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(54) **System and method for localizing objects on a railway track**

Vorrichtung und Verfahren zur Ortung von Objekten auf einem Eisenbahngleis

Système et méthode pour déterminer la position d'objets sur une voie ferrée

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Description

[0001] The present invention relates to a system for localizing objects on a railway track and to a method therefor.

[0002] There are at the moment three main categories of detection system in use for detecting trains on a railway track. The electrical track circuit system dates from 1872 and is based on electrical short-circuiting of rails. This short-circuiting occurs when a train enters a determined governed section (also referred to as governed (rail) block) and via its wheels and axle situated therebetween closes a circuit between the different rails. The electrical track circuit system then assumes that a train is situated within a determined block and designates the relevant block as occupied.

[0003] A second detection system, which was first applied in 1960, is the axle counter system, which detects the number of wheels/axles at a starting point and an end point of a predetermined block. If the number of axles at the start of the block is higher than the number of axles counted at the end of the block, it is assumed that the block is occupied.

[0004] The drawback of both the electrical track circuit system and the axle counter system is that, although it is known that a determined block is occupied, no accurate position determination is possible within this block, which can be up to 5 kilometres long.

[0005] In order to also be able to determine the position of the train the European Rail Traffic Management System (ERTMS) has been developed, which makes use of GPS, balises and GSM-R for determining the position of the train. Since ERTMS is not able to determine the length of the train and, when a carriage is lost, does not therefore give a report to this effect, an axle counter system or electrical track circuit system is still always applied in addition to the ERMTS.

[0006] All the above stated systems, the electrical track circuit system, the axle counter system and ERMTS, are so-called block systems. The rail routes are subdivided into blocks of different lengths, sometimes up to 5 kilometres long. A block in which a train is located is designated as occupied and for safety reasons the block from which the train has come is not fully cleared. At a block length of five kilometres this may mean that a length of ten kilometres is kept clear of other train traffic, this standing in the way of a high degree of occupancy of the track necessary for instance for timetable-free travel. Timetable-free travel is understood to mean that trains travel according to logistical availability and are not tied to predetermined specific times.

[0007] A possible solution of using smaller blocks of for instance 2.5 kilometres doubles the costs of the system. The typical costs per block are substantially independent of the length thereof and lie in the order of magnitude of €400,000.00.

[0008] Block systems have the further drawback that in the case of a suspected error message, for instance due to vandalism, the whole block has to be checked for the presence of an object before this block can be fully cleared. At a block length of for instance 50 kilometres the engineer who clears the block manually no longer has an overall view hereof, which means that the train will travel through the block at reduced speed in order to be able to stop in good time in the case an object is present. The limited speed permitted for safety reasons can result in disruption of the rail system. In addition, resetting takes place manually in the axle counter system, and this is time-consuming.

[0009] A further drawback of the above stated electrical track circuit system and axle counter system is that they are susceptible to vandalism. In the electrical track circuit system it is for instance possible to complete a circuit between connected blocks by arranging coins in a gap between different blocks, which causes confusion in the system. In addition, a circuit can be completed for instance by electrically connecting the two rails with a jump lead, which causes the electrical track circuit system to suspect that a train is located within this block. The axle counter system can be disordered by for instance moving a metal object such as a spade in front of the sensor, this being detected by the system as a passing train wheel.

[0010] Another form of vandalism is the theft of copper in the electrical track circuit system. The thick copper wires used are popular with thieves. When a copper wire is stolen, the track is designated as occupied. Repair is costly in terms of time and money. In 2009 the costs associated with copper theft in the Netherlands amounted to more than ten million Euros.

[0011] A further drawback of the axle counter system is that a minimum wheel size is required before a reliable registration of each wheel takes place. The axle counter system is hereby unsuitable for detecting all types of rail machinery placed on the track for the purpose of work on the track.

[0012] Further drawbacks of the electrical track circuit system lie in the fact that in the autumn a covering of leaves present on a rail track can function as electrical insulator, whereby no circuit is realized, and may result in the highly undesirable situation that for instance barriers at level crossings no longer close when a train approaches. This problem is also known under the term loss of shunt.

[0013] Rust formation on the rails can also result in the electrical track circuit system in trains not being detected by the system. Attempts are made to prevent this by the so-called 'derusting' runs before regular train traffic begins.

[0014] In addition, use is increasingly being made nowadays of rail vehicles with wheels provided with ball bearings. Because the wheels on both sides of the rail vehicle are no longer directly connected to each other with an efficient electrically conducting axle, such wheels provided with ball bearings are less suitable for the electrical track circuit system.

[0015] Another significant problem for both the electri-

cal track circuit system and the axle counter system is the sensitivity to electromagnetic radiation, also referred to as electromagnetic compatibility (EMC). While 800-1500 V is applied in conventional trains, this has been increased to 25 kV in the High-Speed Line (HSL). The associated increase in electromagnetic radiation is expected to result in an increase in EMC problems.

[0016] All the above stated train detection systems further have the shortcoming that they are only able to detect trains or similar vehicles on a block, and not for instance a car blocking a level crossing.

[0017] DE-U1-297 24 276 discloses a monitoring system for preventive safeguarding of a route where work is taking place on the track, wherein a single sensor is equipped with two separate channels for measuring separate parameters. The first channel is directed transversely of the railway track and detects, via a radar signal which measures the distance, whether an object is situated on the railway track. Because it is required for the purpose of giving an alarm that the second channel, which is directed obliquely at an angle of 30° to the railway track, simultaneously measures a speed via Doppler, the number of error messages - for instance because there is an animal on the track - is reduced.

[0018] US-A1-2005/0184883 discloses a railroad crossing warning system according to the preamble of claim 1. Motion sensors are used to detect the approach of a train coming from either direction towards a highway crossing. At the crossing, presence detectors are located to sense moving a stationary train.

[0019] DE-U1-29724276 discloses a system for detecting trains for warning persons working on the track. The approach of a train in the direction towards the persons working on the track is detected when the train is both registered by a Doppler radar, i.e. a motion sensor, and a second sensor which is a distance radar, i.e. a distance sensor.

[0020] An object of the present invention is to provide a system and method for localizing objects on a railway track in which the stated drawbacks do not occur, or at least do so to lesser extent.

[0021] The stated object is achieved with the system for localizing objects on a railway track, comprising:

- at least two sensors which are arranged in the vicinity of the railway track and each cover a separate detection area of the railway track;
- a control unit which is connected to each of the sensors and receives an identifiable warning signal from the individual sensors when they detect an object in their detection area of the railway track;
- wherein the successive sensors measure and transmit the same quantity to the control unit as warning signal;
- wherein the control unit generates an alarm if the measurement data detected by the successive sensors comply with a predetermined condition;
- wherein the sensors are distance sensors and, in the case a distance reduction is detected by at least two successive sensors, the control unit assumes that there is an object on the railway track; and
- wherein the sensors are arranged on cables above the railway track and their detection area extends downward in the direction of the railway track.

[0022] Because at least two sensors cover a separate detection area of the railway track and transmit an identifiable warning signal to the control unit when they detect an object in their detection area of the railway track, the system knows where an object is situated. It is particularly noted that all kinds of object of any size can be detected with the system and, unlike the above discussed systems (electrical track circuit system, axle counter system and ERTMS), it is not limited to trains within a block.

[0023] An identifiable warning signal is understood to mean that there is a link between the warning signal and a unique sensor of the system.

[0024] It is noted that the warning signal is a report of a measured condition to the control unit. The successive similar reports are assessed by the control unit, which only assumes that there is an object on the railway track if it receives similar warning signals from a predetermined number of successive sensors.

[0025] The successive sensors measure the same quantity and transmit the value of the measured quantity as warning signal to the control unit, wherein the control unit generates an alarm if the measurement data detected by the successive sensors comply with a predetermined condition.

[0026] Conditions against which measurement data detected by successive sensors could be tested are for instance "the distance is smaller than a threshold value" or "the distance lies within a determined range".

[0027] The successive sensors form part of an AND-circuit, wherein the control unit requires in each case that a plurality of successive sensors transmit comparable data to the control unit before an alarm is issued.

[0028] According to a preferred embodiment, the sensors are arranged such that their measuring direction is oriented transversely of the railway track and in the direction of the railway track. This has the advantage, among others, that the measurement distance is kept limited, which increases accuracy.

[0029] According to a further preferred embodiment, the control unit assumes that there is an object on the railway track when a warning signal is received from at least three successive sensors. The reliability increases and the susceptibility to vandalism decreases significantly. It would after all require at least three different people to cause three successive sensors to detect an object.

[0030] According to yet another preferred embodiment, the sensors are arranged at some mutual distance in longitudinal direction of the railway track. When a distance between the different sensors is known, it is also possible to derive the direction of travel and speed of this object in addition to determining its position.

[0031] According to yet another preferred embodiment, successive sensors are arranged at a predetermined mutual distance from each other. When the distance between individual sensors is known, it is also possible to determine the speed of the train in addition to an accurate position determination.

[0032] According to yet another preferred embodiment, the distance between successive sensors is constant, which simplifies the determination of position and speed.

[0033] According to yet another preferred embodiment, successive sensors are arranged at a distance of a minimum of two metres, more preferably at a distance of about four metres, from each other. The greater the mutual distance between sensors, the fewer sensors are required and the cheaper the system is. Because a single train carriage is a minimum of 12 metres long, a single 'lost' train carriage will be detected by a minimum of three successive sensors. The system is hereby also suitable for detecting lost carriages in addition to position determination. In contrast to ERTMS, which does enable position determination, the system according to the invention requires no additional electrical track circuit or axle counter system.

[0034] According to yet another preferred embodiment, the sensors are arranged over substantially the whole length of the railway track. The system is hereby not only able to detect a presence of a train in a block, but can also - depending on the distance between the sensors - give an accurate approximation of the location of the train on the railway track.

[0035] With sensors over substantially the whole length of the railway track the system is moreover no longer limited to application within conventional blocks.

[0036] Following brief failure due to malfunction the system can determine where trains and/or other objects are situated on the railway track. In contrast to conventional block systems, it is unnecessary to visually inspect a presence of a train in a (rail) block, which can be up to 5 km long. The system is hereby self-starting and soon fully operational again following brief failure.

[0037] Furthermore, because an accurate position determination of trains on a railway route is possible, the degree of occupancy of the track can be increased while safety remains guaranteed. The system can hereby be applied within future logistical concepts such as timetable-free travel.

[0038] When a sufficiently large number of sensors is applied, the option is also provided of monitoring, replacing or repairing the sensors at a suitable point in time. The system is after all still reliable when one sensor, or even two successive sensors, are defective. Replacement can take place at a quiet moment suitable for the purpose so that there is minimum disruption to rail traffic. The system is reliable and not susceptible to malfunction, since the system continues to function even when several sensors fail.

[0039] According to yet another preferred embodiment, the detection areas monitored by the sensors are separate areas which have no overlap. Because there is no overlap, it is known very precisely, owing to the warning signal which is linked identifiably to a unique sensor, where the object, generally a train (section), is situated on the railway track.

[0040] The sensors are distance sensors and, in the case a distance reduction is detected by at least two successive sensors, the control unit assumes that there is an object on the railway track.

[0041] The sensors are arranged above the railway track with their detection area extending downward in the direction of the railway track. The distance detected in the case of an unoccupied track is about 5 to 6 metres. A soon as a train or other object is located under these sensors, a smaller distance is detected. In the case of a train of 3 metres in height the detected distance is suddenly reduced by 3 metres. Owing to the predictability in distance change the system is not susceptible to malfunction.

[0042] In contrast to sensors which only detect a presence (true/false) of an object, as is for instance the case with optical sensors, sensors which are able to measure a distance offer further advantages.

[0043] Each distance sensor can be used to make a distinction between the closest railway track which has to be monitored and a possible other track situated adjacently thereof. At a distance above a determined threshold value it is known that this object is not situated on the adjacent track to be monitored. In order to prevent errors caused by unseen vehicles each railway track is provided with its own series of distance sensors, whereby only the adjacent track has to be monitored in each case.

[0044] In addition, distance sensors have the advantage that all components can be accommodated in a single sensor housing, while for instance optical sensors always comprise at least two components: a transmitter and a receiver, optionally with one or more reflectors, or a combined transmitter/receiver with one or more reflectors. All these individual components may become unusable, for instance due to technical failure or due to contamination (obstructions or scaling) which disrupts the optical system.

[0045] In the case of sensors which are arranged adjacently of the railway track and which measure distance in for instance a substantially horizontal plane, when a railway track is not occupied the detected distances can vary greatly between the different sensors depending on the free field of vision. A much shorter distance will however also be suddenly detected here when a train moves through the detection area.

[0046] A self-testing system is also obtained by using distance sensors. When a distance sensor fails it will measure a distance zero, which is noted by the control unit. The skilled person will appreciate that, when any sensor which in principle measures continuously fails, this is recognizable as such.

[0047] Self-test capability is also obtained in yet anoth-

er preferred embodiment by tracking in the control unit whether all sensors make a measurement within a determined relative measurement value when a train travels over the railway track. In the case one sensor deviates repeatedly, this sensor is designated by the system as a sensor to be checked/replaced.

[0048] According to yet another preferred embodiment, the distance sensors comprise an ultrasonic sensor and/or a radar and/or a laser. Such sensors have the advantage that the transmitter and receiver are housed in the same unit.

[0049] The sensors are arranged above the railway track and their detection area extends downward in the direction of the track.

[0050] Arranging the sensors above the railway track has several advantages, including not being susceptible to vandalism. In addition, the sensors can be placed above the railway track without time-consuming excavation operations.

[0051] Sensors arranged on the cables above the railway track also provide the option of early detection of such a cable becoming detached, whereby the trains can be informed of this and it is possible to prevent kilometres of cable being pulled loose. This happens several times a year and the necessary repair operations can easily make the relevant route unusable for two days. Distance sensors which are arranged above the railway track and detect in downward direction therefore provide the system with a high degree of self-test capability.

[0052] Sensors which are arranged above the railway track and detect in downward direction are more likely to detect an object on the track than sensors which detect in a lying plane. This is because the height at which a sensor detecting in a lying plane detects determines whether an object is detected or whether the sensor detects below or above the object. A downward viewing sensor is not susceptible to this.

[0053] According to yet another preferred embodiment, close to a level crossing additional sensors are arranged in the vicinity of the railway track and these additional sensors each cover a separate detection area of the level crossing so that objects blocking the railway track at the position of the level crossing can be detected by the system.

[0054] According to yet another preferred embodiment the mutual distance between the sensors close to the level crossing is a maximum of 2 metres. Objects from two metres in length can hereby be detected, including passenger cars blocking the railway track at the position of the level crossing.

[0055] The invention further relates to a method for localizing objects on a railway track, comprising the steps of:

- at least two sensors arranged in the vicinity of the railway track each covering a detection area of the railway track;
- the individual sensors transmitting an identifiable warning signal to a control unit to which they are connected when the individual sensors detect an object in their detection area of the railway track;
- transmitting the same quantity measured by successive sensors as warning signal to the control unit;
- the control unit generating an alarm if the measurement data detected by the successive sensors comply with a predetermined condition;
- wherein the sensors are distance sensors and, in the case a distance reduction is detected by at least two successive sensors, the control unit assumes that there is an object of the railway track; and
- wherein the sensors are arranged above the railway track, and their detection area extends downward in the direction of the railway track.

[0056] According to a preferred embodiment of the method, use is made of a system as described above.

[0057] Preferred embodiments of the present invention are further elucidated in the following description with reference to the drawing, in which:

Figure 1 shows a view of a train on a track provided with the system according to the invention;
Figure 2 shows a view of a carriage which has remained behind on the track provided with the system according to the invention; and
Figure 3 shows a top view of a level crossing.

[0058] Figure 1 shows a section of railway track 4 on which a train 21 is situated. Train 21 consists of a locomotive 22 and a carriage 24 drawn thereby. Situated above railway track 4 is an overhead line 26 on which sensors 8 are arranged at a constant mutual distance.

[0059] Sensors 8, which in the shown embodiment comprise ultrasonic sensors, preferably have non-overlapping detection areas 10 extending downward from sensor 8 in the direction of railway track 4. Each unique sensor 8 thus covers a unique part of railway track 4 with its detection area 10.

[0060] When ultrasonic sensors 8 view an unoccupied railway track 4, they will detect a distance of for instance 5.5 metres. When however there is a train 21 or other object 2 under sensor 8, this sensor 8 suddenly detects a shorter distance. In the case there is a train 21 of 3 metres in height under sensor 8, this sensor 8 suddenly detects a distance of only 5.5 - 3 = 2.5 metres, and this unique sensor 8 transmits an identifiable warning signal to control unit 6.

[0061] When control unit 6 receives a corresponding signal from a predetermined number of successive sensors 8, control unit 6 assumes that there is an object 2 on the railway track.

[0062] Although the system can be applied within the current railway routes, which are divided into (rail) blocks, and can in such a case demonstrate occupancy of such a (rail) block, the system is expressly not limited to such block systems. It is after all possible, by means of iden-

tifiable warning signals received by control unit 6 and coming from unique sensors 8, to provide a very precise approximation of the location at which a train 21 or other object 2 is situated on a railway track 4.

[0063] Because control unit 6 receives identifiable warning signals from all sensors 8 under which object 2 is situated, such as locomotive 22 and carriage 24 in figure 1, control unit 6 is able to determine the length of a train 21.

[0064] In addition, the system is also suitable for detecting individual objects 2, such as for instance a 'lost' carriage 24, on railway track 4 (figure 2).

[0065] As in ERTMS, a position determination is possible (figure 1), while 'lost' carriages 24 (figure 2) are also detected by the system. The system according to the invention can therefore be used without - as is the case with ERTMS - an additional electrical track circuit or axle counter system having to be applied.

[0066] When a train 21 consisting of locomotive 22 and carriage 24 moves over a railway track 4, successive sensors 8 will detect an object 2. If the distance between successive sensors 8 is known, in addition to the position determination it is also possible to determine the speed of train 21, and optionally even the acceleration or deceleration thereof.

[0067] Because information concerning the position and speed of train 21 is known, the system provides the possibility, when a train 21 approaches a level crossing 16, of controlling barriers 20 in dynamic manner.

[0068] In the present systems use is made at a level crossing 16 of the permitted travel speed of a train 21 on the specific route on which level crossing 16 is situated. A sensor (not shown) is arranged at a predetermined distance corresponding to twenty-one seconds travel time to the railway crossing at the permitted travel speed. When this sensor detects an approaching train 21, barriers 20 of level crossing 16 are closed. When train 21 is travelling more slowly than the permitted travel speed, barriers 20 are also closed at the same distance between train 21 and level crossing 16, although because of the lower speed the train 21 will take longer than twenty-one seconds to travel this distance. If a train 21 travels at half the permitted speed, the waiting time is as much as forty-two seconds.

[0069] Because the position, the direction of movement and the speed of train 21 are known according to the system, control unit 6 can precisely determine when train 21 will pass level crossing 16. Barriers 20 can therefore be controlled in dynamic manner, i.e. subject to the travel speed of train 21, whereby the waiting times for traffic 18 crossing railway track 4 are minimized. Traffic flow is hereby enhanced and unsafe situations arising from impatient road users are prevented.

[0070] According to a preferred embodiment the system is further expanded with additional sensors 12 which are situated close to level crossing 16, close to the lane of crossing traffic 18. In the unlikely event a car 18 comes to a stop on level crossing 16 and blocks railway track 4, this object 2 is detected by the additional sensors 12 and control unit 6 will intervene and cause the train 21 approaching level crossing 16 to make an automatic emergency stop.

[0071] In the case of a warning signal coming from sensors 8, 12 associated with a level crossing 16 control unit 6 can, if desired, already assume when there are a smaller number of sensors 8, 12 that an object 2, 18 is situated on railway track 4 at level crossing 16 and take suitable measures. When for instance a detection by only two sensors 8, 12 suffices, smaller objects 2 can then also be detected.

[0072] It is noted that the system according to the invention is also suitable for detecting objects 2 other than a train 21 or a carriage 24 on railway track 4.

[0073] In summary, the system according to the invention provides, among others, the following advantages:

- a semi-continuous detection of objects 2 on the track, wherein these objects 2 are not limited to train (sections);
- a technical solution wherein components close to or on rails 28 are unnecessary;
- a technical solution wherein electrical insulation of individual blocks is unnecessary;
- a system which is not susceptible to electromagnetic compatibility;
- a system which is not susceptible to weather influences, such as falling leaves and storms;
- a system which is not susceptible to rust formation on rails 28;
- a system which imposes only few requirements on (new) trains 21 so as to be detectable by the system, whereby rail machinery with small wheel size can for instance also be detected;
- lower energy consumption in the order of magnitude of 50 W/km, while the block system uses about 250 W/km;
- low implementation costs in that sensors 8, 12 can be arranged on the existing overhead line and no additional excavation operations are required per sensor;
- a system which makes manual resets of a (rail) block unnecessary;
- a system which is self-starting and quickly operational again after a brief failure due to malfunction;
- a self-testing system;
- a system wherein sensors 8, 12 can be checked, replaced or repaired at a quiet moment suitable for the purpose;
- a reliable system not susceptible to malfunction;
- a system which, in addition to occupancy of a (rail) block, can also make an accurate approximation of position and speed of the train traffic;
- a system which enables dynamic control of level crossings;
- a system which can also detect objects 2 other than trains 21, such as a car 18 which is blocking a level

crossing 16, and thereby provides increased safety;
- a system which, like ERTMS, transmits the length of rail vehicle 21 but can also continue to continuously monitor this length and even detects 'lost' carriages, whereby an additional electrical track circuit or axle counter system is unnecessary; and
- a system which can serve as full backup when the current ERTMS fails.

[0074] Although they show preferred embodiments of the invention, the above described embodiments are intended only to illustrate the present invention and not in any way to limit the specification of the invention. The scope of the invention is therefore defined solely by the following claims.

Claims

1. System for localizing objects on a railway track, comprising:

- at least two sensors which are arranged in the vicinity of the railway track and each cover a separate detection area of the railway track;
- a control unit which is connected to each of the sensors and receives an identifiable warning signal from the individual sensors when they detect an object in their detection area of the railway track;
- wherein the successive sensors measure and transmit the same quantity to the control unit as warning signal; and
- wherein the control unit generates an alarm if the measurement data detected by the successive sensors comply with a predetermined condition;

characterized in that

- the sensors are distance sensors and, in the case a distance reduction is detected by at least two successive sensors, the control unit assumes that there is an object on the railway track; and
- wherein the sensors are arranged on cables above the railway track and their detection area extends downward in the direction of the railway track.

2. System as claimed in claim 1, wherein the sensors are arranged such that their measuring direction is oriented transversely of the railway track.

3. System as claimed in any of the foregoing claims, wherein the control unit assumes that there is an object on the railway track when a warning signal is received from at least three successive sensors.

4. System as claimed in any of the foregoing claims, wherein the sensors are arranged at some mutual distance in longitudinal direction of the railway track.

5. System as claimed in any of the foregoing claims, wherein successive sensors are arranged at a distance of a minimum of two metres, more preferably at a distance of about four metres, from each other.

6. System as claimed in any of the foregoing claims, wherein the sensors are arranged over substantially the whole length of the railway track.

7. System as claimed in any of the foregoing claims, wherein the detection areas monitored by the sensors are separate areas which have no overlap.

8. System as claimed in claim 7, wherein the distance sensors comprise an ultrasonic sensor and/or a radar and/or a laser.

9. System as claimed in any of the foregoing claims, wherein close to a level crossing additional sensors are arranged in the vicinity of the railway track which each cover a separate detection area of the level crossing, so that objects blocking the railway track at the position of the level crossing can be detected by the system.

10. System as claimed in claim 9, wherein the mutual distance between the sensors close to the level crossing is a maximum of 2 metres.

11. Method for localizing objects on a railway track, comprising the steps of:

- at least two sensors arranged in the vicinity of the railway track each covering a detection area of the railway track;
- the individual sensors transmitting an identifiable warning signal to a control unit to which they are connected when the individual sensors detect an object in their detection area of the railway track;
- transmitting the same quantity measured by successive sensors as warning signal to the control unit;
- the control unit generating an alarm if the measurement data detected by the successive sensors comply with a predetermined condition;

characterized in that

- the sensors are distance sensors and, in the case a distance reduction is detected by at least two successive sensors, the control unit assumes that there is an object on the railway track; and

- wherein the sensors are arranged on cables above the railway track, and their detection area extends downward in the direction of the railway track.

12. Method according to claim 11, applied to a system according to any of the claims 1-10.

Patentansprüche

1. System zur Lokalisierung von Objekten auf einer Bahnstrecke mit:

mindestens zwei Sensoren, die in der Nähe der Bahnstrecke angeordnet sind und von denen jeder einen separaten Erfassungsbereich der Bahnstrecke abdeckt,
einer Steuereinheit, die mit jedem der Sensoren verbunden ist und ein identifizierbares Warnsignal von den einzelnen Sensoren empfängt, wenn sie ein Objekt in ihrem Erfassungsbereich der Bahnstrecke erfassen,
wobei die aufeinanderfolgenden Sensoren dieselbe Quantität messen und an die Steuereinheit als Warnsignal übertragen und
wobei die Steuereinheit einen Alarm erzeugt, falls die durch die aufeinanderfolgenden Sensoren gemessenen Daten eine vorgegebene Bedingung erfüllen,
dadurch gekennzeichnet, dass
die Sensoren Abstandssensoren sind und, für den Fall, dass eine Abstandsverminderung durch mindestens zwei aufeinanderfolgende Sensoren erfasst wird, die Steuereinheit annimmt, dass sich ein Objekt auf der Bahnstrecke befindet, und
wobei die Sensoren an Kabeln oberhalb der Bahnstrecke angeordnet sind und sich ihr Erfassungsbereich nach unten in Richtung der Bahnstrecke erstreckt.

2. System nach Anspruch 1, wobei die Sensoren so angeordnet sind, dass ihre Messrichtung quer zu der Bahnstrecke orientiert ist.

3. System nach einem der vorstehenden Ansprüche, wobei die Steuereinheit annimmt, dass sich ein Objekt auf der Bahnstrecke befindet, wenn ein Warnsignal von mindestens drei aufeinanderfolgenden Sensoren empfangen wird.

4. System nach einem der vorstehenden Ansprüche, wobei Sensoren in einem gewissen gegenseitigen Abstand in Längsrichtung der Bahnstrecke angeordnet sind.

5. System nach einem der vorstehenden Ansprüche, wobei aufeinanderfolgende Sensoren in einem Abstand von mindestens zwei Metern, vorzugsweise in einem Abstand von etwa vier Metern voneinander angeordnet sind.

6. System nach einem der vorstehenden Ansprüche, wobei die Sensoren über im Wesentlichen die gesamte Länge der Bahnstrecke angeordnet sind.

7. System nach einem der vorstehenden Ansprüche, wobei die Erfassungsbereiche, die durch die Sensoren überwacht werden, separate Bereiche ohne Überlappung sind.

8. System nach Anspruch 7, wobei die Abstandssensoren einen Ultraschallsensor und/oder Radar und/oder einen Laser aufweisen.

9. System nach einem der vorstehenden Ansprüche, wobei nahe eines Bahnübergangs zusätzliche Sensoren in der Nähe der Bahnstrecke angeordnet sind, von denen jeder einen separaten Erfassungsbereich des Bahnübergangs abdeckt, sodass Objekte, die die Bahnstrecke an der Position des Bahnübergangs blockieren, durch das System erfasst werden können.

10. System nach Anspruch 9, wobei der gegenseitige Abstand zwischen den Sensoren nahe des Bahnübergangs maximal 2 Meter beträgt.

11. Verfahren zum Lokalisieren von Objekten auf einer Bahnstrecke mit den Schritten:

mindestens zwei Sensoren sind in der Nähe der Bahnstrecke angeordnet, von denen jeder einen Erfassungsbereich der Bahnstrecke abdeckt,
die einzelnen Sensoren übertragen ein identifizierbares Warnsignal an eine Steuereinheit, mit der sie verbunden sind, wenn die einzelnen Sensoren ein Objekt in ihrem Erfassungsbereich der Bahnstrecke erfassen,
Übertragen derselben Quantität, die durch aufeinanderfolgende Sensoren gemessen wurden, als Warnsignal an die Steuereinheit,
die Steuereinheit erzeugt einen Alarm, falls die Messdaten, die durch die aufeinanderfolgenden Sensoren erfasst wurden, eine vorgegebene Bedingung erfüllen,
dadurch gekennzeichnet, dass
die Sensoren Abstandssensoren sind und, für den Fall, dass eine Abstandsverminderung von zumindest zwei aufeinanderfolgenden Sensoren erfasst wird, die Steuereinheit annimmt, dass sich ein Objekt auf der Bahnstrecke befindet, und
wobei die Sensoren an Kabeln oberhalb der Bahnstrecke angeordnet sind und sich ihr Er-

fassungsbereich nach unten in Richtung der Bahnstrecke erstreckt.

12. Verfahren Anspruch 11, das bei einem System nach einem der Ansprüche 1 bis 10 verwendet wird.

Revendications

1. Dispositif de localisation d'objets sur une voie ferrée, comprenant :

- au moins deux capteurs qui sont agencés à proximité de la voie ferrée, chacun couvrant une zone de détection distincte sur la voie ferrée ;
- une unité de commande qui est reliée à chacun des capteurs et reçoit un signal d'alerte identifiable en provenance des capteurs individuels lorsqu'ils détectent un objet dans leur zone de détection sur la voie ferrée ;
- dans lequel les capteurs successifs mesurent et transmettent la même quantité à l'unité de commande en tant que signal d'alerte ; et
- dans lequel l'unité de commande produit une alarme si les données de mesure détectées par les capteurs successifs satisfont une condition prédéterminée ;

caractérisé en ce que

- les capteurs sont des capteurs de distance et, dans le cas où une réduction de distance est détectée par au moins deux capteurs successifs, l'unité de commande suppose qu'il y a un objet sur la voie ferrée ; et
- dans lequel les capteurs sont agencés sur des câbles au-dessus de la voie ferrée et leur zone de détection s'étend vers le bas dans la direction de la voie ferrée.

2. Dispositif selon la revendication 1, dans lequel les capteurs sont agencés de telle sorte que leur direction de mesure est orientée transversalement par rapport à la voie ferrée.

3. Dispositif selon l'une quelconque des revendications précédentes, dans lequel l'unité de commande suppose qu'il y a un objet sur la voie ferrée lorsqu'un signal d'alerte est reçu en provenance d'au moins trois capteurs successifs.

4. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les capteurs sont agencés à une certaine distance mutuelle dans la direction longitudinale de la voie ferrée.

5. Dispositif selon l'une quelconque des revendications précédentes, dans lequel des capteurs successifs sont agencés à une certaine distance d'un minimum de deux mètres, plus préférablement, à une distance de quatre mètres environ l'un l'autre.

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les capteurs sont agencés sensiblement sur la totalité de la longueur de la voie ferrée.

7. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les zones de détection surveillées par les capteurs sont des zones distinctes qui ne présentent pas de recouvrement.

8. Dispositif selon la revendication 7, dans lequel les capteurs de distance comprennent un capteur d'ultrasons et/ou un radar et/ou un laser.

9. Dispositif selon l'une quelconque des revendications précédentes, dans lequel, à proximité d'un passage à niveau, des capteurs supplémentaires sont agencés à proximité de la voie ferrée, chacun couvrant une zone de détection distincte du passage à niveau, de telle sorte que des objets bloquant la voie ferrée à l'emplacement du passage à niveau peuvent être détectés par le dispositif.

10. Dispositif selon la revendication 9, dans lequel la distance mutuelle entre les capteurs proches du passage à niveau est au maximum égale à 2 mètres.

11. Procédé de localisation d'objets sur une voie ferrée, comprenant les étapes de :

- couverture, avec au moins deux capteurs agencés à proximité de la voie ferrée, d'une zone de détection sur la voie ferrée ;
- transmission, par les capteurs individuels, d'un signal d'alerte identifiable à une unité de commande à laquelle ils sont reliés lorsque les capteurs individuels détectent un objet dans leur zone de détection sur la voie ferrée ;
- transmission de la même quantité mesurée par des capteurs successifs en tant que signal d'alerte à l'unité de commande ;
- production, par l'unité de commande, d'une alarme si les données de mesure détectées par les capteurs successifs satisfont une condition prédéterminée ;

caractérisé en ce que

- les capteurs sont des capteurs de distance et, dans le cas où une réduction de distance est détectée par au moins deux capteurs successifs, l'unité de commande suppose qu'il y a un objet sur la voie ferrée ; et
- dans lequel les capteurs sont agencés sur des

câbles au-dessus de la voie ferrée, et leur zone de détection s'étend vers le bas suivant la direction de la voie ferrée.

12. Procédé selon la revendication 11, appliqué à un dispositif selon l'une quelconque des revendications 1 à 10.

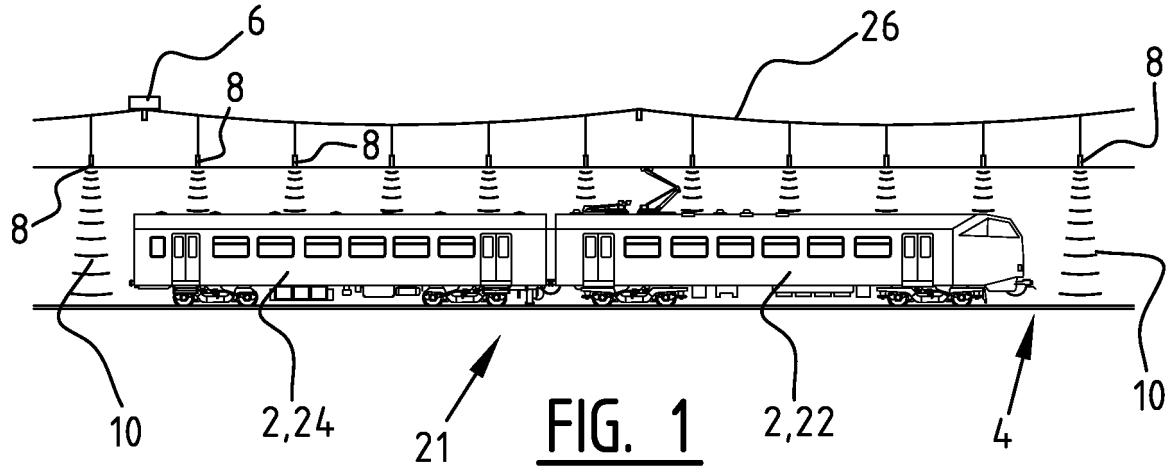


FIG. 1

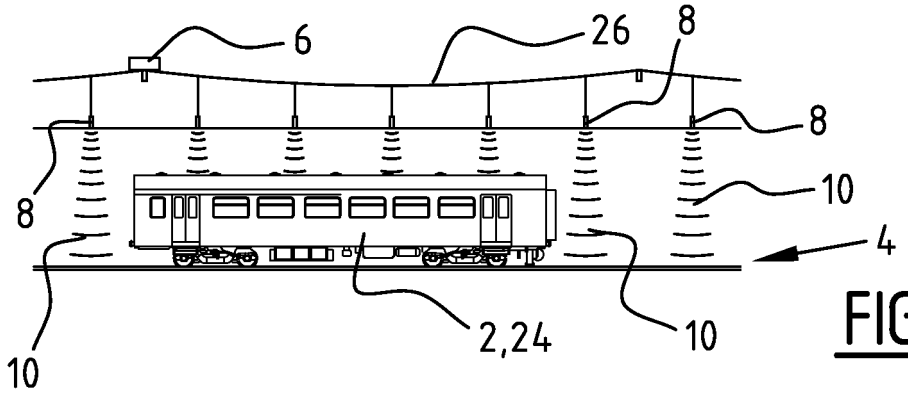


FIG. 2

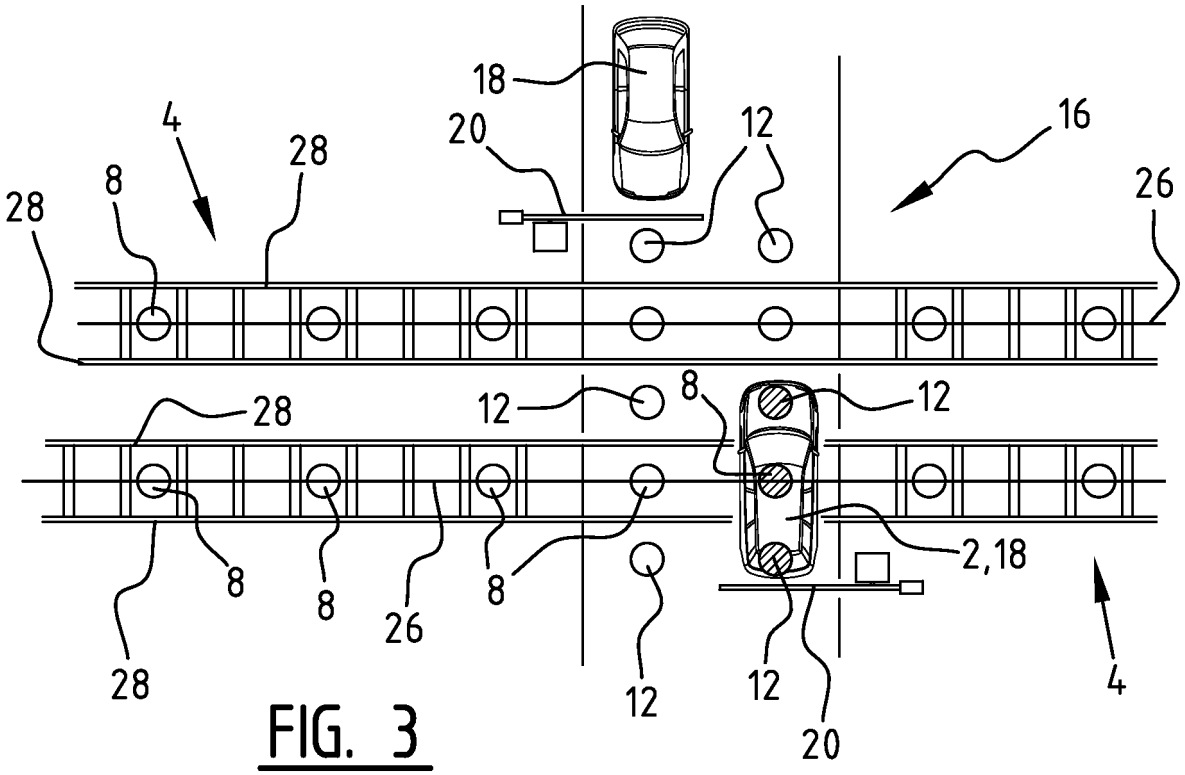


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 20050184883 A1 **[0018]**