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(54) **Arrangement and method for detecting track bound traffic**

(57) One or several balises (1, 2) used to transmit telegrams to passing railway trains and a lineside electronic unit (8) connected to the balises (1, 2) bear alternating current fed loops (4.1, 4.2, 4.L, 4.R) sensing a signal representing the underside structure of a passing

train (9). The signal is used for track occupancy detection and train length determination. In a preferred embodiment, the signal is provided by the loop impedance variations induced by permeable material of a passing train's underside.

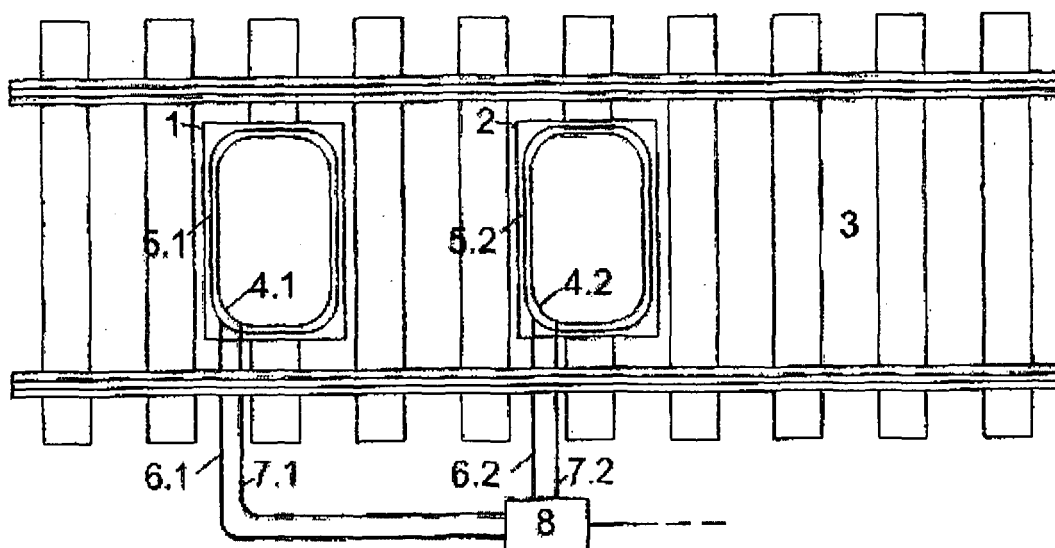


Figure 1

Description

TECHNICAL FIELD

[0001] The invention relates to an arrangement and to a method for detecting track bound traffic, in particular traffic on railways. For particularly, the invention relates to track occupancy detection devices for track bound traffic, in particular railways. Usually, track occupancy is determined by comparing signals resulting from vehicle passages at several locations along a track. These signals need to be similar in order to evidence that the train has not lost a carriage during the journey. Such devices supply track occupancy data to other systems like interlockings, which set and release routes accordingly.

BACKGROUND ART

[0002] In particular for a railway interlocking it is of vital importance to know where the trains are positioned, at least which segments of track are currently occupied. For this purpose it is vital to monitor train integrity, i. e. to know whether a train has lost a carriage and therefore has not fully left the previous track segment. In the state-of-the-art this information comes from track circuits, see e. g. CA412640A or axle counters, see e. g. GB213778. Installing track circuits or axle counters is expensive, particularly if long cables have to be drawn from the track sections to a central location. In the case of jointless tracks with audio frequency track circuits, there are tuning units that need to be installed with a variety of constraints and it requires skilled personnel. Axle counters are fairly expensive and costly to install and they often need calibration,

[0003] Among other Automatic Train Protections systems, the new European Train Control System Level 1 uses track-mounted controlled transponders, also referred to as balises to transmit movement authorities to passing trains, see e. g. EP1607300. These devices do not cover track occupancy detection. The proposed European Train Control System Level 3 only provides balises and avoids lineside track occupancy detection devices. The trains report their position to the lineside by radio. This system also needs train integrity data for track release. For several train types like permanently coupled multiple unit passenger trains this data can readily be obtained by on-board devices. This does not hold for other train types like goods trains with no data link from the locomotive to the last carriage. Therefore European Train Control System lines need track circuits or axle counters so far.

SUMMARY OF THE INVENTION

[0004] Object of this invention is a cost and performance optimised detection of traffic on tracks, and more particularly, a corresponding track occupancy detection device.

[0005] It is a basic idea to use track-mounted balises for the detection. Such balises are known for the purpose of data transfer between a vehicle passing the balise and the balise. It is proposed that at least one balise comprises a sensing device adapted to produce a signal when a vehicle is passing the balise and that there are signal detecting means, which are connected to and/or integrated in the sensing device and which are adapted to determine from the signal that the train is passing the balise. This solution is simple and cost-effective since the balise is used for data transfer and as well for vehicle detection.

[0006] In particular, a connection (e.g. a cable and/or wireless connection) between the balise and a control unit, which controls the data transfer, can be used for transferring control signals and for transferring signals for the purpose of vehicle detection. The determination that the signal produced by the balise when a vehicle is passing actually represents a passing vehicle can be made within the balise, by a determination device in the vicinity of the balise and/or by a determination device far away from the balise (such as the control device).

[0007] A signal is understood to be any information which can be obtained by the detecting means, e.g. by actively sending data to the detecting means and/or by measuring an operating state (such as the impedance) of the sensing device.

[0008] An arrangement comprising at least one balise and a control unit for controlling the data transfer may have, according to one embodiment of the invention, additional means measuring a signal (in particular a sequence of signals or a time-dependent signal) representing the underside structure of the passing train.

[0009] For example, in a European Train Control System Level 1, balises are usually mounted in the track in pairs - one fixed balise and one controlled balise. A controlled balise gets input regarding the telegram to send from a so-called Lineside Electronic Unit LEU that is connected to it using a special cable that can be hundreds of meters long. The LEU sends information related to the telegram to the connected balises all the time, not just when there is a train present. The balise contains a conducting loop system that constitutes one side of an air-transformer. The other side of the transformer is situated on the passing train. As the train passes over the balise, the transformer takes shape.

[0010] In particular, the invention is to add an extra function to the LEU and balise that performs train detection and train integrity check. The extra function should preferably not interfere with the European Train Control System standard. Therefore, according to a preferred embodiment, at least one, preferably, at least two extra conducting loops being directly accessible to the LEU and being (in the case of at least two loops) shifted in the train travelling direction are added to a balise. Alternatively, two balises or more than two balises each bear at least one extra loop. The extra loop(s) is/are preferably mounted next to the loop(s) that already exist in the present balise. Additional conductor pairs may be added

to the cables that connect the balises and the LEU.

[0011] More generally speaking, the balise of the arrangement may comprise a loop of an electrically conducting material being the sensing device. Preferably, this loop is an additional loop. "Additional" means in addition to any other loop or loops of the balise which is/are used to transfer data.

[0012] The loop may be alternating current-fed so that its impedance changes according to the coupling with the vehicle passing the balise. A power supply feeds alternating current to the loop or loops of the balise(s). In the detection means, a dedicated impedance measuring device is present that is connected to the (extra) loops in the balise(s), for example via the cables. When there is no vehicle near the balise, the loop has a first impedance (a certain measurable impedance). When a vehicle is passing, the material of the vehicle, e.g. metal, is above the balise, having a permeability differing from air. The impedance of the loop significantly changes due to mutual inductance. A detected change of impedance is equivalent to track occupancy which is registered by the detecting means (e.g. the control device). Track occupancy data may be added to the interface protocol between the detecting means and interlocking.

[0013] The impedance may be determined by measuring the electric current in the loop. However, other measurement principles may be applied alternatively, such as measuring the shift (caused by the change of the permeability) of the resonance frequency of an oscillator circuit which comprises the loop.

[0014] According to a preferred embodiment, two or more loops contained in the one or more balises are positioned at a distance to each other in the direction of travel of the track and the arrangement comprises evaluation means adapted to evaluate a time shift between signals produced by the loops, thereby evaluating a measure for the speed of the passing vehicle. In particular, the speed can be calculated using the known distance between the loops in the direction of travel and by determining the spatial signal shape.

[0015] When a vehicle (such as a train) travels over the loops a time shift between the detections of a significant impedance change in each of the two loops will occur. Since their physical separation is fixed, it is possible to calculate the speed of the front section of the vehicle. However the measured impedance will vary during the vehicle passage depending on the amount and proximity of the metal, i.e. depending on whether the balise is under a wheel set, a bogie, a suspended car body or in between carriages etc. At every moment it is possible to correlate the two measured impedances and determine their separation in time. The instantaneous speed of the train at all times during the passage is therefore known, e.g. known by the LEU.

[0016] Two alternating current-fed loops may be located at shifted positions (with respect to the vehicle's or train's travelling direction, i.e. the direction of travel of the track) in the balise or balises and the impedances chang-

es resulting from of the train's underside passing the balise or balises.

[0017] Vehicle (such as a train comprising several units mechanically coupled together) integrity can be determined by comparing the signal shapes representing the vehicle. Mainly, the change of permeability is caused by the underside of the vehicle which passes the balise closely. For example, the impedance in the loop is highest below axles of a passing rail vehicle. Missing peaks represent missing axles (i.e. integrity is violated). If some parts of the signal are missing at any stage, it is concluded that the train has lost a carriage and corrective action can be taken. Integrating the speed of the train over time yields the total length of the train.

[0018] As an alternative or additional measure, the length of the vehicle is registered and compared to neighbouring control units (which control balises in other sections of the track) and/or reported to the interlocking for every balise passage. It would then be the task of the interlocking computer to ensure that within the allowable inaccuracy the reported length of the train is the same throughout the train journey. If the length of the train becomes significantly smaller at any stage, the train has lost a carriage and corrective action can be taken. Note that the ratio of track circuits to balise groups on a typical European Train Control System Level 1 line is about 1:1. The Invention can also be combined with fixed balises only thus providing track occupancy detection for systems like the European Train Control System Level 2 substituting track circuits and axle counters. The LEU then does not control the transmission of movement authorities and the like via the balises.

[0019] The following optional features further detail and improve the described principle.

[0020] To avoid a situation where disturbances from the traction system of trains in a neighbouring track disturb the impedance measurements, measurements should be restricted to the short-wave band.

[0021] Immunity is further improved if the impedance measurements are performed in a range of frequencies simultaneously. Spread-spectrum techniques can be used for this purpose.

[0022] If the single turn loops in the balise were to have the shape of an "8" instead, there will be no electromagnetic field radiating in the far zone. This is a desirable EMC property.

[0023] Immunity to lightning is improved if the extra conductor pair connecting the balise to the control device (e.g. the LEU) is galvanically insulated at both ends using ordinary transformers.

[0024] The impedance measuring signal can be superimposed on the conductor pair that already connects the balise to the control device for movement authority telegram transmission. This means that the existing cable can be used as it is today, which is an extra reduction in cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

- Figure 1: Double Train Detection Balises Figure 1 shows a preferred embodiment of a balise 1 with 1 additional loop 4.1, a second similar balise 2 and a lineside electronic unit 8.
- Figure 2: Single Train Detection Balises Figure 2 shows another preferred embodiment of a balise 1 with 2 additional loops 4.L and 4.R.
- Figure 3: Double Train Detection Balises Lateral View Figure 3 shows a train 9 travelling over two balises 1 and 2.
- Figure 4: Double Train Detection Balises Diagrams Figure 4 shows two diagrams with the loop impedances representing the underside of a passing train plotted over the time.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] As shown in figure 1, two balises 1 and 2 are mounted in a conventional manner at the centre of a railway track 3. The balises 1 and 2 each bear a conductive loop fed by alternating current, labelled 4.1 for the left balise and 4.2 for the right balise. A second loop system 5.1 respectively 5.2 is the usual reception and transmission loop system for movement authorities to the train. The alternating current-fed loops are connected via cables 6.1 respectively 6.2 and the movement authority loops via cables 7.1 respectively 7.2 to a lineside electronic unit LEU 8. The LEU is connected to an interlocking, symbolised by dotted lines.

[0027] Figure 2 shows an optional preferred embodiment differing from figure 1 in that balise 2 is omitted and balise 1 contains two alternating current fed loops 4.L and 4.R surrounding volumes shifted along the train travelling direction, thus shifted to the left and right in the figure.

[0028] According to figure 3 a train 9 travels along the railway track 3 and passes the balises 1 and 2 from figure 1. The train's underside has a varying structure with bogies 10 bearing the wheel sets. Alternating current is fed to the balise loops. Downwards arrows represent the permeability of the volume surrounded by the loop currents leading to increased impedance. For a train, the main increase of permeability results from metal. The more metal is present and the closer it is to a balise, the higher is the loop impedance. In the figure, balise 1 is beneath a bogie's massive wheel set being close to the balise 1. The impedance results to be high as depicted by the thick arrow. Balise 2 is beneath a gap between the train's carriages. There is little metal at this location and the impedance results to be weak as depicted by the narrow arrow.

[0029] The diagrams in figure 4 show the impedance 11 of the loop 4.1 in balise 1 and impedance 12 of loop 4.2 in balise 2 of figure 3 plotted over time. The references 11 and 12 point at the situation shown in figure 3. The time propagates towards the right on the abscissa. When no train is above a balise 1, 2, the impedance is low as shown at the left half of the upper diagram and a short stretch at the left of the lower diagram. When a train travelling towards the left passes over a balise 1, 2, the signal increases. The train in figure 3 enters from the right and travels to the left. It first passes balise 2 being mounted further to the right. The lower diagram therefore shows an earlier impedance increase and the upper diagram shows a similar signal time shifted towards the right. The signal intensity varies with the amount and proximity of the metal at the train's underside. For example, the bogies 10 result in medium impedance and at the wheel set locations short peaks occur. There are gaps between the bogies and between the carriages. The signals from the two balises 1, 2 are time shifted but their shapes are similar because the same metal masses successively move over the balises 1, 2. The known distance between the balises 1, 2 divided by the time shift yields the train speed which can be determined for each part of the signal whose shape can be correlated to the other balise's signal. In the diagrams, e. g. the first two wheel sets can easily be identified as the first two signal peaks from the left. Integrating the train speed with respect to the passage duration yields the train length. Because of the high data sampling rate, these measurements are accurate.

INDEX LIST

[0030]

- | | |
|-----|--|
| 1 | Balise |
| 2 | Balise |
| 3 | Railway Track |
| 4.1 | Alternating Current-fed Loop in Balise 1 |
| 4.2 | Alternating Current-fed Loop in Balise 2 |
| 4.L | Left Alternating Current-fed Loop in Balise 1 |
| 4.R | Right Alternating Current-fed Loop in Balise 1 |
| 5 | Data Transmission Loop |
| 6 | Alternating Current-fed Loop Cable |
| 7 | Data Transmission Loop Cable |
| 8 | Lineside Electronic Unit |
| 9 | Train |
| 10 | Bogie |
| 11 | Loop Impedance of Balise 1 |
| 12 | Loop Impedance of Balise 2 |

Claims

1. An arrangement comprising one or more track-mounted balises (1, 2) and a lineside control unit (8), wherein the arrangement is adapted to transmit data to passing vehicles (9),

characterised in that

- at least one balise or at least one of the balises (1, 2) comprises a sensing device adapted to produce a signal when a vehicle is passing the balise (1, 2) and the arrangement comprises signal detecting means, which are connected to and/or integrated in the sensing device and which are adapted to determine from the signal that the vehicle is passing the balise (1, 2).
2. The arrangement of claim 1, wherein the sensing device comprises a loop (4.1, 4.2, 4.L, 4.R) of an electrically conducting material.
 3. The arrangement according to the preceding claim, wherein the loop (4.1, 4.2) is alternating current-fed and its impedance changes according to the coupling with the vehicle passing the balise (1, 2).
 4. The arrangement of one of the two preceding claim, wherein
 - two or more of the loops (4.1, 4.2, 4.L, 4.R) contained in the one or more balises (1, 2) are positioned at a distance to each other in the direction of travel of the track,
 - the arrangement comprises evaluation means adapted to evaluate a time shift between signals produced by the loops, thereby evaluating a measure for the speed of the passing vehicle.
 5. The arrangement of the preceding claim, **characterised by** means calculating the vehicle's length from the speed and the time needed to pass a balise (1, 2).
 6. The arrangement according to one of the preceding claims, **characterised by** means transmitting signals and/or data representing the underside structure of the passing vehicle (9) from the sensing device to a lineside unit (8) or interlocking, wherein the lineside unit (8) is adapted to evaluate the data and determine whether the data represents the complete underside structure of the vehicle (9).
 7. A method of determining a passing track-bound vehicle, wherein one or more track-mounted balises (1, 2), which is/are controlled by a lineside control unit (8) for transferring data to passing vehicles, is/are used as a sensing device to produce a signal when a vehicle is passing the balise (1, 2) and it is determined from the signal that the vehicle is passing the balise (1, 2).
 8. The method of claim 7, wherein a loop (4.1, 4.2, 4.L, 4.R) of an electrically conducting material which is part of the balise (1, 2) is used for the production of the signal.
 9. The method of the preceding claim, wherein the loop (4.1, 4.2) is alternating current-fed and its impedance according to the coupling with the vehicle passing the balise (1, 2) is the signal or is used to produce the signal.
 10. The method of one of the two preceding claim, wherein
 - two or more of the loops (4.1, 4.2, 4.L, 4.R) contained in the one or more balises (1, 2) are positioned at a distance to each other in the direction of travel of the track,
 - a time shift between signals produced by the loops is evaluated, thereby evaluating a measure for the speed of the passing vehicle.
 11. The method of the preceding claim, wherein the vehicle's length is calculated from the speed and the time needed to pass a balise (1, 2).
 12. The method of one of the preceding claims, wherein signals and/or data representing the underside structure of the passing vehicle (9) are transmitted from the sensing device to a lineside unit (8) or interlocking, wherein the lineside unit (8) evaluates the data and determines whether the data represents the complete underside structure of the vehicle (9).

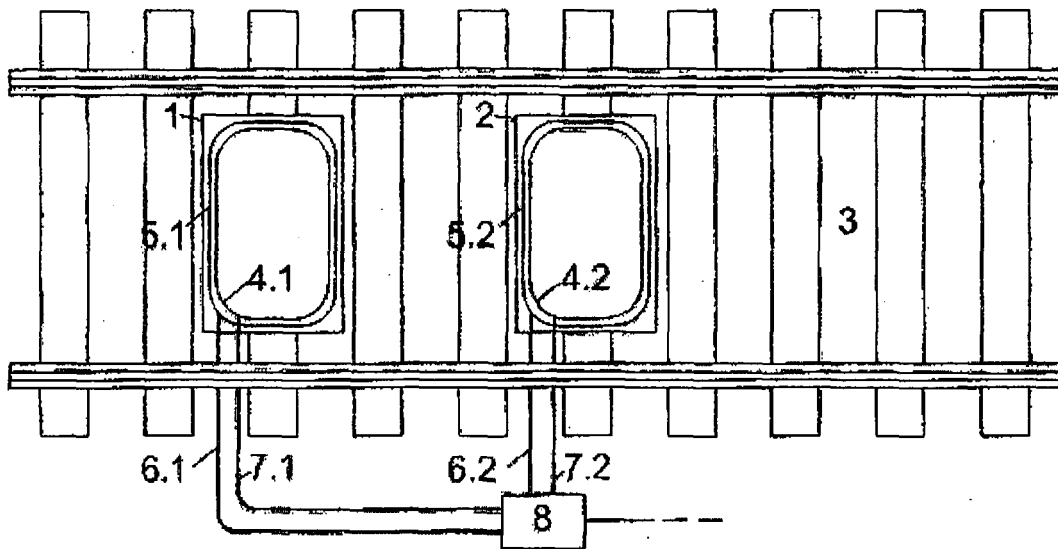


Figure 1

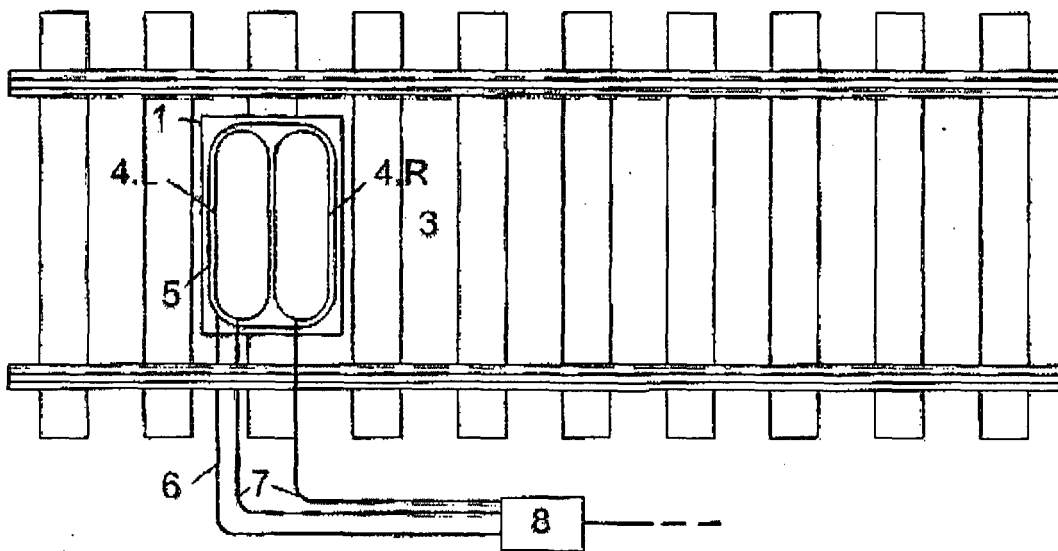


Figure 2

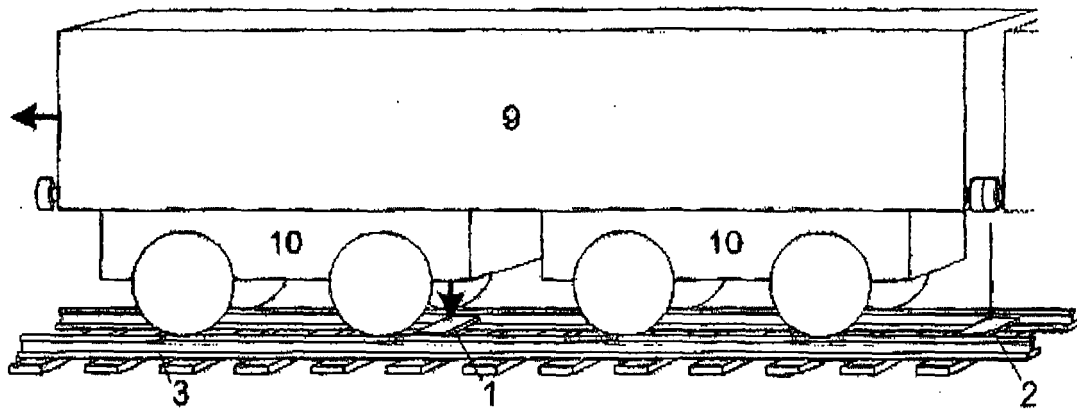


Figure 3

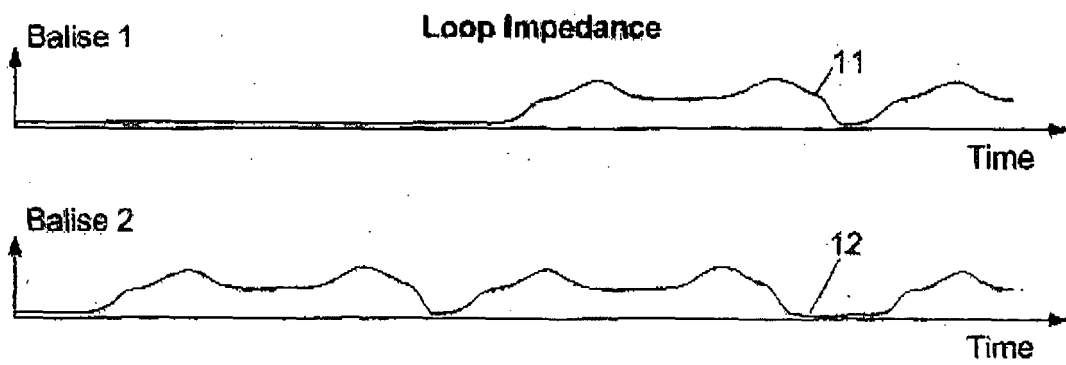


Figure 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 7715

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	EP 0 252 199 A (ACEC [BE]) 13 January 1988 (1988-01-13) * column 1, line 29 - column 3, line 45; figure 1 * -----	1-12	ADD. B61L1/14
			TECHNICAL FIELDS SEARCHED (IPC)
			B61L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 1 July 2008	Examiner Janhsen, Axel
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 00 7715

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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01-07-2008

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