A system and a method for simultaneously controlling and storing the physical parameters that change during the internal stress adjustment operations in the installation of the so called “long welded rail” are described. The system comprises a main processing unit, consisting of a computer with a proper interface card, and one or more detection devices (1) disposed at predetermined positions on the rails (3) and connected with the main processing unit. Each detection device (1) is able to check, during all the release and subsequent stress adjustment stages for the rail (3), all the data related to the longitudinal movements of a certain rail section (3) with respect to the underlying sleepers (5) completely bound from said rail (3), and to send these data to the remote main processing unit. Each detection device (1) is made of two separate components, a main component (7) which contains the detection elements and is configured to be fastened to at least one of the sleepers (5), and at least a checking component (9), adapted to be fastened to the rail (3).
"SYSTEM AND METHOD FOR SIMULTANEOUSLY CONTROLLING AND STORING THE PHYSICAL PARAMETERS DURING THE INTERNAL STRESS ADJUSTMENT OPERATIONS IN THE LONG WELDED RAIL INSTALLATION"

The present invention is about a system and a method for simultaneously controlling and storing the physical parameters that change during the internal stress adjustment operations in the installation of the so called "long welded rail" (LWR).

Almost all the operating railways are built with 50 and 60 UNI type rails welded together, with expansion prevented by the sliding resistance opposed by the sleeper and ballast assembly. Therefore, compression or traction stresses occur in the operating rails as the temperature changes. The railway companies set the adjustment temperature for each track section and the rails should not have any internal stress when said temperature is reached. This allows to ensure the tensional balance needed for the railway equipment stability in any environmental condition. The operation for ensuring the tensional balance is called "long welded rail internal stress adjustment operation".

Operatively, the long welded rail internal stress adjustment operations are performed by forcing the rails without constraints, i.e. disconnected from the sleepers, to be mechanically stretched at lower temperatures with respect to the adjustment one, in order to reach the same length caused by the rail heating due to the equivalent thermal head.

The stress adjustment operations are normally performed using devices called rail stretch clamps, able to carry out the calculated mechanical stretches on rail sections having a length up to 864 m. This length is the maximum value used by the Italian railway company, but other railway companies could use different values. The whole rail section is divided in two half-sections, inside which reference "quarters" are fixed; for each quarter, the stretch proportionality with respect to the whole stretch calculated on the rail half-section has to be verified.

At present, the stretch proportionality verification is performed by several properly entrusted persons, who move many times along the whole rail section under adjustment in order to evaluate on sight the displacements of the marks drawn on the rails with respect to the sleepers from which said rails have been temporarily released. The defect detection and the consequent communication to the squads of
workmen performing the mechanical release of the rails from their constraints are
often ill-timed, due to the time needed for the movement from one checkpoint to
another.

It is thus an object of the present invention to provide for a system and a
method for simultaneously controlling and storing the physical parameters that
change during the internal stress adjustment operations in the installation of the so
called long welded rail which allow, through a mechanical device easy to install at
predetermined positions on the rail, to simultaneously and remotely control the
temperatures and the stretches of said rail during all the stress regulation stages.

The system according to the present invention comprises a main processing
unit, consisting of a computer provided with a proper interface card according to a
preferred embodiment, and one or more mechanical detection devices disposed at
predetermined positions on the rail, connected to the main processing unit through a
wireless communication system or equivalent and able to operate at the same time
on both rails of a track.

The system and method according to the present invention have the features
set forth in independent claims 1 and 10. Further advantageous features of said
system are set forth in the dependent claims.

Characteristics and advantages of the invention will be better described in
greater detail hereinafter, also with the aid of the annexed drawings, which show
illustrative but not limiting embodiments of the main component of the system for
simultaneously controlling and storing the rail section physical parameters.
Obviously, the same reference numbers in the different figures show the same or
equivalent components.

Figure 1 is an axonometric schematic view of a mechanical detection device
according to the present invention.

Figure 2 is a side view of the mechanical detection device of Figure 1.

Figure 3 is a side sectional view showing the mechanical detection device of
Figure 1 positioned on a rail section.

Figure 4 is a side sectional view showing the mechanical detection device of
Figure 1 fastened to a rail sleeper.

With reference to the Figures of the annexed drawings, an embodiment of a
mechanical detection device 1 for checking the variation of the physical parameters
during the internal stress adjustment operations in the installation of the long welded
rail is shown. The purpose of each detection device 1 is to check, during all the release and subsequent stress adjustment stages for a generic rail section 3, all the data related to the longitudinal movements of the rail 3 with respect to the underlying sleepers 5 (Figure 4), completely unbound from said rail 3, as well as to send said data to a remote main processing unit through a proper communication channel. The main processing unit can be a computer provided with a proper interface card able to communicate with each detection device 1.

Each detection device 1 is made of two separate components, a main component 7 which contains the detection elements (Figures 1 and 2) and is configured to be fastened to the sleeper(s) 5, and a checking component 9, adapted to be fastened to the rail 3. The main component of the detection device 1 is provided with a mechanical checking bar 11 maintained in permanent contact with the checking component 9 through a spring device.

For example, the checking component 9 can be fastened to the rail 3 through a bracket 13 mounted on the flange 15 of said rail 3, and it is disposed in a substantially vertical position. The checking bar 11 of the main component 7 is substantially horizontal and perpendicular to the development axis of the rail 3. The checking bar 11 is integral with the cursor 17 of an electronic position transducer mounted on the sleepers 5 through a proper fastening element, and it is able to move inside the detection device 1 along a linear slide guide 19.

The position of the checking elements 9 and 11, in physical contact one with the other, has the purpose to detect the longitudinal movements only of the rail 3 with respect to the sleepers 5 without alterations due to other side or vertical displacements imposed by the works.

Furthermore, a proper thermometrical feeler for detecting the temperature of the rail 3, to be disposed in a corresponding housing 21, can be connected to each detection device 1.

The displacement and temperature data detected by the position transducers and the thermometrical feelers respectively are processed by a proper electronic card disposed in the housing 23 of each detection device 1 and subsequently sent, preferably through a wireless communication device integrated in said electronic card, to the main processing unit. The operation of all the equipments included in each detection device 1 is ensured by a proper battery pack 25.

Instead of the above described device for checking the rail relative
displacement, it is possible to replace the mechanical checking elements and the position transducer of each detection device 1 with other electronic distance measuring equipments (laser, radar, infrared, ultrasonic, etc.), trained as well on their corresponding checking elements.

Furthermore, the above described detection devices can also be disposed by reversing the position of the checking elements, maintaining as well the same functionality: the detection device 1 connected to the position transducer can be fastened to the rail 3 rather than the sleepers 5, while the checking element 9 can be fastened to one of the sleepers 5.

The electronic card and the battery pack 25 could also be disposed in a stand alone box properly connected with the detection device 1.

The detected temperature data are used in an automatic way by the main processing unit to compute the expansion to be imposed to the rail quarters according to the half-sections length.

The visualization of all the detected data allows a single operator to evaluate in real-time the instant when the rails can be considered as completely free from constraints and to start, with a simple command, the adjustment operations with the simultaneous storage of the position data detected by each detection device 1 in said instant. These stored data become a reference for the imposed proportional expansions.

The main processing unit keeps on processing in real-time the received data, automatically verifying the expansion proportionality in each rail section, the immobility of the fixed points and the displacements with respect to the operative tolerances.

The operator is thus able to control by himself all the data and to indicate in real-time where the rail shaking activities have to be intensified in order to obtain a true proportionality of the imposed expansions and thus the tension homogeneity.

The main processing unit can also automatically store the detected data, allowing the subsequent visualization and printing of the tension adjustment main data which are useful as well to certificate the correct execution of all the operations.

In brief, each apparatus forming the detection system according to the present invention operates as follow. Each detection device 1 detects the rail longitudinal movements since its application on said rail and systematically at each predetermined time interval, detecting as well the rail temperature, if required,
through the proper thermometrical feeler. All the detected data are then sent, through a proper communication system, to the main processing unit which, in advance:

- receives the input data concerning line, track, rail, train direction and distinction between right and left rail (in ordinary double-track lines, the right rail is the centre line side one, while the left rail is the platform side one, being possible to easily change this setting);
- receives the input data required to define the half-section lengths, the distance between the sleepers and the adjustment temperature;
- computes and automatically inputs the missing data (the progressive kilometres, the length of each half-section measured in meters or in sleeper number, the number of sleepers between two quarters and other data are set);
- receives the input data concerning any fixed point movement detected in previous adjustment operations in order to take them into account in further computations (this value is equal to zero by default).

After each detection device 1 has been positioned and activated, the main processing unit performs the following operations for each single rail section:

- stores all the data sent by the detection devices 1 and detects any transmission failures;
- for each detection device 1, it shows the rail displacement in both directions and the rail temperature if the thermometrical feeler is installed;
- for each single rail (left or right) and upon a command by the operator, it sets the instant for completing the constraint release operations;
- stores at the same time the detected position and temperature for each detection device 1, the system setting the subsequent adjustment operations on these information;
- computes the means (Tm) of the temperature data detected on each rail half-section and, according to the rail section length, computes the whole extensions of each half-section and the quarter subdivision; the computed extensions (ΔL computed) are shown in mm in the diagrams of each quarter.

During the adjustment operations, the main processing unit performs in real-
time the following operations:

- processes the extension data detected by each detection device, the data values being expressed in millimetres, compares said data with the computed ones, shows in percentage form the detected extensions compared with the theoretical ones to allow a proportionality control (the computations are made by subtracting the value of any fixed point displacements from the detected extension values) and displays with different colours the values beyond the predetermined tolerances.

When the complete extension of each rail half-section is reached, a message is displayed to notify the end of the traction or heating operations.

The whole detection system according to the present invention keeps on acquiring data up to its switching off. The data are then automatically stored, their fast display being allowed through subsequently retrievable menus. If desired, the data file can be saved and archived in a read only format.

Therefore, it should be understood that the system and method for controlling and storing the physical parameters that change during the rail section internal stress adjustment operations described so far in a preferred embodiment brilliantly achieves the intended purposes, allowing to detect, transmit, collect and compute in real-time the physical data required to set the tensions in the long welded rail in a more precise, reliable and quick way with respect to the prior art. The system allows as well a considerable reduction of the data detection, evaluation and computation error possibility due to a less human factor incidence.

Although the system and method for controlling the changes of the rail section physical parameters according to the invention has been disclosed and shown only with reference to a particular embodiment, it will be clear for a person skilled in the art that various changes, variations, replacements and additions of parts with other functionally equivalent components could be made, without departure from the scope of protection defined by the appended claims.
CLAIMS

1. A system for simultaneously controlling and storing the physical parameters that change during the internal stress adjustment operations in the installation of the so called "long welded rail", comprising a main processing unit, consisting of a computer with a proper interface card, and one or more detection devices (1) disposed at predetermined positions on the rails (3) and connected with said main processing unit, each detection device (1) being able to check, during all the release and subsequent stress adjustment stages for said rail (3), all the data related to the longitudinal movements of a certain section of said rail (3) with respect to the underlying sleepers (5) completely unbound from said rail (3), and to send said data to said remote main processing unit, characterized in that each of said detection devices (1) is made of two separate components, a main component (7) which contains the detection elements and is configured to be fastened to at least one of said sleepers (5), and at least a checking component (9), adapted to be fastened to said rail (3), said main component (7) of said detection device (1) being provided with at least a mechanical checking bar (11) maintained in permanent contact with said at least a checking component (9) through a spring device.

2. The system according to claim 1, characterized in that the checking bar (11) of the main component (7) is integral with the cursor (17) of an electronic position transducer mounted on the sleeper (5) through a proper fastening element, and it is able to move inside the detection device (1) along a linear slide guide (19).

3. The system according to claim 1, characterized in that each checking component (9) is fastened to the rail (3) through a bracket (13) mounted on the flange (15) of said rail (3), and it is disposed in a substantially vertical position.

4. The system according to claim 1, characterized in that a proper thermometrical feeler for detecting the temperature of the rail (3), to be disposed in a proper housing (21), can be connected to each detection device (1).

5. The system according to claim 4, characterized in that each detection device (1) is provided with a housing (23) for an electronic card able to process the displacement and temperature data detected by said detection device (1) position transducers and thermometrical feeler respectively.

6. The system according to claim 5, characterized in that the electronic card of each detection device (1) comprises a wireless communication device able to send the displacement and temperature data to the main processing unit.
7. The system according to claims 1 to 6, characterized in that the operation of all the equipments included in each detection device (1) is ensured by a proper battery pack (25).

8. The system according to claim 1, characterized in that the position of the mechanical detection devices (1, 9) can be inverted, the detection device (1) connected to the position transducer being fastened to the rail (3) rather than to the sleepers (5) and the checking element (9) being fastened to one of the sleepers (5) rather than to the rail (3).

9. The system according to claim 2, characterized in that the mechanical checking elements (9, 11) and the position transducer of each detection device (1) can be replaced with other electronic distance measuring equipments (laser, radar, infrared, ultrasonic, etc.).

10. The system according to claim 7, characterized in that the electronic card and the battery pack (25) could be disposed in a stand alone box properly connected with the detection device (1).

11. A method for simultaneously controlling and storing the physical parameters that change during the internal stress adjustment operations in the installation of the so called "long welded rail", said method using a system according the preceding claims, characterized in that the main processing unit processes in real-time the data received by each detection device (1), automatically verifying the expansion proportionality in the different rail sections (3), the immobility of the fixed points and the displacements with respect to the operative tolerances, and supplies to the operator the data for intensifying the shaking activities on said rail (3) in order to obtain a true proportionality of the imposed expansions and thus the tension homogeneity in each rail section (3).

12. The method according to claim 11, characterized in that the main processing unit can automatically store the detected data, allowing the subsequent visualization and printing of the tension adjustment main data which are useful as well to certificate the correct execution of all the operations.
## A. CLASSIFICATION OF SUBJECT MATTER

**INV. G01B5/14 E01B35/12**

According to International Patent Classification (IPC) or to both national classification and IPC.

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**EOIB GOIB**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**EPO-Internal, PAJ, WPI Data, INSPEC, COMPENDEX, IBM-TDB**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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**Further documents are listed in the continuation of Box C**

**See patent family annex**

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**Date of the actual completion of the international search**: 1 August 2006

**Date of mailing of the international search report**: 11/08/2006

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Grand J-Y

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