



(19)
Federal Republic of Germany -
German Patent and Trademark
Office

(10) **DE 10 2008 020 700 A1** 05/11/2009

(12)

Disclosure Document

(21) File reference: **10 2008 020 700.4**

(51) Int Cl.⁸: **B61L 23/06** (2006.01)

(22) Application date: **04/24/2008**

(43) Disclosure date: **11/05/2009**

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(56) Documents reviewed for assessing patentability:

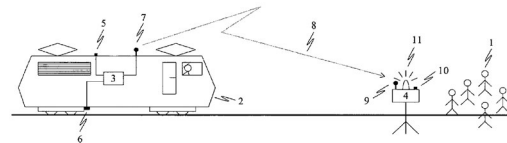
**DE 44 34 861 A1
DE 10 2004 053163 A1**

The following information was taken from documents submitted by the applicant

Examination application filed according to § 44 PatG (Patentgesetz [Patent Act]).

(54) Title: **Railway collision warning device**

(57) Abstract: The invention relates to a railway collision warning system to warn of a collision risk between a rail-bound vehicle (2) and at least one person (1), wherein the warning device comprises a stationary unit (3) that is arranged on the rail-bound vehicle (2) and is equipped to transmit radio signals (8) containing current travel information using a transmission unit (7) in contact with the stationary unit (3). The warning device also comprises a mobile unit (4) with a receiving unit (9) provided to be arranged in the proximity of the at least one person (1) and to receive the transmitted radio signals (8) using the receiving unit (9); wherein the mobile unit (4) is equipped to determine a collision risk between the rail-bound vehicle transmitting the radio signal (8) and the at least one person (1) located in the proximity of the mobile unit (4) as a function of the travel information contained in the received radio signals (8) and to warn the at least one person (1) as a function of the determined collision risk.



Specification

[0001] The invention relates to a railway collision warning system to warn of a collision risk between a rail-bound vehicle and at least one person, wherein the warning device comprises a stationary unit that is arranged on the rail-bound vehicle and is equipped to transmit radio signals containing current travel information using a transmission unit in contact with the stationary unit.

[0002] The invention also relates to a mobile unit and to a mobile transponder to warn of a collision risk.

State of the art

[0003] A central safety aspect of railway traffic is to control and safeguard rail traffic on the clear track. This involves using guidance and control devices that are arranged along the rail track and that are operated from a central location to safely guide the train on the clear track. Using these guidance and control devices, the path of the train on the track is accurately determined such that the risk of a collision with other traffic participant is kept as low as possible.

[0004] A train safety system is then for example known from EP 1 232 926 A1, wherein balise groups are arranged at track locations along the travel path. Balises are active or passive transponders that are excited when a rail-bound vehicle passes over them and that then send messages to the rail-bound vehicle. Whereas fixed data balises transmit a fixed data set, transparent or controlled balises are coupled to a signal source and transmit different data sets as a function of the detected signal. The specified method involves determining the speed of the rail-bound vehicle from the predetermined receiving timestamps from telegrams transmitted by two balises sequentially arranged at a known distance and comparing said speed to a maximum speed limit. A warning or a forced braking action is tripped when the maximum speed limit is exceeded.

[0005] US 2004/0267415 A1 discloses a train control system based on the ETCS standard (European Train Control System) that employs balise information along the track. Rail-bound vehicles transmit the local position, the speed, and any further information to an interlocking system using a special railway mobile radio network (Global System for a Mobile Communication Railway – GSM-R). Rail-bound vehicles are then monitored and controlled centrally.

[0006] The disadvantage of this type of train guidance and control include the enormous costs when installing the required rail field elements together with the subsequent maintenance. Moreover, these rail field elements only have a limited service life and must then be replaced in specified intervals because they are continuously exposed to weather conditions. In particular in relation to infrequently used secondary rails, maintaining such a train guidance and control system is nowadays no longer cost-efficient to ensure the required rail traffic safety.

[0007] DE 198 40 715 C2 discloses a rail-bound vehicle control facility for so-called FFB (Funk-Fahr-Betrieb [Radio-Driving Mode]), wherein the control computers in the rail-bound vehicles each have a railway map with information about the railway network. Individual track sections are then centrally assigned by radio by a train tracking safety facility to no more than one vehicle in order to avoid collisions in this manner.

[0008] DE 198 47 292 A1 describes a communication system for such a Radio-Driving Mode, wherein the radio connection is centrally established by a gateway computer to transmit data between the subsystems.

[0009] Similar systems are also used to control air traffic safety, such as the “traffic alert and collision avoidance system” (TCAS), wherein the transponders in other aircraft are queried in the surrounding airspace. The position and course information obtained from the transponders is analyzed with respect to potentially colliding courses. As a function of the distance from the potential collision opponent, the TCAS system issues a traffic advisory (traffic advisory, TA) or a resolution advisory (resolution advisory, RA). In the event that two aircraft are on a collision course, the TCAS systems in the two aircraft communicate with each other regarding the evasive maneuver. The TCAS system is for example described in EP 0 905 528 A2.

[0010] The so-called AIS automatic identification system (automatic identification system) is known in ship traffic, wherein ships equipped with an AIS transponder broadcast time-cyclical navigation information using broadcast methods containing details concerning position, course, and status of the ship. The transmitted data can be received by all other ships and also on land and can, for example, be analyzed for a collision warning. The AIS system is for example described in DE 100 28 927 A1.

[0011] A train collision warning facility is known from DE 10 2005 042 218 A1, which is designed to detect collisions with other rail-bound vehicles. The warning facility in this case uses a radio transmission and receiving unit to cyclically transmit data packets that contain certain travel information of the vehicle, such as the current vehicle position, the vehicle speed, and the direction of travel. Another railway vehicle that is also equipped with such a warning facility receives these data packets and compares them with its own travel information. A collision risk can then be inferred as a function of this comparison of the railway vehicle's own travel information with the travel information relating to the other railway vehicles.

[0012] It is in this case disadvantageous that the cited onboard vehicle facilities can only detect a collision risk between traffic participants of the same type, such as ships or between two railway vehicles. With respect to railway operations, this frequently presents the problem that construction work and maintenance work are performed along the rail track, without closing the entire track section to all train traffic. In order to protect such construction or maintenance crews against a collision with an approaching rail-bound vehicle, there are corresponding corporate group policies (train travel regulations) that define in-person or technical safeguards at railway construction sites.

[0013] In-person safeguards involve positioning a safety spotter and a safety supervisor at a corresponding distance upstream of the construction site. When a train approaches, a two-tone horn is sounded to signal to the crews working at the railway construction site that the track must be cleared due to an approaching train. The disadvantage in this case in particular is that this method is labor-intensive and repeatedly results in accidents, either because the worker did not hear the signal, or because the signal was not sounded or sounded late.

[0014] A technical safeguard can for example involve use of a cable along the track section, wherein corresponding contacts are attached on the rail and connected to the cable. An automatic horn and light unit is connected to this cable, such that an acoustic or optical alarm can be tripped when a train approaches. A disadvantage in this case is that this method requires expensive equipment and requires a cumbersome and labor-intensive installation, which makes little sense in particular for temporary and traveling construction sites.

Task

[0015] Based on the above, the task of the invention is to provide a safer and more cost-effective capability for collision warning between a railway vehicle and personnel, in particular, construction crews.

Solution

[0016] The task of the present invention is solved according to the invention by the train collision warning device of the type described above in that the warning device furthermore comprises a mobile unit with a receiving unit designed to be arranged in the proximity of at least one person and designed to receive the transmitted radio signals using the receiving unit, wherein the mobile unit is equipped to identify a collision risk between the rail-bound vehicle transmitting the radio signals and the at least one person located in the proximity of the mobile unit as a function of the travel information contained in the received radio signals, and to warn the at least one person as a function of the identified collision risk.

[0017] The train collision warning device in this case comprises a stationary and a mobile unit. The stationary unit is installed on a rail-bound vehicle and comprises a transmission unit or has a connection to such a transmission unit.

The stationary unit is in this case equipped such that it continuously determines corresponding travel information of the rail-bound vehicle, which can for example advantageously be achieved using a travel detection unit that has a connection to the stationary unit. However, it is also conceivable that the stationary unit is connected to the corresponding data bus of the rail-bound vehicle such that the required travel information can be read. The stationary unit installed on the rail-bound vehicle now transmits corresponding radio signals using the transmission unit, wherein the radio signals contain current travel information of the rail-bound vehicle. This transmitted signal is transmitted using the broadcast method such that it can be received in a certain radius by the corresponding receiving units.

[0018] The train collision warning device furthermore contains a mobile or portable unit that advantageously has an autonomous power supply and a corresponding receiving unit for receiving radio signals transmitted by the stationary unit. After the mobile unit receives such radio signals, the travel information for the corresponding rail-bound vehicle contained in the radio signals is extracted. Based on the received travel information for a rail-bound vehicle, the mobile unit can now determine whether there is a collision risk with the personnel located in the proximity of the mobile unit. If the mobile unit detected such a collision risk, a corresponding warning is issued to the personnel so that the latter can clear the track, therefore clearing the track section.

[0019] This type of construction safeguard neither requires elaborate technical installations along the track section, nor potentially hazardous, unsafe methods due to human error. The mobile unit is in this case set up in the proximity of the personnel such that visual or audio contact is established, and the mobile device is able to warn personnel on the track. The mobile unit is appropriately set up along the track section perimeter of the railway construction site.

[0020] The travel information relied upon to determine the collision risk can then for example contain the current vehicle speed of the rail bound vehicle, the current vehicle position, and/or the current direction of travel. But further travel information that can be relied upon for collision checking is also conceivable.

[0021] It is then for example advantageous when the stationary unit on the rail-bound vehicle is connected to a rail track identification unit in order to have the ability to determine the rail track occupied by the rail-bound vehicle. The rail track occupied by the rail bound vehicle is then also transmitted as travel information such that the mobile unit can determine the collision risk with rail track accuracy. This ultimately increases the reliability when determining the collision risk.

[0022] The mobile unit is advantageously equipped such that it can warn the personnel located in the proximity of the mobile unit about an approaching rail-bound vehicle using acoustic, optical, and/or haptic signals.

[0023] It is particularly advantageous when the train collision warning device comprises mobile or portable transponders that can be arranged on or attached to the personnel to be warned. When the mobile unit detects a collision risk with an approaching rail-bound train, the mobile unit issues a near-range warning signal that can be received by the transponders. After receiving such a near-range warning signal, which for example can be based on corresponding near range radio technology, the corresponding person can, for example, be warned by an acoustic, optical, and/or haptic signal. As a result, it is, for example, possible to ensure that the personnel to be warned are warned even when the mobile unit itself cannot warn the personnel, for example due to high ambient noise.

[0024] It is exceedingly advantageous when the mobile or portable transponder has an actuation element, such as a pushbutton, in order to receive an acknowledgment from the personnel to be warned about the issued warning in response to the received near-range warning signal and the correspondingly issued warning. The personnel to be warned must for this purpose actuate the actuating element after the transponder issued a warning about an approaching train. After the personnel to be warned acknowledged the warning signal of the mobile transporter using the element, the mobile transponder transmits a near range acknowledgment signal that can be received by the mobile unit.

[0025] The mobile unit is in this case advantageously equipped such that it can determine the number of transponders having received the near-range warning signal. The number of so-called active transponders is in this case determined as a function of the received near range acknowledgment signals such that the mobile unit can determine how many personnel have reacted to the collision warning using the mobile transponders.

[0026] It is then, for example, conceivable that the mobile unit is equipped to compare the number of transponders that have acknowledged the collision warning with a predetermined number of personnel exposed to a collision risk.

[0027] It is advantageous when the mobile unit is equipped to transmit a collision status signal as a function of the determined number of actuated transponders or as a function of the comparison with a predetermined number of personnel equipped with a transponder. For this purpose, the mobile unit has a transmitter unit that can transmit the collision status signal to the rail-bound vehicle with which a collision risk is imminent. For this purpose, the stationary unit of the rail-bound vehicle has a corresponding receiving unit, or has a connection to such a receiving unit, in order to receive such a collision status signal. As a result, it is possible that a return message can be transmitted to the rail-bound vehicle based on which the train can determine a potential collision risk with the construction crew.

[0028] It is then, for example, conceivable that the vehicle operator can be warned about a collision with the construction crew based on such a collision status signal when the collision status signal indicates that not all personnel have acknowledged the collision warning using the transponder. It is then without limitation also conceivable that the vehicle can then be automatically slowed down to avoid a collision resulting in personal injury. Using this method, the risk of a collision of a rail-bound vehicle with a construction crew can be drastically reduced.

[0029] It is however also conceivable that the mobile unit is designed so small and transportable such that it is suited to be arranged on or attached to a person to be warned. A further additional transponder is not required in this case because the mobile unit can perform the warning function of the person.

[0030] The task is also solved according to the invention by a mobile unit described above.

[0031] The task is furthermore solved according to the invention with the aforementioned mobile transponder.

Exemplary Embodiments

[0032] The present invention is discussed in detail based on examples using the enclosed drawings. The drawings show in:

[0033] Fig. 1 – a schematic representation of the warning device with a mobile unit,

[0034] Fig. 2 – a schematic representation of the warning device with a mobile unit and a plurality of mobile transponders.

[0035] Fig. 1 shows an example of a train collision warning device for warning of a collision risk between a plurality of persons **1** and a rail-bound vehicle **2**. The train collision warning device in this case comprises a stationary unit **3**, which is arranged on the rail bound vehicle **2**, and a mobile unit **4**, which is arranged in the proximity of the personnel **1** to be warned. It is then, for example, conceivable that the personnel **1** are a construction crew performing work on the track section. The mobile unit **4** is then set up in the proximity of the track section and the construction crew such that any light and audio warning signals from the mobile unit **4** can be perceived by the personnel **1** to be warned.

[0036] The stationary unit **3** arranged on the rail-bound vehicle **2** is in this exemplary embodiment connected to a GNSS sensor (global navigation satellite system) **5** and to a travel detection unit **6** to determine the current travel information and the position of the rail-bound vehicle, the vehicle speed, the current direction of travel, and the track occupied by the rail-bound vehicle **2**. The stationary unit **3** is also connected to a transmission unit **7** such that the travel information determined by the stationary unit **3** is transmitted using a corresponding radio signal **8** that transmits the data packets containing the current travel information. This radio signal **8** is preferably transmitted with the broadcast method such that it can be received in a certain radius about the rail-bound vehicle **2**.

[0037] The mobile unit 4 set up in the proximity of the personnel 1 has a corresponding receiving unit 9 to receive the radio signal 8 transmitted by the stationary unit 3 using the transmission unit 7 when the mobile unit 4 is located in the transmission radius of the rail-bound vehicle 2. In this example, the mobile unit 4 is furthermore also equipped with a GNSS sensor 10 to autonomously determine the current position of the mobile unit 4. The mobile unit 4 also has a light signal facility 11 that is enabled when the mobile unit 4 has detected a collision risk with a rail-bound vehicle 2 based on the radio signals 8 transmitted by the rail-bound vehicle 2 and the travel information contained in these.

[0038] Based on the fact that the mobile unit 4 is arranged in the proximity of the personnel 1 to be warned, the light signal emitted by the mobile unit 4 using the light signal facility 11 can be perceived such that the personnel 1 becomes aware that a rail-bound vehicle 2 is approaching their position. It is in this case conceivable that the light signal facility 11 to emit different light signals (frequency, color) to signal different warning levels. Such a light signal facility 11 can, for example, be an omni-directional light known from the prior art.

[0039] When a rail-bound vehicle 2 now approaches the position of the mobile unit 4 or that of the personnel 1 to be warned, the radio signal 8 transmitted by the rail-bound vehicle 2 is received by the mobile unit 4. The mobile unit 4 now extracts from this radio signal 8 the travel information contained therein of the rail-bound vehicle 2 and correspondingly compares said information to its own information in order to determine a collision risk. If the mobile unit 4 now determines that the rail-bound vehicle is on a collision course with the personnel 1, a corresponding warning signal is now generated so that the personnel 1 can clear the hazard zone. After the rail-bound vehicle 2 has passed the hazard location, the mobile unit 4 detects that the rail-bound vehicle 2 no longer presents a collision risk, therefore canceling a corresponding collision warning. The personnel 1 can now reenter the hazard zone, for example, to continue the work.

[0040] Fig. 2 also shows the basic structure of a train collision warning device with a mobile unit, as described in Fig. 1. However, the mobile unit 4 in the exemplary embodiment shown in Fig. 2 additionally has a near range transmission and receiving unit 12. Moreover, the personnel 1 to be warned are equipped with a mobile transponder 13 that can, for example, be worn on the wrist in the form of a wristwatch. The mobile transponder 13 is in this case able to warn the personnel 1 by acoustic, optical, or haptic means, that is to say, by emitting a corresponding warning signal.

[0041] If the mobile unit 4 now detects a collision risk with a rail-bound vehicle 2, the mobile unit 4 relies on the near-range transmitter 12 to transmit a near-range warning signal 14 that can be received by the mobile transponders 13. A corresponding acoustic, optical, or haptic signal is now generated as a function of this near-range warning signal to warn the personnel 1 about an imminent collision with a rail-bound vehicle 2. This has the advantage that the mobile unit 4 can also be set up outside of visual and audio range of the personnel 1 to be warned.

[0042] In the exemplary embodiment Fig. 2, the mobile transponders 13 have an actuation button that can be pressed when a corresponding warning signal was received by the mobile transponders 13. After this actuation button was pressed by the personnel 1 to be warned in response to a warning signal, a corresponding near-range acknowledgment signal 15 is sent to the mobile unit 4 that can be received by the near-range transmission and receiving unit 12.

[0043] Based on this acknowledgment message 15, the mobile unit 4 can now determine the number of acknowledgments 15 to infer the number of personnel who have reacted to the warning signal 14. The mobile unit 4 can now compare the number of personnel who reacted to the acknowledgment signal 15 to a predetermined number of personnel expected to be present in the hazard zone. If the number is identical, all personnel 1 have reacted to the acknowledgment signal 15. However, if the number of acknowledgments is less than the predetermined number of personnel, not all personnel have reacted to the warning signal, and the assumption can be made that a warning signal was not heard.

[0044] If it was determined that such a warning signal was not heard by at least one person 1, it is now conceivable that the mobile unit 4 in turn relies on a corresponding transmission unit to transmit a radio signal to the rail-bound vehicle 2 to notify the latter that the hazard zone is not yet clear of personnel 1. The stationary unit 3 on the rail-bound vehicle 2 can then for example be connected to a display unit 16 in the operator cab of the vehicle operator 17 to display to the latter that there is an imminent collision risk with personnel. The vehicle operator 17 can then initiate appropriate measures.

[0045] But it is also conceivable that the stationary unit 3 is connected to the internal electronics of the rail-bound vehicle 2 and is equipped to automatically slow down the rail-based vehicle 2 when a corresponding message was received from the mobile unit 4.

[0046] The following tables once again highlight the sequence of events to avoid an accident with a train, for example at a construction site.

Collision risk with a train in the same track

stationary Unit		mobile Unit		Transponder
Send current travel information	=>	Receive current travel information and determine collision risk		
		Send a near-range warning signal	=>	Receive the near-range warning signal
				Trigger an acoustic/optical/haptic warning
		Receive the acknowledgment signal and determine the number of acknowledgments	<=	Person presses acknowledgment button and sends a near-range acknowledgment signal
Send current travel information	=>	Receive current travel information and determine collision risk		
		Send instructions to clear the track	=>	Receive the instructions
				Trigger an acoustic/optical/haptic instruction to clear the track
		Receive the acknowledgment signal and determine the number of acknowledgments	<=	Person clears the track and presses acknowledgment button; a near-range acknowledgment signal is sent
Receive warning signal and trigger warning for the train operator	<=	Send a warning if not all persons have cleared the track		
Receives signal and if appropriate cancels the warning for the train operator	<=	Send a "Track clear" signal when all persons have cleared the track		

All-clear message after the train has passed

stationary Unit		mobile Unit		Transponder
Send current travel information	=>	Receive the current travel information and determine that a collision risk no longer applies		
		Send an all-clear signal	=>	Receive the all-clear signal
				Trigger an acoustic/optical/haptic all clear signal
		Receive the acknowledgment signal and determine the number of acknowledgments	<=	Person presses acknowledgment button and sends an acknowledgment signal

CITATIONS INCLUDED IN THE SPECIFICATION

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Patent Literature Cited

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- US 2004/0267415 A1 [0005]
- DE 19840715 C2 [0007]
- DE 19847292 A1 [0008]
- EP 0905528 A2 [0009]
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Patent Claims

1. A train collision warning device to warn of a collision risk between a rail-bound vehicle (2) and at least one person (1), wherein the warning device comprises a stationary unit (3) that is equipped to be arranged on the rail-bound vehicle (2) and to transmit radio signals (8) containing current travel information using a transmission unit (7) that has a connection to the stationary unit (3), **characterized in that** the warning device furthermore comprises a mobile unit (4) with a receiving unit (9) provided to be arranged in the proximity of at least one person (1) and to receive the transmitted radio signals (8) using the receiving unit (9), wherein the mobile unit (4) is equipped to determine a collision risk between the rail-bound vehicle (2) transmitting the radio signals (8) and the at least one person (1) located in the proximity of the mobile unit (4) as a function of the travel information contained in the received radio signals (8) and to warn the at least one person (1) as a function of the determined collision risk.
2. The warning device according to claim 1, characterized in that the travel information contains the current vehicle position, the current vehicle speed, and the current direction of travel.
3. The warning device according to claim 1 or 2, characterized in that the stationary unit (3) has a connection to a travel detection unit (6) arranged on the rail-bound vehicle (2) to determine the current travel information.
4. The warning device according to any of the above claims, characterized in that the stationary unit (3) has a connection to a rail track identification unit to determine the rail track currently occupied by the rail-bound vehicle (2) as travel information.
5. The warning device according to any of the above claims, characterized in that the mobile unit (4) is equipped to issue warnings using acoustic, optical (11) and/or haptic signals
6. The warning device according to any of the above claims, characterized in that the warning device furthermore comprises at least one mobile transponder (13) provided to be arranged on a person (1) to be warned and to receive a near-range warning signal (14) transmitted by the mobile unit (4) as a function of the collision risk.
7. The warning device according to claim 6, characterized in that the near-range warning signal (14) is a signal based on a near-range radio technology.
8. The warning device according to claim 6 or 7, characterized in that the mobile transponder (13) is arranged to warn the person (1) when receiving the near-range warning signal (14) by means of optic, acoustical, and/or haptic signals (11).
9. The warning device according to any of claims 6 to 8, characterized in that the mobile transponder (13) comprises an element actuated by the person (1), wherein the mobile transponder (13) is equipped such that a near-range acknowledgment signal (15) is sent to the mobile unit (4) when a near-range signal (14) is received and the element is actuated by the person (1) to be warned.
10. The warning device according to claim 9, characterized in that the mobile unit (4) is equipped to receive the near-range acknowledgment signal (15) and to determine the number of transponders (13) receiving the near-range warning signal (14) as a function of the received near-range acknowledgment signals (15).
11. The warning device according to claim 10, characterized in that the mobile unit (4) is equipped to compare a predetermined number of persons to the determine number of transponders (13) having acknowledged the near-range warning signal (14).
12. The warning device according to claim 10 or 11, characterized in that the mobile unit (4) furthermore comprises a transmission unit (9) and is equipped to transmit a collision status signal using the transmission unit (9) as a function of the determined number of mobile transponders (13) or as a function of the comparison.

13. The warning device according to claim 12, characterized in that the stationary unit (3) of the rail-bound vehicle (2) furthermore comprises a receiving unit (7) and is equipped to receive the collision status signal using the receiving unit (7).

14. The warning device according to claim 13, characterized in that the stationary unit (3) of the rail-bound vehicle (2) is equipped to warn a vehicle operator (17) and/or to automatically slow down the rail-bound vehicle (2) as a function of the collision status signal.

15. The warning device according to any of the above claims, characterized in that the mobile unit (4) is equipped to be arranged on a person (1) to be warned and to warn the person (1) as a function of the determined collision risk.

16. A mobile unit (4) to warn at least one person (1) of a collision as a function of a determined collision risk with a rail-bound vehicle (2) according to any of the above claims.

17. The mobile unit (4) according to claim 16, characterized in that the mobile unit (4) has an autonomous power supply.

18. The mobile unit (4) according to claim 16 war 17, characterized in that the mobile unit (4) comprises an integrated receiving unit (9).

19. A mobile transponder (13) to warn a person (1) when determining a collision risk with a rail-bound vehicle (2) according to any of claims 1 to 15.

2 sheets of drawings to follow

Enclosed Drawings

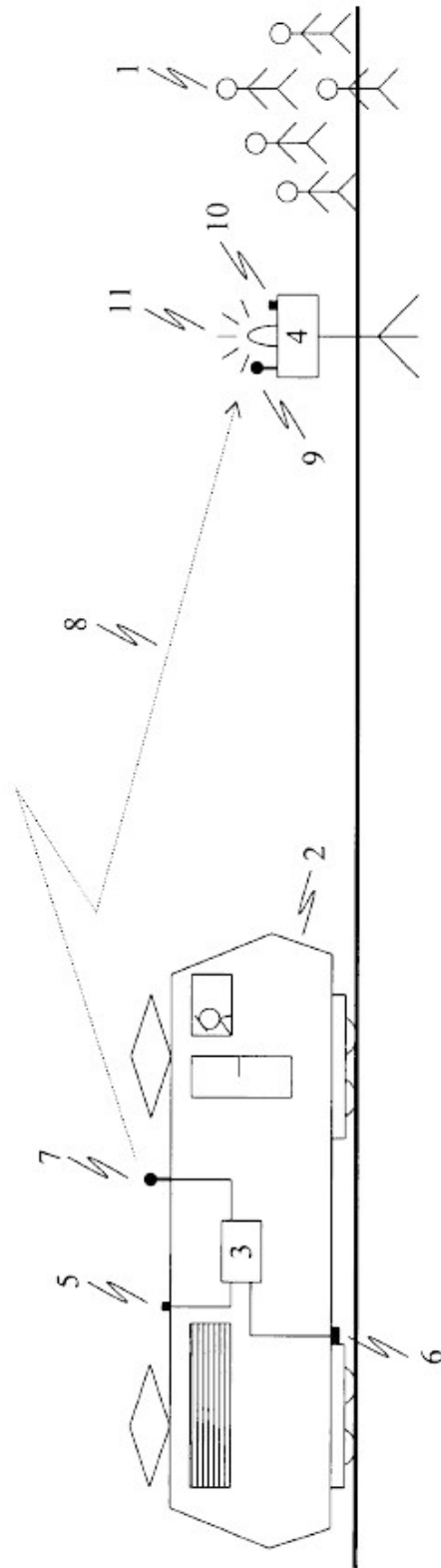


Figure 1

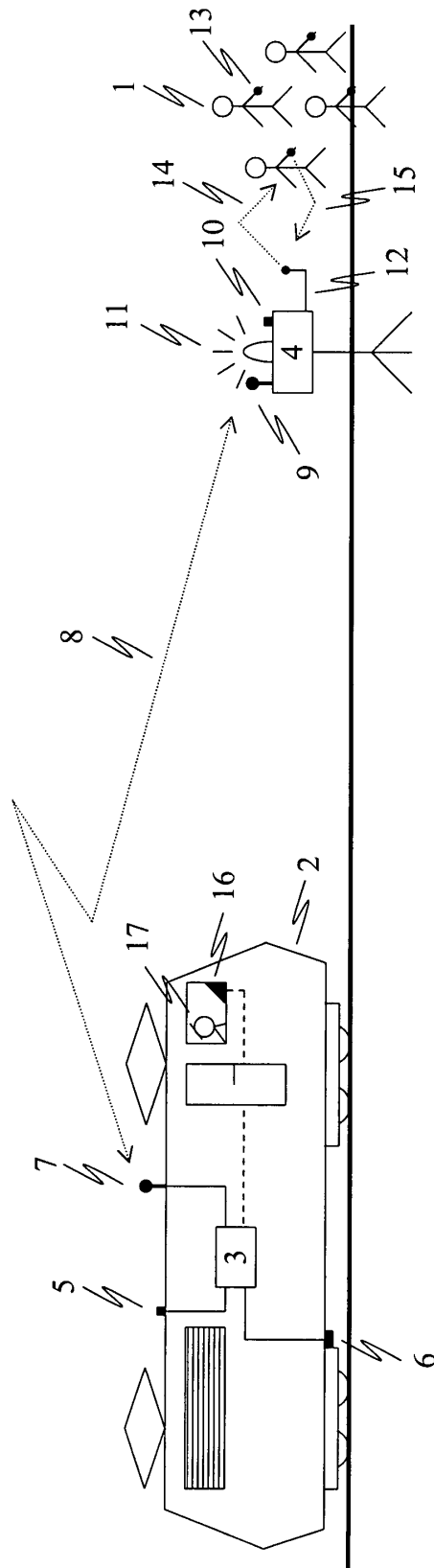


Figure 2