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(54) **AUTOMATIC DETECTION OF TRAIN DERAILMENT**

(57) The invention has for object an automatic radio-electro-mechanical system for the detection of the derailment of one or more railway wagons towed by a locomotive, with an alarm signal in the cabin.

The system involves the use of 2 electromechanical sensors (load cells) for detecting the tensile stress to the hook (one for each direction of travel of the locomotive), an accelerometer, a GPS module and a module that uses common GSM-R mobile telephone technology specific for railways (Global System for Mobile Communications - Railways).

The electro-mechanical sensors are constituted by load cells of the type to bending, tension, or cut, equipped with strain gauges installed preferably according to the electrical diagram of a double full Wheatstone bridge in order to detect the stress at the locomotive traction hook.

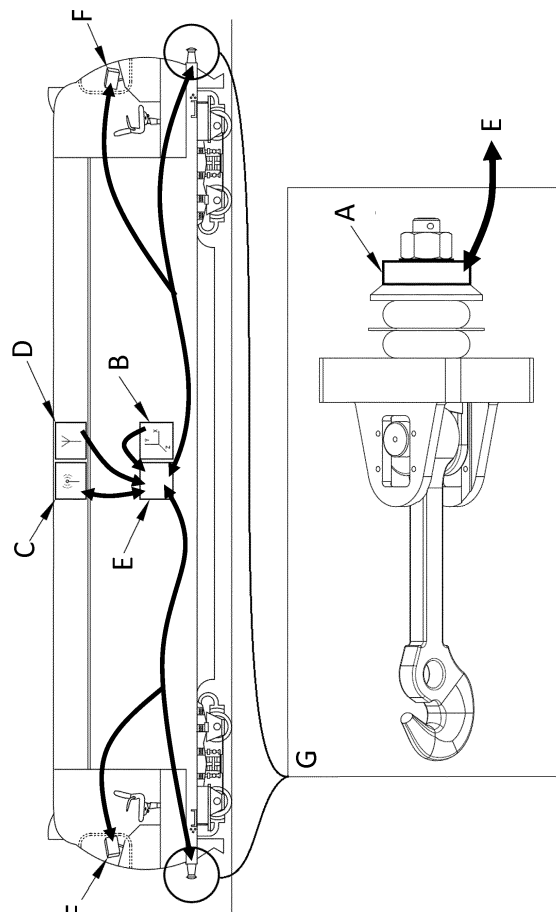
In the preferred embodiment, the accelerometer detects at least the acceleration on three axes.

In the preferred embodiment, the GPS module detects the data according to the NMEA 0183 standard.

In the preferred embodiment, the mobile phone module sends and receives data to and from remote via GSM-R commonly used by railways for air transmission and reception.

The audio and visual alarm in the cabin is automatically launched by the software following the processing of the data related to the abnormal driving or when a derailment occurs.

The system involves the use of an HMI (human machine interface) for the installation and operation of the software.



Description

STATE OF THE ART

[0001] . The train derailment is the phenomenon that occurs when one or more prebuilt wheelset transverse constraint formed by the flange of wheel and the rail head shall lose; such an event can cause extensive damage to vehicles, to railway infrastructure, in particular to the track equipment, to the electric traction and to the signaling installations.

[0002] . Today, modern locomotives, equipped with automatic adjustments for the running, have available extremely high powers that allow them to tow heavy convoys thus preventing the driver to realize, in a timely manner, the enhanced tensile strength, due to one or more wagons astray; the phenomenon of the derailment is not limited to a few hundreds of meters of damaged infrastructure (the space needed to safely shutdown the convoy after the perception of the derailment) but also continues to kilometers before the driver has perception and intervene with rapid braking.

[0003] . It must also be considered the risk related to the prolongation of the derailment of a wagon progressing inadequately that increases the seriousness of the risk linked to the welfare of the people, the surroundings, and to rail traffic in general.

[0004] . The idea of being able to quickly assess whether a cart is derailed is not new; already in the past years several systems have been studied to assess in real time the conditions of derailment of a train.

[0005] . Among these, the most known is the detection of derailment through the pneumatic system of a railway vehicle said "EDT 101" of the German company KNOOR-BREMSE of Monaco; however, to date we are still not fully used to it for the need of having to install on all freight wagons these systems and this represents a major obstacle to their use, given the high number of wagons currently circulating in Italy and in Europe.

SCOPE OF THE INVENTION

[0006] . Hence the idea of creating a system that does not need to be installed on all wagons, but simply on the locomotives only; in this way, it definitely solves the problem related to the number of vehicles to be equipped of instrumentation, since the number of locomotives is a small fraction of the total number of circulating railway vehicles; the system of the present invention can be used on all of the locomotives pulling hooks towing wagons cargo and / or passenger coaches.

[0007] . The invention object of this application is composed of:

- a) a load cell mounted to the hook of the locomotive to detect in a continuous manner the tensile stress,
- b) an accelerometer able to recognize the different nature of the effort resulting from the derailment than

the normal running condition specified on the route (acceleration, braking, uphill, downhill, curves),
c) a GPS module to geo-reference the convoy at the time of the derailment and calculate the speed of travel,

d) an appropriate software that evaluates with an HMI (human machine interface) if there are any anomalous tensile stresses due to the derailment of one or more wagons,

e) a module using GSM-R specific for railways (Global System for Mobile Communications - Railways) for the transmission of data remotely,

f) an audio and visual alarm in the cab for the driver.

[0008] . The objective to be achieved, with the invention of the present application, is that to warn the driver that the convoy is in abnormal running conditions or derailment, so as to minimize the damage to the convoy and to the infrastructure.

DETAILED DESCRIPTION OF THE INVENTION

[0009] . The invention object of the present application is a system composed by several electronic and electro-mechanics equipment belonging to three separate functional groups:

- a) Measurement equipment (Fig. 1 and 2 - A - B - C - D),
- b) Equipment of first processing and transmission of measurement data (Fig. 1 and 2 - E),
- c) Equipment of final data processing and its registration with issuing of audible and visual alarm signal, at the recognition of the derailment with possible deployment in remote data (Fig.1 and 2 - F).

[0010] . Measurement equipment for the traction stress consists of an electro-mechanical sensor (traction, cut, or bend-type load cell - Fig. 1 and 2 - A) equipped of strain gauges, installed as an electrical scheme of a double Wheatstone bridge, or by half Wheatstone bridge or by a quarter of a Wheatstone bridge or by one or more complete Wheatstone bridge.

[0011] . The apparatus for detection and measurement of the traction stress are preferably present in number of 2 units for each locomotive (one for each direction of travel).

[0012] . The load cells (Fig.1 and 2 - A) preferably will be mounted on the traction hook of the sole locomotive and they detect the value of the stress applied to the traction hook of the entire convoy.

[0013] . The fastening of the load cell method is purely mechanical and is, preferably, for coupling along the traction rod (Fig. 2 - G).

[0014] . The load cell, suitably powered from the locomotive battery or any other source of electrical energy, will release a value in mV directly proportional to the variation of stress to the hook; this voltage, amplified by a

signal conditioner (analog or digital) will be sent to the equipment of first processing and transmission data preferably by cable or by radio (Fig. 1 and 2 - E).

[0015] . In a preferred mode of realization, the load cell is of toroidal geometry and is mounted in the axis of the traction hook of the locomotive (Fig. 1 and 2 G - A).

[0016] . The first processing and data transmission apparatus (Fig. 1 and 2 - E) communicates by wire or by radio with the final data processing equipment (Fig. 1 and 2 - F).

[0017] . The accelerometer (Fig. 1 and 2 - B) detects accelerations of the locomotive, at least along the three Cartesian axes: X, Y and Z.

[0018] . The GPS module (Fig. 1 and 2 - C) detects data related to geographic coordinates, preferably according to the NMEA 0183 protocol.

[0019] . The mobile module (Fig. 1 and 2 - D), at the end of the journey, transmits by GSM-R all data recorded along the way.

[0020] . All the installed sensors, in a preferred mode of realization, are electronically connected to a micro-processor for the first processing and subsequent transmission of data and, with the exception of the load cell, they are placed in a container, for example in PVC or metal equipped with connectors for cables and antennas required for the receipt and transmission of data ().

[0021] . In this preferred mode of realization, the container Fig. 1 and 2 - E) has suitably shaped holes to allow the fixing of the panel connectors for the wiring of the cables coming from the sensors (Fig. 1 and 2 - A - B - C - D), and a USB panel connector to allow the electronic equipment be connected to a PC (Fig. 1 and 2 - F) for the data transmission operations and for the periodic maintenance of the system.

[0022] . In this preferred mode of realization, the electronic equipment inside the container (Fig. 1 and 2 - E) include a suitable power supply capable of adequately transforming the voltage taken from the electrical system of the locomotive or from other power source for supplying the entire system.

[0023] . The analog signal issued by the load cell is converted into a digital value (numeric value) and it is sent through a serial communication, via cable to the device of the final processing of the data, equipped with dedicated software.

[0024] . The final data processing equipment (Fig. 1 and 2 - F) consists of an HMI (human machine interface) where the dedicated software can process all data received from the sensors, their parameters, verify and record them.

[0025] . The software, on the basis of the driving conditions, from the magnitude of the variation of the detected tensile stress to the hook, considering also the duration of the variation of the stress, and on the basis of the variation of acceleration and speed of the train, is able to detect anomalous stress trends at the locomotive hook and activate the alarm with light and sound signaling systems.

[0026] . The software automatically creates an encrypted file for saving input data, process data and output data that remains available to the infrastructure manager and the train service manager in the event of subsequent investigations.

[0027] . Once the train service is over, the software sends all data remotely, preferably by GSM-R specific for railways (Global System for Mobile Communications - Railways) or by a common mobile phone technology or any other protocol commonly today used for data transmission over the air.

Claims

1. Automatic radio-electro-mechanical system for the detection of the derailment of one or more railway wagons towed by a locomotive, with an alarm signal in the cabin, comprising:

- i) One load cell for each traction hook at the sole locomotive (A) for the measurement of the stresses within the traction hook,
- ii) An accelerometer (B),
- iii) A GPS module (C),
- iv) A module that uses the GSM-R mobile telephone technology (D) specific for railways (Global System Communication - Railways) for the transmission of data remotely,
- v) A HMI interface (F),
- vi) Optical and acoustic alarm devices in the cabin.

2. System according to claim 1 in which the measurement of traction stress takes place by means of load cells (A) provided with strain gauges installed in the cell preferably according to the wiring diagram of a double Wheatstone Bridge.

3. System according to claim 2 in which the Wheatstone bridge is selected from one or more of whole Wheatstone Bridges, a half Wheatstone bridge and a quarter of a Wheatstone bridge.

4. System according to claims 2-3 wherein the strain gauges, are selected among the following types: traction and compression, bending, and cut.

5. System according to claims 1-4, further comprising transmitting data from the sensors (i, ii, iii, iv) to the first processing apparatus (E), and the transmission from the first processing apparatus to the final processing apparatus (v) (F).

6. System according to claim 5, in which the transmission of data from the first processing apparatus to the final processing of the apparatus preferably takes place by cable or by radio, preferably at a selected

wavelength between micro wave, short wave, medium wave and long waves.

7. System according to claims 5-6 wherein the first processing apparatus are amplifiers or conditioners of analog or digital signal and amplify the signal received from sensors. 5
8. System according to claim 7, wherein the final processing apparatus running the dedicated software, that correlates the traction effort to the hook of the locomotive with the parameters detected by all the other sensors and verifies the condition of the train being misled, emitting, when necessary, a visual and acoustic alarm signal. 10 15

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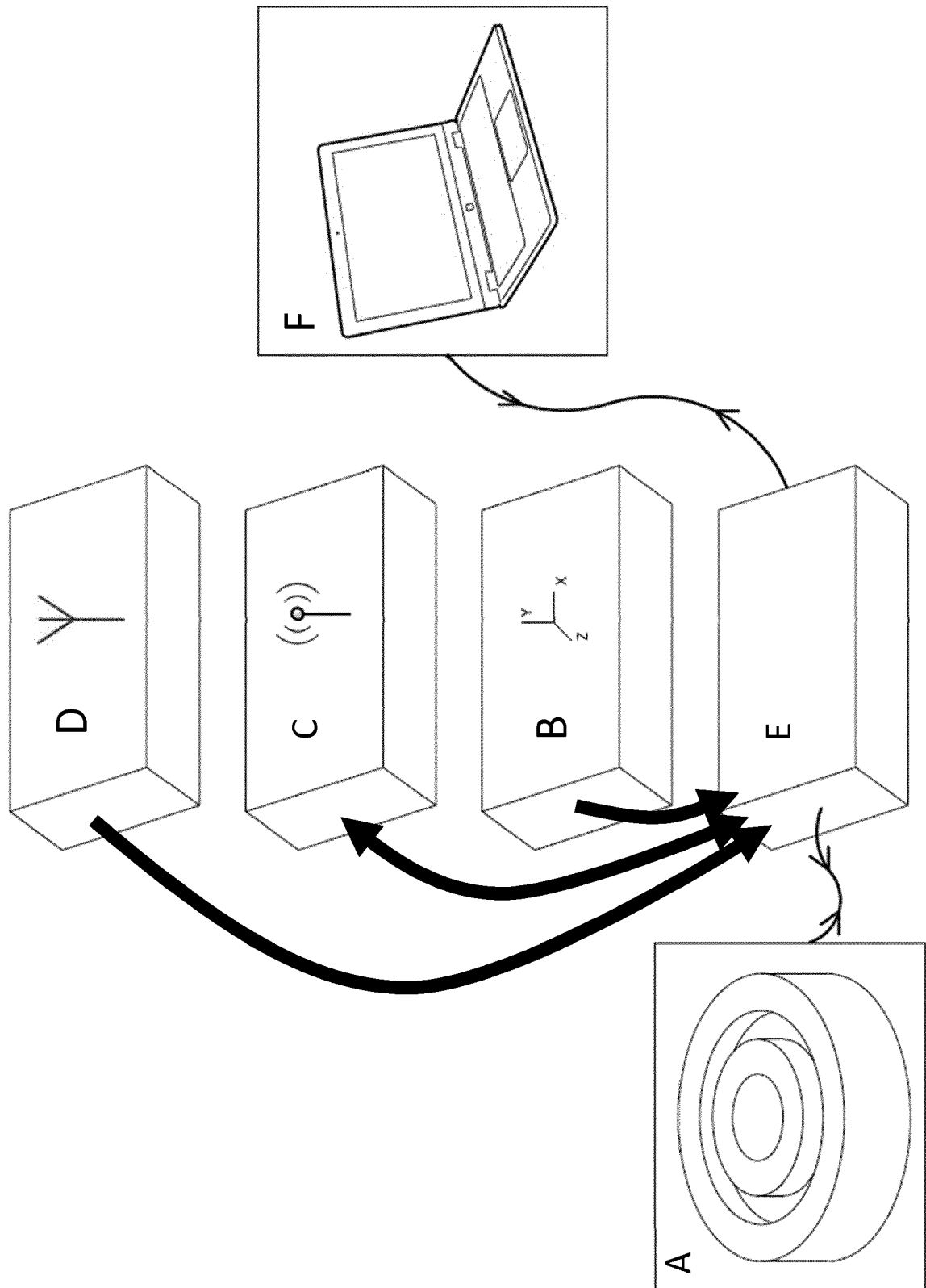
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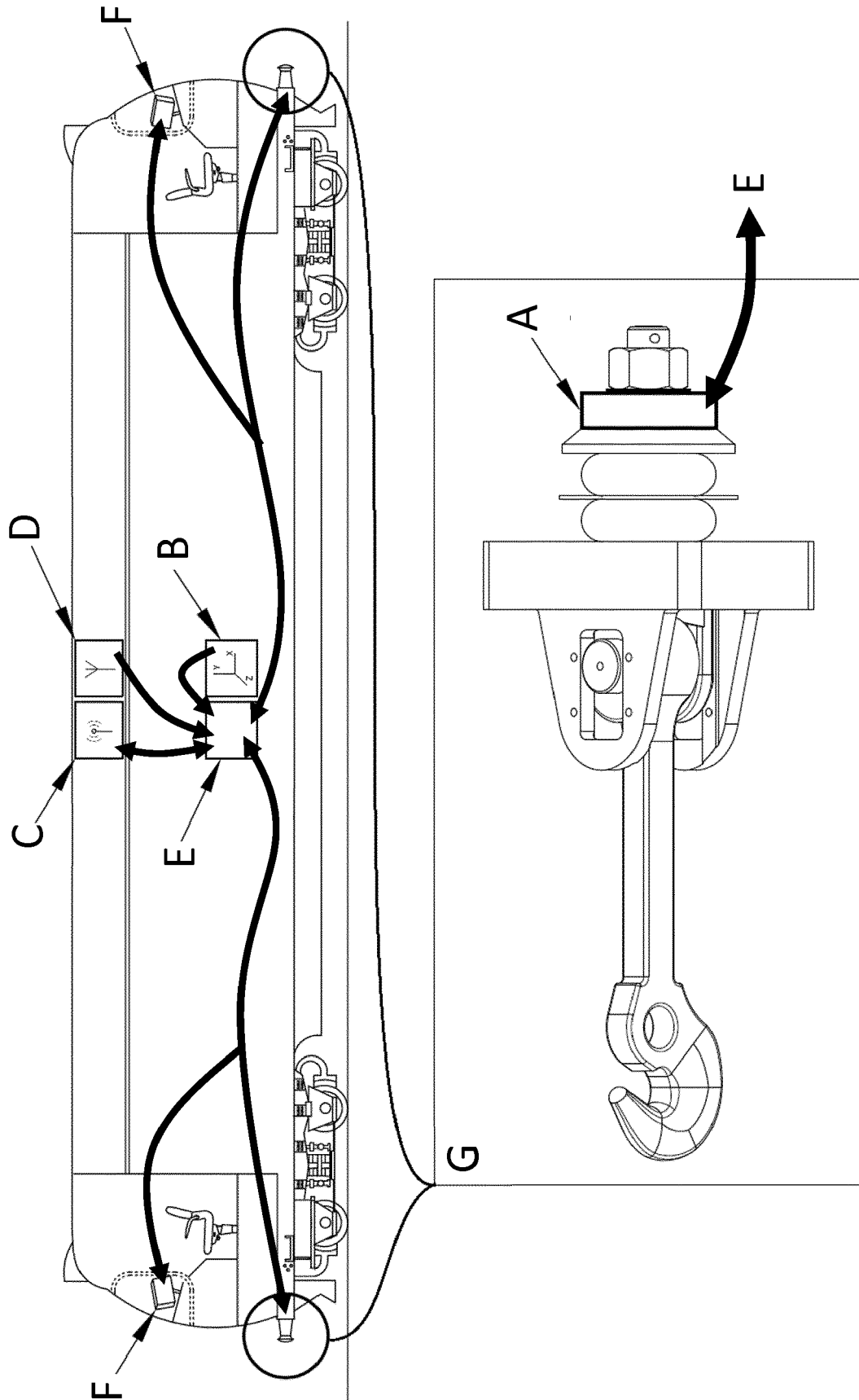
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EUROPEAN SEARCH REPORT

 Application Number
 EP 18 16 7324

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2008/195265 A1 (SEARLE DONALD STEPHEN [AU] ET AL) 14 August 2008 (2008-08-14) * paragraph [0029] - paragraph [0048] * * paragraph [0072] - paragraph [0105] * * paragraph [0115] - paragraph [0116] * * figure 2 *	1-8	INV. B61L15/00 B61L23/00 B61L25/02
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			TECHNICAL FIELDS SEARCHED (IPC)
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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 8 June 2018	Examiner Janssen, Axel
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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 EPO FORM 1503 03.02 (P04C01)

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

EP 18 16 7324

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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
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08-06-2018

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