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(54) **METHOD FOR DETERMINING QUANTITIES CHARACTERISTIC OF A MOVING OBJECT AND APPARATUS FOR IMPLEMENTING THE METHOD**

VERFAHREN ZUR BESTIMMUNG DER MENGENCHARAKTERISTIK EINES SICH BEWEGENDEN OBJEKTS UND VORRICHTUNG ZUR DURCHFÜHRUNG DES VERFAHRENS

PROCEDE PERMETTANT DE DETERMINER LES CARACTERISTIQUES DIMENSIONNELLES D'UN OBJET MOBILE ET APPAREIL EN PERMETTANT LA MISE EN OEUVRE

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(73) Proprietor: **Tecnogamma S.p.A.
31050 Badoere di Morgano (IT)**

(72) Inventor: **CASAGRANDE, Ettore
I-31050 Badoere di Morgano (IT)**

(74) Representative: **Piovesana, Paolo
Via F. Baracca, 5/a
30173 Venezia-Mestre (IT)**

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Description

[0001] The present invention relates to a method for determining quantities characteristic of a moving object, and an apparatus for implementing the method.

[0002] Both the method and the apparatus are of general use, even though a particular application relates to the railway sector. In this respect, in this sector the constant increase in traffic and in the transit speed of trains together with ever increasing safety and quality standards demand constant and precise monitoring of a multiplicity of risk factors.

[0003] Of these factors the most important relate to the overall dimensions of railway vehicles and, in the case of goods vehicles, of the goods transported thereby, their weight and the temperature of particular parts of them.

[0004] With regard to the overall dimensions of railway vehicles, especially in the case of goods vehicles, the loads can undergo displacement from their original position and project beyond outline limits, risking collision with structures to the side of the track (poles, signals, cantilever roofs, tunnel walls).

[0005] With regard to temperature, during the train movement certain mechanical parts, and in particular the brakes, the axle boxes or the pantograph trolleys, can abnormally overheat. Again, the load carried by goods carriages can in certain cases trigger fires. In the case of road to rail transport, trucks and trailers carried on railway vehicles together with their load constitute a further risk factor, especially when loaded with fuel and not subject to control during the journey.

[0006] With regard to the weight of railway vehicles, it is known that any excess weight, in addition to increasing rail wear, also increases the risk of deformation or breakage of the carriage axles or of the rail connections. In addition, load unbalance can result in serious safety problems. Consequently, continuous monitoring of the static and dynamic load on the rails would appear to be extremely useful, both to optimize maintenance work and to reduce costs.

[0007] With regard to the wheel sets of railway vehicles, it is known from U.S. 5,368,260 to monitor the angle-of-attack during the movement of the vehicle.

[0008] An aim of the invention is to propose a method for determining the characteristic quantities of a railway vehicle, and an apparatus for implementing the method, however it should be noted that the method and apparatus can be generally used to determine the characteristic quantities of any moving object.

[0009] This and other aims which will be apparent from the ensuing description are attained by a method for determining characteristic quantities of a moving object as described in claim 1.

[0010] To implement the method of the invention, an apparatus is provided as described in claim 20.

[0011] A preferred embodiment of the present invention is described in detail hereinafter by way of non-limiting example, with reference to the accompanying draw-

ings, in which:

- Figure 1 is a schematic front view of a portal equipped for determining the outline of a railway train,
- 5 Figure 2 illustrates schematically the operating principle of the apparatus for determining said outline,
- Figure 3 is a schematic front view of the portal of Figure 1 also equipped for determining the thermal profile of the train,
- 10 Figure 4 is a schematic cross-section showing the principle of determining the train static load,
- Figure 5 is a plan view of a track portion equipped for determining the dynamic load of the train,
- 15 Figure 6 is a schematic perspective view showing the train proximity and speed sensor,
- Figure 7 is a general schematic view of a portal incorporating the various units connected to the processing and control units, and
- 20 Figure 8 is a perspective view of variant of a device for measuring the static and dynamic load.

[0012] As can be seen from the figures, in its most complete form the apparatus for implementing the method of the invention comprises an integral portal composed of two uprights 2 positioned on the two sides of a railway track 4 at any point of the track, for example before entering a particularly critical tunnel, or upstream of any portion of track to be monitored.

[0013] On each upright there is installed a laser telemeter 6, positioned above the overall outline of the train 8, at least one traditional video camera 12 and a thermovisual video camera 10 for measuring the thermal profile of the train.

[0014] On the track portion 4 adjacent to the portal, in correspondence with each sleeper 14 a sensor 16 is positioned, which in cooperation with other similar sensors enables the static and dynamic load of the train 8 on the track 4 to be determined.

[0015] Finally, upstream of said portal, with reference to the travel direction of the train 8, photoelectric cell sensors 18 are provided for determining the passage and speed of the train 8.

[0016] The laser telemeter 6 installed on each upright 2 comprises a laser source 20 able to transmit an amplitude modulated laser signal 22 of predetermined frequency, onto a rotary mirror rotating at a predetermined speed, such as to deviate the signal 22, consisting of a laser beam, into a vertical plane perpendicular to the travel direction of the train 8, with an angular swing able to scan the train. In the present description the term "amplitude modulated laser signal" means a pulse modulated laser signal (pulsed laser signal) or modulated with a known waveform not of pulse type (modulated laser signal).

[0017] Next to the laser signal 20 a sensor 26 is provided consisting of a photomultiplier tube able to receive

the laser pulses reflected from the surface of the train 8, to reconstruct its outline. In front of said sensor 26 a special narrow band optical interference filter 28 is provided set for the laser wavelength, to immunize the system against any interference from external light and hence enable it to fully operate in any light condition.

[0018] The tube is controlled by an electronic unit 30 (using a time to digital converter) able to calculate the distance between each of the points on the train 8 struck by the pulsed laser beam 22 and the sensor 26.

[0019] The device for measuring the train thermal profile, installed on each upright 2, comprises a pair of thermovisual video cameras 10, positioned at each of the two ends of the upright 2 and disposed with their optical axis converging in order to completely frame the transiting train 8. They are sensitive to the infrared waves emitted by the various parts of the train 8 and are able to reconstruct its thermal map. Specifically, that thermovisual video camera 10 positioned at the lower end of the upright 2 is orientated upwards, to determine the temperature of the brakes and of the train moving parts, while that thermovisual video camera 10 positioned at the upper end of the upright 2 is orientated downwards, to determine the temperature of the loads, of the external surfaces and of the pantograph trolley.

[0020] The video cameras 10 are controlled by the local processing unit 30, which besides synchronizing their operation is able to collect data for local processing, in addition to memorizing the data and activating the connection to a remote computer 32. The thermovisual video cameras 10 are connected to the local processing unit 30 by optical fibres, which provide high immunity to noise.

[0021] The device for measuring the static and dynamic load of the train is a high precision system for monitoring the stresses exerted by the train 8 on the track 4. Its principle of operation is based on determining the elastic deformations induced on each rail 42 on passage of the train 8, and more precisely on determining the deformations involving the elastic layer 44 present between each rail 42 and the underlying sleeper 14.

[0022] This device consists essentially of a sound-configured sensor 16 mounted on a robust bracket and fixed to the sleeper 14 just below the foot of the rail 42. With this sensor there is associated a wire turn forming part of an LC circuit connected to an electronic control circuit 43.

[0023] As will be apparent hereinafter, passage of the train causes temporary compression of the elastic layer 44 and a consequent increase in the distance between the sensor 16 and the upper surface of the foot of the rail 42. Measuring the resonance frequency of the LC circuit enables that distance to be calculated and hence the extent of the elastic stress due to passage of the train 8.

[0024] For a more complete determination of the train characteristics, and more particularly of any faceting of the wheels 46 due to braking, sliding or load unbalance, several pairs of sensors 16 are provided, installed on each sleeper 14 in correspondence with both the rails 42

and for a number of sleepers corresponding to a length of track 4 at least equal to the circumference of the wheels 46 of the train 8.

[0025] Again in this case each sensor 16 is connected to the local processing unit 30 via fibre optic connections, which ensure a very high transmission speed for the relevant data.

[0026] As stated, the device of the invention also comprises a unit for determining passage of the train 8 and for calculating its speed. Its purpose is to activate the aforescribed devices only as the train 8 approaches, so that they operate only when necessary, to reduce their maintenance to a minimum.

[0027] For this purpose, at a predetermined distance from and upstream of the measurement portal there are installed the photoelectric cell devices 18 for sensing passage of the train 8 and its speed, this latter being calculated from their distance apart and the time measured between passage of the train in front of them.

[0028] Moreover according to the invention, in addition to this unit for determining train passage and calculating its speed, in that track portion between this unit and the constituent uprights 2 of the portal, other sensors (not shown) are provided which in addition to monitoring the train speed are also able to calculate its acceleration or deceleration.

[0029] Two traditional video cameras 12 sensitive to the visible spectrum are also installed on the two uprights between the sensing units and are synchronized with the other devices. The images acquired by these video cameras are used in particular situations to display to a remote operator the images of the train involved in the event to be indicated.

[0030] Finally the apparatus of the invention comprises a remote control unit to which measured data processed by the different local units are fed, in order to provide a complete picture of the characteristics of each train passing in front of the apparatus and to indicate any possible alarm situations due to differences between the measured parameters and the standard parameters beyond certain fixed thresholds.

[0031] The operation of the apparatus of the invention will now be described with reference to the individual constituent measuring devices.

Determination of the train outline

[0032] On passage of the train 8 a pulsed laser beam 22 is directed onto the rotating mirror 24 to scan the train. Each laser pulse deviated by the rotating mirror 24 onto the surface of the train 8 is reflected thereby and sensed by the photomultiplier 26 positioned within the apparatus to the side of the laser source 20.

[0033] With each pulse there corresponds the determination of a point on the outline to be determined, so that on completion of scanning a certain number of points have been obtained which by subsequent interpolation enable the continuous outline of the investigated train to

be defined. The measurement system is able to adapt to the train speed, because of the ability to vary the rotational speed of the mirror 24. This enables a finer threshold to be achieved for analyzing the outline in the case of goods trains (slower), which can more easily present projections beyond their outline. In such a case, which could for example create problems when the train 8 enters a tunnel, the system is able to feed a corresponding alarm signal and, if necessary, to cause the train to stop before it enters the track portion under control.

Thermal profile measurement

[0034] The thermovisual video cameras 10 are sensitive to the infrared radiation emitted by those parts of the train 8 framed by the video cameras.

[0035] The intensity of the infrared radiation emitted by a unit of surface is related to the temperature of that unit, hence by measuring this radiation at various points the thermal map of the moving train can be constructed.

[0036] As stated, the surface of the railway train is totally measured by using four video cameras 10, two for each side of the train 8, one of which is for the lower part (for analyzing overheating of brakes and moving parts) and the other for the upper part (for analyzing the loads, the outer surface and the pantograph trolley).

[0037] The first processing step take place directly on board the video camera assembly, by the processing card connected to it. A control card synchronizes the various video cameras 10 and collects the data. Final processing of the acquired images is done by the local data processing unit 30, which also provides for memorization and activates the connection to the remote supervising computer 32.

[0038] According to the invention the processing system is able to analyze the thermal map determined by the video cameras 10. This analysis comprises verifying in continuous cycle the temperature at each point and comparing it with predetermined threshold values, to be able to immediately activate an alarm procedure should these values be exceeded. This alarm procedure comprises an automatic warning to the railway network and a simultaneous transmission to the central supervisory system of all information required to exactly identify the event which has caused the alarm, and in particular:

- the type of alarm generated,
- the reference number of the carriage involved,
- the digital photograph of the overheated region with the thermal map overlying it,
- the temperature level reached,
- the size of the overheated region which has generated the alarm.

[0039] Hence monitoring the train surface temperature enables the following to be identified:

- fire danger in carriages, in goods trucks and in loco-

motives,

- overheating of moving parts (wheels, brakes, wheel axles),
- overheating of carriages,
- overheating of the pantograph trolley.

Static and dynamic load measurement

[0040] As stated, the loads and stresses on the track 4 are calculated by measuring the elastic deformations induced in the track on passage of the train 8.

[0041] The operating principle is based on the contactless inductive sensor 16 installed in proximity to the foot of the rail 42. On the sensor 16 there is disposed a wire turn which, when current flows therethrough, generates on the forward lying rail foot a magnetic field which itself generates induced currents (Eddy currents) therein, which induce a magnetic counter-field in the original wire turn, of intensity related to the distance between the wire turn and the rail foot. This distance can be determined by an algorithm, by measuring the resonance frequency of the LC circuit comprising the wire turn.

[0042] A pair of sensors 16 positioned on the same sleeper 14 in correspondence with the two rails 42 allows determination both of the weight supported by each train wheel axle and enables any load unbalance to be identified.

[0043] The use of several pairs of sensors 16 covering a portion of track 4 equal to at least the wheel circumference enables any wheel facets to be detected. Such facets determine a non-uniformity of weight measured by the successive pairs of sensors 16.

[0044] The data obtained by the sensors 16 are transmitted through the optical fibre connection to the local processing system 30, which verifies by continuous cycle the loads measured by the sensor, stores them in its internal memory, compares them with the predetermined threshold and analyzes them to determine the unbalance or the dynamic stresses.

[0045] In a different embodiment, shown in Figure 8, the device for measuring the static and dynamic load of the train consists of a rigid bar 17, which supports three sensors of the same type as that already described. The rigid bar 17 is fixed at its ends to two adjacent sleepers and is able to sense and measure, by comparison between the three response signals of the three sensors on train passage, the deformations of the rails 42 caused thereby.

[0046] As stated, on each upright 2 there is applied a traditional video camera 12; these are synchronized with the other devices, their function being to acquire the image of that train part involved in the laser measurement, in order to display any abnormalities to the operator, who is distant from the measurement point.

[0047] The acquisition system is integrated by reflectors operating only during acquisition and able to uniformly illuminate in a standard manner the image area taken.

[0048] For greater clarity a concrete embodiment of the apparatus of the invention will now be illustrated.

[0049] It is assumed that the maximum speed attainable by the railway train is 200 km/h.

[0050] For determining the train outline a pulsed laser beam at a frequency of 1 MHz was used for each sensor directed on the octagonal mirror 24, which was rotated at a speed of 3750 r.p.m., to hence obtain scanning by the beam over an angle of about 80° at a frequency of 30,000 scans per second. The profile measurement accuracy obtained was ± 1 cm with a horizontal resolution of 5 cm and a vertical resolution at 200 km/h (passenger train) of 10 cm and a vertical resolution at 80 km/h (goods train) of 3 cm.

[0051] To determine the thermal profile of the train four video cameras were used able to acquire thermal images with a frequency of 20 Hz, i.e. 20 photographic images/second, with a resolution of 1 cm/pixel. The video cameras used by the measurement system were constructed using matrices of sensors based on Ga-As (gallium arsenide) technology which enable very high sensitivity, low noise and excellent thermal resolution to be obtained. This type of sensor is particularly rapid and hence has a very wide acquisition band (up to 20 GHz in the 8-12 μ frequency spectrum. The standard matrix format of the pixels constituting the image plane of the sensor is 600x400. A measurement precision of $\pm 2^\circ\text{C}$ was obtained.

[0052] The opening time for the shutter of the container housing each video camera is about 2 seconds.

[0053] To determine the train static and dynamic load, sensors were used having a measuring field of about 10 mm, with a maximum sensitivity to variations of about a few tens of microns. The minimum time required to obtain a measurement is about 10 ms, hence an acquisition frequency of about 100 Hertz can be obtained. A measurement precision of ± 20 kg was obtained.

Claims

1. A method for determining quantities characteristic of a moving object, in particular the outline of a railway train, **characterised by**:

- scanning with at least one laser telemeter, the laser signal of which is amplitude modulated, by rotating it about an axis parallel to the direction of movement of said object,
- measuring the distances between said telemeter and the corresponding point struck by the laser beam, after establishing a relationship between the scanning angle assumed by the laser beam at the moment of measurement and the value of the corresponding distance measured,
- then processing the determined data, to hence determine points on the outline of said object.

2. A method as claimed in claim 1, **characterised by** scanning with a pulsed laser signal.

3. A method as claimed in claim 1, **characterised in that** after determining by said measurements the corresponding points of the object struck by the laser beam, the remaining points are determined by interpolation, to obtain the complete outline of the object.

4. A method as claimed in claim 1, **characterised by** regulating the speed of rotation of the beam of said laser telemeter on the basis of the speed of movement of said object.

5. A method as claimed in claim 1, **characterised by** using two laser telemeters positioned on both sides of the moving object.

6. A method as claimed in claim 1, **characterised by** using for each telemeter a fixed laser source orientated towards a rotating mirror.

7. A method as claimed in claim 1, **characterised by** using a pulsed laser beam at a frequency of about 1 MHz.

8. A method as claimed in claim 1, **characterised by** interposing within the path of the pulsed laser beam a narrow band interferential optical filter, set on the laser wavelength.

9. A method as claimed in claim 1 to be used for determining the outline of a railway train, **characterised in that**, in addition to determining the outline of said train, the load of this later is measured by determining the elastic deformations induced thereby on the track on passage of said train.

10. A method as claimed in claim 9, **characterised by** determining said elastic deformations by measuring the variation in the distance between a sensor fixed to the track sleeper and the rail, which rests on an elastic layer resting on said sleeper.

11. A method as claimed in claim 9, **characterised by** determining said elastic deformations by measuring the variations in the distance between at least three sensors mounted on a rigid bar fixed at its ends to two sleepers and maintained slightly spaced above the rail.

12. A method as claimed in claim 10 or 11, **characterised by** determining the distance variation between the rail and sensor by generating with an LC circuit, provided within the sensor, a magnetic field on a rail and then measuring the variation in the resonance frequency of said LC circuit on passage of the train.

13. A method as claimed in claim 9, **characterised by** effecting the load measurement on both the rails in correspondence with the same transverse plane, to determine any load unbalance by comparing the two measurements. 5
14. A method as claimed in claim 9, **characterised by** effecting load measurements on a track portion of length at least equal to the circumference of the train wheels, and comparing the measured values to determine any wheel faceting. 10
15. A method as claimed in claim 1 to be used for determining the outline of a railway train, **characterised in that**, in addition to determining the outline of said train, the thermal profile of different parts of this later is determined by using at least one fixed thermovisual video camera sensitive to the infrared radiation emitted by said different parts of said train. 15
16. A method as claimed in claim 15, **characterised by** using on each side of the train a lower video camera orientated to measure the temperature of the brakes and of the moving parts and an upper video camera orientated to measure the temperature of the loads, of the external surfaces and of the pantograph trolley of the train. 20 25
17. A method as claimed in claim 13, **characterised by** comparing the temperature data obtained by the video cameras with the normal temperature levels of the various parts of the railway train, then activating an alarm signal in the case of difference between the measured values and the normal values. 30 35
18. A method as claimed in claim 1, **characterised by** determining with at least one video camera the image of that train part involved in the laser measurements. 40
19. A method as claimed in claim 18, **characterised by** illuminating, during acquisition, that train part taken by said video camera. 45
20. An apparatus for implementing the method claimed in one or more of claims from 1 to 19, comprising:
- a fixed structure (2) positioned in proximity to the path of the object of which the characteristic quantities are to be determined, 50
 - at least one laser telemeter (6) mounted on said fixed structure (2) and able to emit an amplitude modulated laser signal on passage of said object,
 - means (24) for rotating said laser telemeter such that the beam emitted thereby moves in a plane substantially perpendicular to the direction of movement of said object, 55
 - means (28) for measuring the distance between said telemeter and the point struck by said rotating laser beam,
 - means for correlating the scanning angle assumed by the laser beam at the time of measurement with the distance value determined by said measurement means,
 - means (30) for processing the determined measurement data and for constructing the outline of said object by points.
21. An apparatus as claimed in claim 20, **characterised in that** the laser telemeter comprises a laser source (20) able to transmit the laser signal onto a rotating mirror (24) rotated at a predetermined speed.
22. An apparatus as claimed in claim 21, **characterised in that** associated with the laser source there is provided a sensor (26) able to receive laser pulses reflected from the object in order to reconstruct the outline of said object.
23. An apparatus as claimed in claim 20, **characterised in that** the fixed structure consists of a portal the uprights (2) of which are positioned on both sides of a railway track (4).
24. An apparatus as claimed in claim 23, **characterised in that** on at least one upright there is mounted a device (10) for measuring the thermal profile of the train transiting on the railway track.
25. An apparatus as claimed in claim 24, **characterised in that** the measurement device comprises a pair of thermovisual video cameras disposed with their optical axis converging in order to completely frame the transiting train.
26. An apparatus as claimed in claims 20 and 25, **characterised in that** the video cameras are controlled by the processor means.
27. An apparatus as claimed in claim 20, **characterised by** comprising a device (16) for measuring the static and dynamic load of the train.
28. An apparatus as claimed in claim 27, **characterised in that** said device consists of a sensor able to measure the deformations of the elastic layer (44) between the rail (42) and the underlying sleeper (14).
29. An apparatus as claimed in claim 20, **characterised by** comprising a unit for sensing the passage of the train and for calculating its speed.
30. An apparatus as claimed in claim 23, **characterised in that** traditional video cameras (12) sensitive to the visible spectrum are installed among the meas-

urement units on the uprights and are synchronized with the other devices.

31. An apparatus as claimed in claim 27, **characterised in that** the device for measuring the static and dynamic load is a rigid bar (17) supporting at least three sensors.

Patentansprüche

1. Verfahren zum Bestimmen der Mengencharakteristik eines beweglichen Objektes, insbesondere des Umrisses eines Eisenbahnzuges, **gekennzeichnet durch:**

- Abtasten mit mindestens einem Lasertelemeter, dessen Lasersignal amplitudenmoduliert ist, **durch** Rotieren um eine Achse parallel zu der Bewegungsrichtung des Objektes,
- Messen des Abstandes zwischen dem Telemeter und dem entsprechenden Punkt, der vom Laserstrahl getroffen wird, nach dem Etablieren eines Verhältnisses zwischen dem vom Laserstrahl im Moment der Messung angenommenen Abtastwinkel und dem Wert des entsprechenden gemessenen Abstands,
- anschließendes Verarbeiten der bestimmten Daten, um somit die Punkte des Umrisses des Objekts zu bestimmen.

2. Verfahren nach Anspruch 1, **gekennzeichnet durch** Abtasten mit einem gepulsten Lasersignal.

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** nach dem Bestimmen der entsprechenden Punkte des vom dem Laserstrahl getroffenen Objekts durch die Messungen die übrigen Punkte durch Interpolation bestimmt werden, um den vollständigen Umriss des Objekts zu erhalten.

4. Verfahren nach Anspruch 1, **gekennzeichnet durch** das Regulieren der Rotationsgeschwindigkeit des Lasertelemeterstrahls auf der Basis der Geschwindigkeit der Bewegung des Objekts.

5. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Verwendung von zwei Lasertelemetern, die auf beiden Seiten des beweglichen Objekts positioniert sind.

6. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Verwendung einer festen Laserquelle für jeden Telemeter, welche in Richtung eines rotierenden Spiegels ausgerichtet ist.

7. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Verwendung eines gepulsten Lasers

gnals bei einer Frequenz von ungefähr 1MHz.

8. Verfahren nach Anspruch 1, **gekennzeichnet durch** Zwischenschalten eines optischen Schmalbandinterferenzfilters, der auf die Laserwellenlänge eingestellt ist, innerhalb des Weges des gepulsten Laserstrahls.

9. Verfahren nach Anspruch 1 zum Bestimmen des Umrisses eines Eisenbahnzuges, **dadurch gekennzeichnet, dass** zusätzlich zum Bestimmen des Umrisses dieses Zuges seine Belastung später durch die Bestimmung elastischer Verformungen gemessen wird, welche bei der Durchfahrt des Zuges auf den Gleisen induziert werden.

10. Verfahren nach Anspruch 9, **gekennzeichnet durch** Bestimmen der elastischen Verformungen **durch** Messen der Abweichungen in dem Abstand zwischen einem Sensor, der an der Gleisschwelle fixiert ist, und der Schiene, die auf einer elastischen auf der Schwelle liegenden Schicht liegt.

11. Verfahren nach Anspruch 9, **gekennzeichnet durch** Bestimmen der elastischen Verformungen **durch** Messen der Abweichungen in dem Abstand zwischen mindestens drei Sensoren, die an einer festen Stange montiert sind, welche an ihren Enden an zwei Schwellen fixiert ist und leicht über der Schiene gehalten wird.

12. Verfahren nach Anspruch 10 oder 11, **gekennzeichnet durch** Bestimmen der Abstandsabweichung zwischen der Schiene und dem Sensor **durch** Erzeugen eines Magnetfeldes auf einer Schiene mit einer LC-Schaltung, die in dem Sensor bereitgestellt ist, und anschließendem Messen der Abweichung in der Resonanzfrequenz der LC-Schaltung bei Durchfahrt des Zuges.

13. Verfahren nach Anspruch 9, **gekennzeichnet durch** Ausführen der Belastungsmessung auf den beiden Schienen in Übereinstimmung mit derselben schrägen Fläche, um **durch** das Vergleichen der zwei Messungen ein Belastungsungleichgewicht zu bestimmen.

14. Verfahren nach Anspruch 9, **gekennzeichnet durch** Ausführen der Belastungsmessungen auf einem Gleisabschnitt der Länge von mindestens der Umfangsfläche der Zugräder, und Vergleichen der Messwerte, um eine Radfläche zu bestimmen.

15. Verfahren nach Anspruch 1 zum Bestimmen des Umrisses eines Eisenbahnzuges, **dadurch gekennzeichnet, dass** zusätzlich zum Bestimmen des Umrisses dieses Zuges das Wärmeprofil seiner verschiedenen Teile später unter Verwendung von

mindestens einer befestigten Wärmebildkamera bestimmt wird, welche empfindlich auf die von den unterschiedlichen Teilen des Zuges ausgegebene Infrarotstrahlung reagiert.

16. Verfahren nach Anspruch 15, **gekennzeichnet durch** die Verwendung einer unteren Videokamera auf jeder Seite des Zuges, die ausgerichtet ist, um die Temperatur der Bremsen und der beweglichen Teile zu messen, und einer oberen Videokamera, die ausgerichtet ist, um die Temperatur der Belastungen, der Außenflächen und des Stromabnehmerwagens des Zuges zu messen.

17. Verfahren nach Anspruch 13, **gekennzeichnet durch** Vergleichen der von den Videokameras erhaltenen Temperaturdaten mit dem normalen Temperaturniveau der verschiedenen Teile des Eisenbahnzuges, und anschließendem Aktivieren eines Alarmsignals im Falle eines Unterschieds zwischen den Mess- und den Normalwerten.

18. Verfahren nach Anspruch 1, **gekennzeichnet durch** Bestimmen des Bildes des Zugteils, der in die späteren Messungen eingebunden ist, mit mindestens einer Videokamera.

19. Verfahren nach Anspruch 18, **gekennzeichnet durch** Illuminieren des von der Videokamera aufgenommenen Zugteiles während der Erfassung.

20. Vorrichtung zum Implementieren des Verfahrens nach einem oder mehreren Ansprüchen von 1 bis 19, umfassend:

- eine feste Struktur (2), die in der Nähe des Weges des Objektes positioniert ist, dessen Mengencharakteristiken zu bestimmen sind,
- mindestens ein Lasertelemeter (6), das an der festen Struktur (2) befestigt ist und bei Durchfahrt des Objektes ein amplitudenmoduliertes Lasersignal aussenden kann,
- Mittel (24) zum Rotieren des Lasertelemeters, so dass sich der ausgesendete Strahl dabei in die Ebene bewegt, die sich im Wesentlichen senkrecht zur Bewegungsrichtung des Objektes befindet,
- Mittel (28) zum Messen des Abstandes zwischen dem Telemeter und dem Punkt, der von dem rotierenden Laserstrahl getroffen wird,
- Mittel zum Korrelieren des vom Laserstrahl zum Zeitpunkt der Messung angenommenen Abtastwinkels mit dem von dem Messmittel bestimmten Abstandswert,
- Mittel (30) zum Verarbeiten der bestimmten Messdaten und zum Bilden des Umrisses des Objektes durch Punkte.

21. Vorrichtung nach Anspruch 20, **dadurch gekennzeichnet, dass** das Lasertelemeter eine Laserquelle (20) umfasst, die das Lasersignal auf einen rotierenden Spiegel (24) übertragen kann, der mit einer vorbestimmten Geschwindigkeit rotiert wird.

22. Vorrichtung nach Anspruch 21, **dadurch gekennzeichnet, dass** verbunden mit der Laserquelle ein Sensor (26) bereitgestellt ist, der von dem Objekt reflektierte Laserimpulse empfangen kann, um den Umriss des Objektes zu rekonstruieren.

23. Vorrichtung nach Anspruch 20, **dadurch gekennzeichnet, dass** die feste Struktur aus einem Portal besteht, dessen Ständer (2) auf beiden Seiten einer Gleisanlage (4) positioniert sind.

24. Vorrichtung nach Anspruch 23, **dadurch gekennzeichnet, dass** an mindestens einem Ständer ein Gerät (10) angebracht ist, um das Wärmeprofil des auf der Gleisanlage fahrenden Zuges zu messen.

25. Vorrichtung nach Anspruch 24, **dadurch gekennzeichnet, dass** das Messgerät ein Paar Wärmebildkameras umfasst, die so angeordnet sind, dass ihre optischen Achsen konvergieren, um den durchfahrenden Zug vollständig zu umrahmen.

26. Vorrichtung nach Anspruch 20 und 25, **dadurch gekennzeichnet, dass** die Videokameras von dem Prozessormittel gesteuert werden.

27. Vorrichtung nach Anspruch 20, **dadurch gekennzeichnet, dass** sie ein Gerät (16) zum Messen der statischen und dynamischen Belastung des Zuges umfasst.

28. Vorrichtung nach Anspruch 27, **dadurch gekennzeichnet, dass** das Gerät aus einem Sensor besteht, der die Verformungen der elastischen Schicht (44) zwischen der Schiene (42) und der darunter befindlichen Schwelle (14) messen kann.

29. Vorrichtung nach Anspruch 20, **dadurch gekennzeichnet, dass** sie eine Einheit zum Abtasten der Durchfahrt des Zuges und zur Berechnung seiner Geschwindigkeit umfasst.

30. Vorrichtung nach Anspruch 23, **dadurch gekennzeichnet, dass** die herkömmlichen Videokameras (12), die empfindlich auf das sichtbare Spektrum reagieren, zwischen den Messeinheiten auf den Ständern installiert und mit den anderen Geräten synchronisiert sind.

31. Vorrichtung nach Anspruch 27, **dadurch gekennzeichnet, dass** das Gerät zum Messen der statischen und dynamischen Belastung eine feste Stan-

ge (17) ist, die mindestens drei Sensoren unterstützt.

Revendications

1. Procédé pour déterminer les caractéristiques dimensionnelles d'un objet mobile, en particulier le contour d'un train de voie ferrée, **caractérisé par**:

- un balayage avec au moins un télémètre à laser, dont le signal de laser est modulé en amplitude, en tournant ce dernier autour d'un axe parallèle à la direction du déplacement dudit objet,
- une mesure des distances entre ledit télémètre et le point d'impact correspondant du rayon laser, après avoir établi une relation entre l'angle de balayage assuré par le rayon laser au moment de la mesure et la valeur de la distance correspondante mesurée,
- puis un traitement des données déterminées, pour déterminer ainsi des points sur le contour dudit objet.

2. Procédé comme revendiqué dans la revendication 1, **caractérisé par** un balayage avec un signal de laser à impulsion.

3. Procédé comme revendiqué dans la revendication 1, **caractérisé en ce qu'**après avoir déterminé par lesdites mesures les points d'impact correspondants sur l'objet par le rayon laser, les points restants sont déterminés par interpolation, afin d'obtenir le contour complet de l'objet.

4. Procédé comme revendiqué dans la revendication 1, **caractérisé par** un réglage de la vitesse de rotation du rayon dudit télémètre à laser en se basant sur la vitesse de déplacement dudit objet.

5. Procédé comme revendiqué dans la revendication 1, **caractérisé par** une utilisation de deux télémètres à laser positionnés sur les deux côtés de l'objet mobile.

6. Procédé comme revendiqué dans la revendication 1, **caractérisé par** une utilisation pour chaque télémètre d'une source de laser fixe orientée vers un miroir rotatif.

7. Procédé comme revendiqué dans la revendication 1, **caractérisé par** une utilisation d'un rayon laser à impulsion à une fréquence d'environ 1 MHz.

8. Procédé comme revendiqué dans la revendication 1, **caractérisé par** une interposition à travers le chemin du rayon laser à impulsion d'un filtre optique à bande étroite d'interférence, réglé sur la longueur

d'onde du laser.

9. Procédé comme revendiqué dans la revendication 1 pour être utilisé pour déterminer le contour d'un train de voie ferrée, **caractérisé en ce que**, en plus de la détermination du contour dudit train de voie ferrée, la charge de ce dernier est mesurée en déterminant les déformations élastiques provoquées par celle-ci sur la voie au passage dudit train.

10. Procédé comme revendiqué dans la revendication 9, **caractérisé par** une détermination desdites déformations élastiques en mesurant la variation de la distance entre un détecteur fixé à la traverse de voie et le rail, qui repose sur une couche élastique reposant sur ladite traverse.

11. Procédé comme revendiqué dans la revendication 9, **caractérisé par** une détermination desdites déformations élastiques en mesurant les variations de la distance entre au moins trois détecteurs montés sur une barre rigide fixée à ses extrémités à deux traverses et maintenue légèrement espacée au-dessus du rail.

12. Procédé comme revendiqué dans la revendication 10 ou 11, **caractérisé par** une détermination de la variation de distance entre le rail et le détecteur en générant avec un circuit LC, disposé à l'intérieur du détecteur, un champ magnétique sur le rail et en mesurant ensuite la variation de la fréquence de résonance dudit circuit LC au passage du train.

13. Procédé comme revendiqué dans la revendication 9, **caractérisé par** une exécution de la mesure de la charge sur les deux rails en correspondance avec le même plan transversal, afin de déterminer toute charge mal équilibrée en comparant les deux mesures.

14. Procédé comme revendiqué dans la revendication 9, **caractérisé par** une exécution de la mesure de la charge sur une portion de voie de longueur au moins égale à la circonférence des roues de trains, et une comparaison des valeurs mesurées pour déterminer toute déformation de roue.

15. Procédé comme revendiqué dans la revendication 1 pour être utilisé pour déterminer le contour d'un train de voie ferrée, **caractérisé en ce que**, en plus de la détermination du contour dudit train de voie ferrée, le profil thermique de différentes parties de ce dernier est déterminé en utilisant au moins une caméra vidéo fixe à vision thermique sensible aux radiations infrarouges émises par lesdites différentes parties dudit train.

16. Procédé comme revendiqué dans la revendication

- 15, **caractérisé par** une utilisation de chaque côté du train d'une caméra vidéo inférieure orientée pour mesurer la température des freins et des parties mobiles et d'une caméra vidéo supérieure pour mesurer la température des charges, des surfaces externes et du trolley du pantographe du train.
17. Procédé comme revendiqué dans la revendication 13, **caractérisé par** une comparaison des données de température obtenues par les caméras vidéo avec les niveaux de température normale des différentes parties du train de voie ferrée, suivie d'une activation d'un signal d'alarme dans le cas d'une différence entre les valeurs mesurées et les valeurs normales.
18. Procédé comme revendiqué dans la revendication 1, **caractérisé par** une détermination avec au moins une caméra vidéo d'une image de cette partie de train concernée par les mesures de laser.
19. Procédé comme revendiqué dans la revendication 18, **caractérisé par** un éclairage, pendant l'acquisition, de cette partie de train prise par ladite caméra vidéo.
20. Appareil pour appliquer le procédé revendiqué dans l'une ou plusieurs des revendications 1 à 19, comprenant :
- une structure fixe (2) positionnée à proximité du chemin de l'objet dont les caractéristiques dimensionnelles sont à déterminer,
 - au moins un télémètre à laser (6) monté sur ladite structure fixe (2) et apte à émettre un signal de laser modulé en amplitude au passage dudit objet,
 - un moyen (24) pour tourner ledit télémètre à laser de sorte que le rayon émis par celui-ci se déplace dans un plan sensiblement perpendiculaire à la direction de déplacement dudit objet,
 - un moyen (28) pour mesurer la distance entre ledit télémètre et le point d'impact dudit rayon laser en rotation,
 - un moyen pour corrélérer l'angle de balayage assuré par le rayon laser au moment de la mesure avec la valeur de distance déterminée par ledit moyen de mesure,
 - un moyen (30) pour traiter les données déterminées de mesure et pour construire le contour dudit objet par des points.
21. Appareil comme revendiqué dans la revendication 20, **caractérisé en ce que** le télémètre à laser comprend une source de laser (20) apte à transmettre le signal de laser vers un miroir rotatif (24) à une vitesse prédéterminée.
22. Appareil comme revendiqué dans la revendication 21, **caractérisé en ce qu'en** association avec la source de laser est prévu un détecteur (26) apte à recevoir des impulsions de laser réfléchies depuis l'objet afin de reconstruire le contour dudit objet.
23. Appareil comme revendiqué dans la revendication 20, **caractérisé en ce que** la structure fixe consiste en un portail dont les montants (2) sont positionnés sur les deux côtés d'une voie ferrée (4).
24. Appareil comme revendiqué dans la revendication 23, **caractérisé en ce que** sur au moins un montant est monté un dispositif (10) pour mesurer le profil thermique du train transitant sur la voie ferrée.
25. Appareil comme revendiqué dans la revendication 24, **caractérisé en ce que** le dispositif de mesure comprend une paire de caméras vidéo à vision thermique disposées avec leur axe optique convergeant afin de cadrer complètement le train en transit.
26. Appareil comme revendiqué dans les revendications 20 et 25, **caractérisé en ce que** les caméras vidéo sont commandées par le moyen de traitement.
27. Appareil comme revendiqué dans la revendication 20, **caractérisé en ce qu'il** comprend un dispositif (16) pour mesurer la charge statique et dynamique du train.
28. Appareil comme revendiqué dans la revendication 27, **caractérisé en ce que** ledit dispositif consiste en un détecteur apte à mesurer les déformations de la couche élastique (44) entre le rail (42) et la traverse sous-jacente (14).
29. Appareil comme revendiqué dans la revendication 20, **caractérisé en ce qu'il** comprend une unité pour détecter le passage du train et pour calculer sa vitesse.
30. Appareil comme revendiqué dans la revendication 23, **caractérisé en ce que** des caméras vidéo traditionnelles (12) sensibles au spectre visible sont installées parmi les unités de mesure sur les montants et sont synchronisées avec les autres dispositifs.
31. Appareil comme revendiqué dans la revendication 27, **caractérisé en ce que** le dispositif pour mesurer la charge statique et dynamique est une barre rigide (17) supportant au moins trois détecteurs.

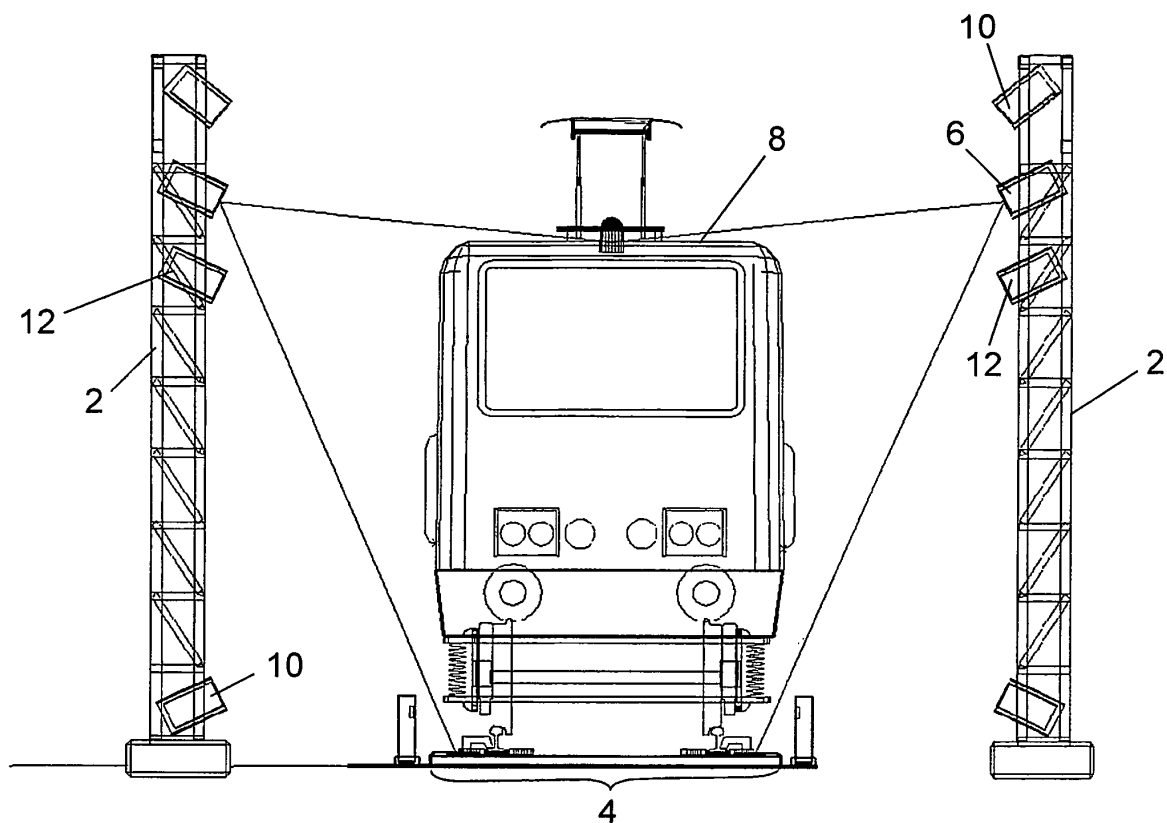


FIG. 1

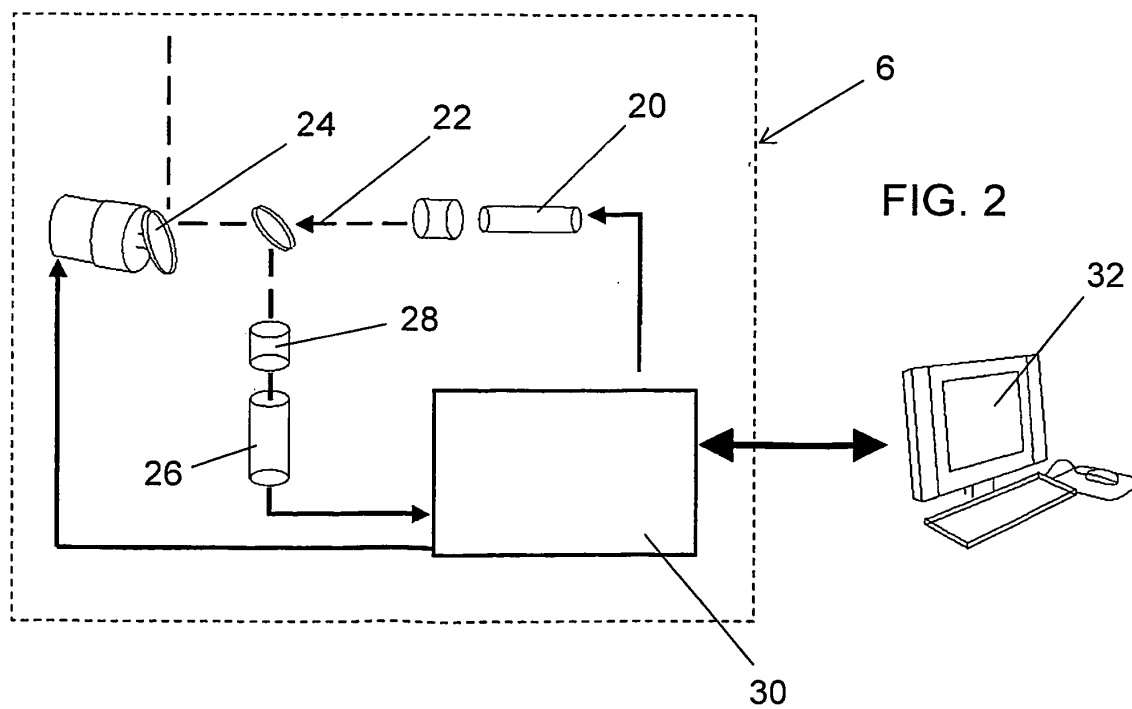


FIG. 2

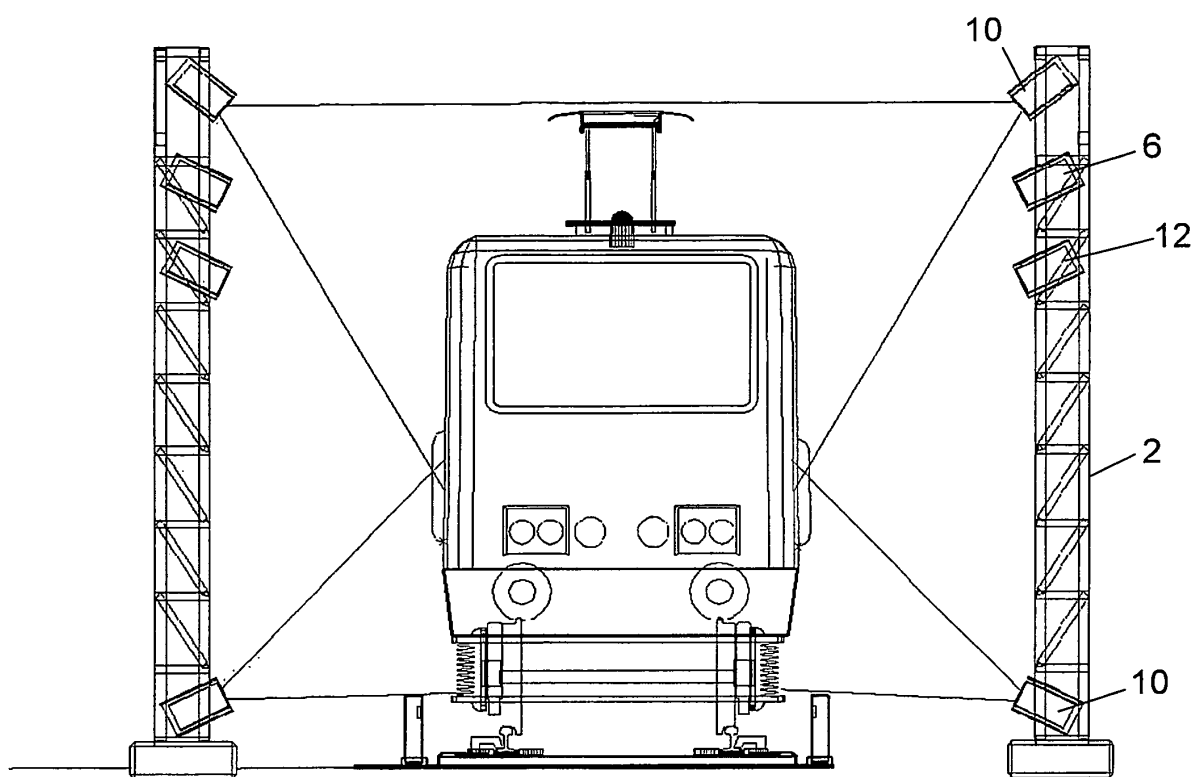


FIG. 3

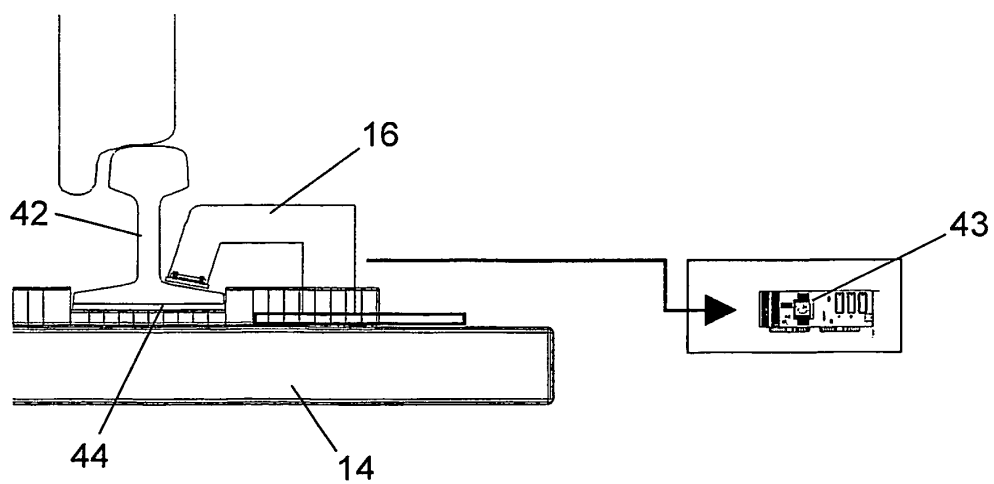


FIG. 4

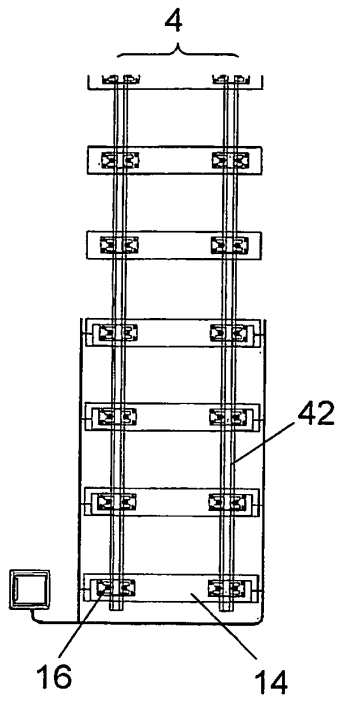


FIG. 5

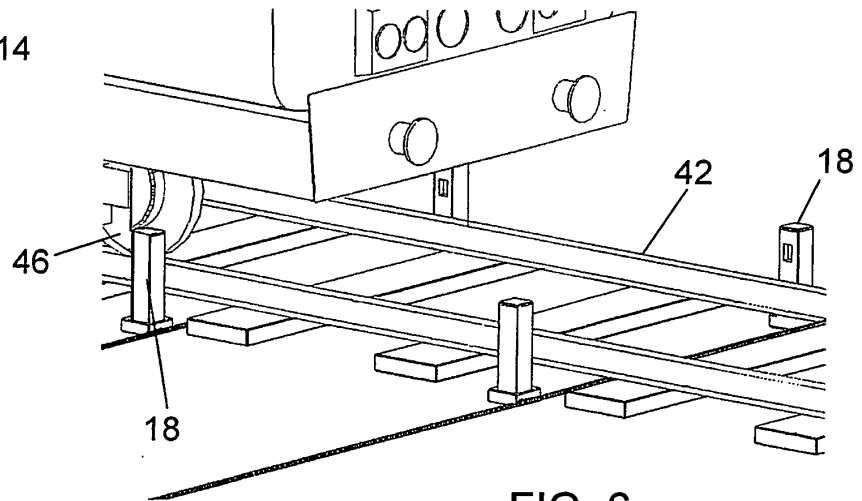


FIG. 6

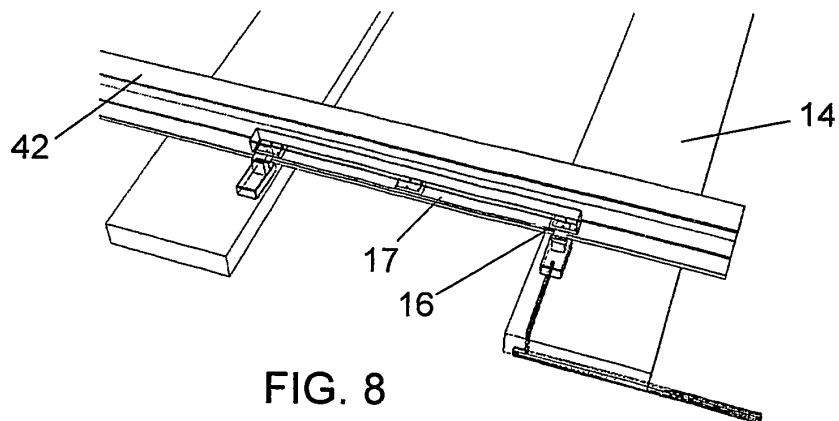


FIG. 8

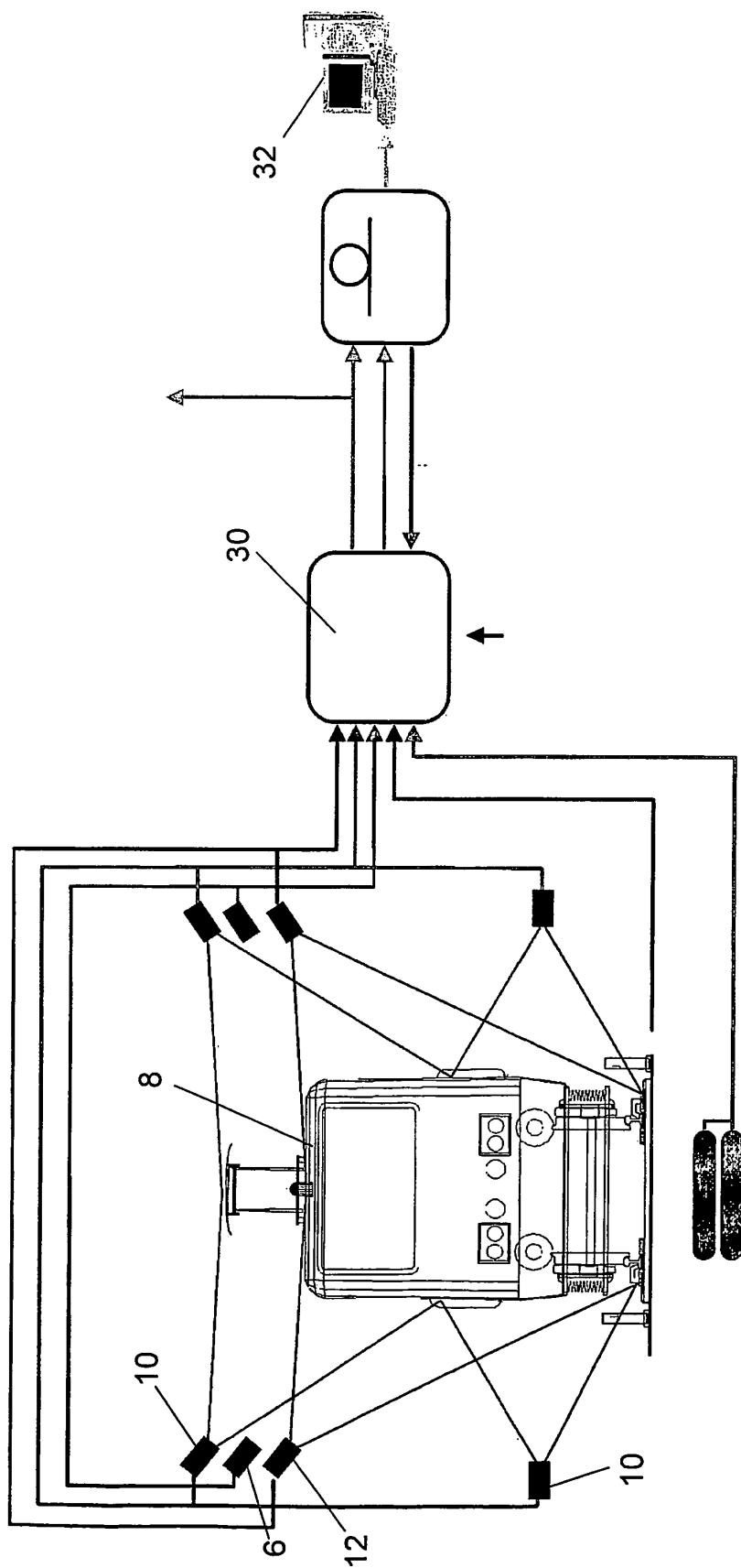


FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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