signal (SD) and the wheel presence signal (X) are added to obtain the resulting signal (Y), while potential, mutual interferences between the diagnostic signal (SD) and the wheel presence signal (X) are eliminated such that these signals are added together only at times t_i , when the frequency band used by the output signal (Y) at time t_i is significantly lower, preferably 10 times lower, than the bottom boundary of the frequency band used by the signal (SD) at time t_i , and afterwards the resulting signal (Y) is sent further, using a current loop, to the evaluation system (UO) and this resulting signal (Y) is decomposed using bottom bandwidth filtration (FG) and top bandwidth filtration (FD), obtaining a separate, secondary diagnostic signal ($SD_UO \sim SD$) and a separate, secondary wheel presence signal ($X_UO \sim X$), wherein the secondary diagnostic signal ($SD_UO \sim X$) is sent to the diagnostic module (MD), while the secondary wheel presence signal ($X_UO \sim X$) is sent to the wheel detection module (MW) and the separated signals are then analysed using a known method.
2. A wheel sensor monitoring system including a wheel

detection system, a wheel sensor interior monitoring system including preferably sensors detecting temperature, vibrations, humidity and a wheel sensor environment monitoring system and an evaluation system, **characterised in that** it includes a voltage-current conversion system (KUI) with a wheel detection system (UDK) connected to its input via the first resistor (R1) and a wheel sensor interior monitoring system (UMC) connected via the second resistor (R2) and via a converter (K1), preferably a modem, while the system output (KUI) is connected with the top bandwidth filter system (FGP) and with the bottom bandwidth filter system (FDP), wherein the top bandwidth filter system (FGP) is connected with a monitoring evaluation system (UM_UO) via a converter (K2), preferably a modem, and the bottom bandwidth filter system (FDP) is connected with a wheel detection evaluation system (UDK_UO).

3. A system according to Claim 2, **characterised in that** an external wheel environment monitoring system (UMZ) is connected to the wheel sensor interior monitoring system (UMC) using a serial interface, preferably using galvanic separation.

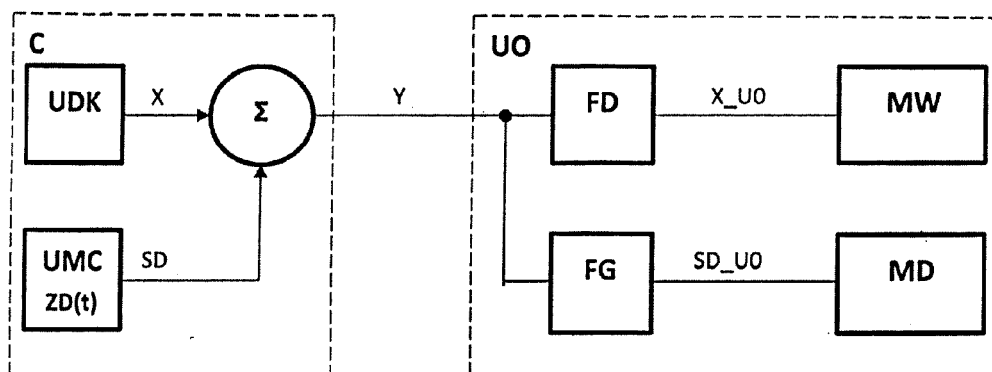


fig. 1

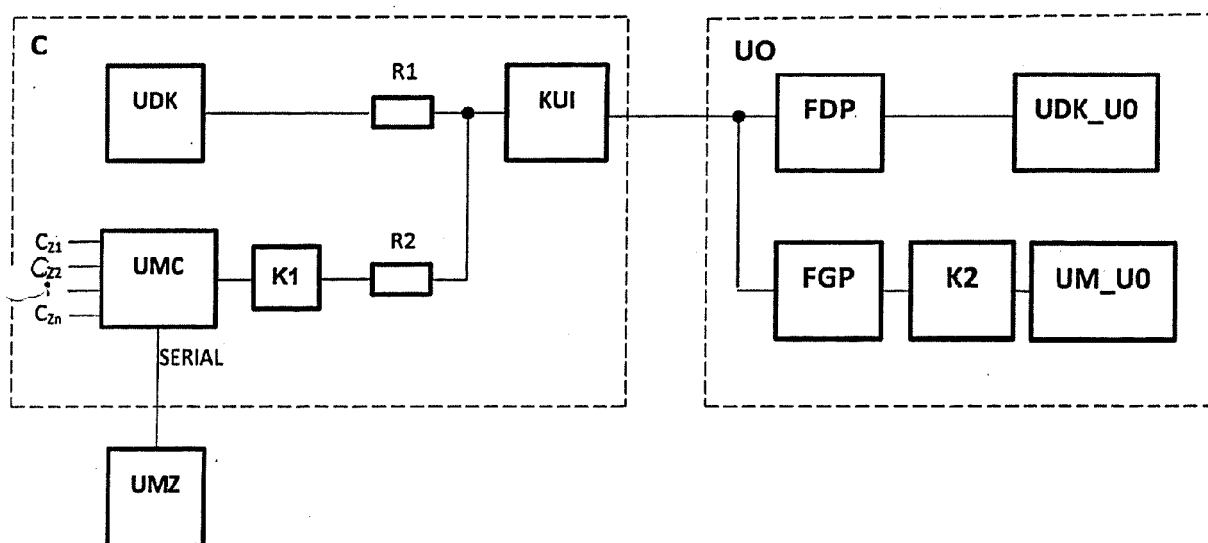


fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 18 46 0044

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	DE 10 2009 005042 A1 (SIEMENS AG [DE]) 29 July 2010 (2010-07-29) * paragraphs [0001], [0006] - [0008], [0012], [0013]; figures 1-2 *	1-3	INV. B61L1/16 B61L27/00
Y	DE 198 09 087 A1 (SIEMENS AG [DE]) 26 August 1999 (1999-08-26) * column 1, line 35 - line 41 * * column 1, line 62 - column 2, line 3 * * column 2, line 27 - column 5, line 8 * * figures 1-3 *	1-3	
A	DE 197 09 840 A1 (SIEMENS AG [DE]) 3 September 1998 (1998-09-03) * column 2, line 65 - column 6, line 18 * * figures 1,2 *	1-3	
A	DE 32 18 541 C1 (SIEMENS AG) 3 November 1983 (1983-11-03) * column 5, line 26 - column 8, line 49; figure *	1-3	
A	EP 3 072 775 A1 (SIEMENS SCHWEIZ AG [CH]) 28 September 2016 (2016-09-28) * paragraphs [0009] - [0013], [0016] - [0020]; figures 1-3 *	1	TECHNICAL FIELDS SEARCHED (IPC) B61L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 December 2018	Examiner Massalski, Matthias
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			

EPO FORM 1503 03.82 (P04C01)

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

EP 18 46 0044

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.

06-12-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102009005042 A1	29-07-2010	NONE	
DE 19809087 A1	26-08-1999	NONE	
DE 19709840 A1	03-09-1998	NONE	
DE 3218541 C1	03-11-1983	NONE	
EP 3072775 A1	28-09-2016	NONE	