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(54) Communication system for vehicles particularly railway vehicles or the like and stationary units

(57) Communication system for vehicles, particularly railway vehicles or the like and stationary units, which system provides:
equipment on each railway vehicle which so called on-board equipment is associated to a section transmitting signals interrogating at least one or more operating stationary units each one provided at one of various predetermined locations of the vehicle route and particularly of the railway line and which equipment is associated to a section receiving reply signals of at least one or more operating stationary units that have been interrogated, while operating stationary units are provided with receiving/transmitting means for receiving interrogation signals and for transmitting reply signals.

According to the invention, the transmission section of the equipment on a vehicle produces an interrogation signal composed of a carrier wave that is frequency-modulated according to a modulation key corresponding to a univocal identification code of the railway vehicle or the like that is different and unique for each vehicle, while receiving/transmitting means of operating stationary units receive said interrogation signal and re-transmit it to the receiving section associated to the on-board equipment adding the signal contribution containing reply information of the corresponding operating stationary unit in the form of a carrier modulation by said reply information to the signal received and frequency-modulated with the vehicle identification code.

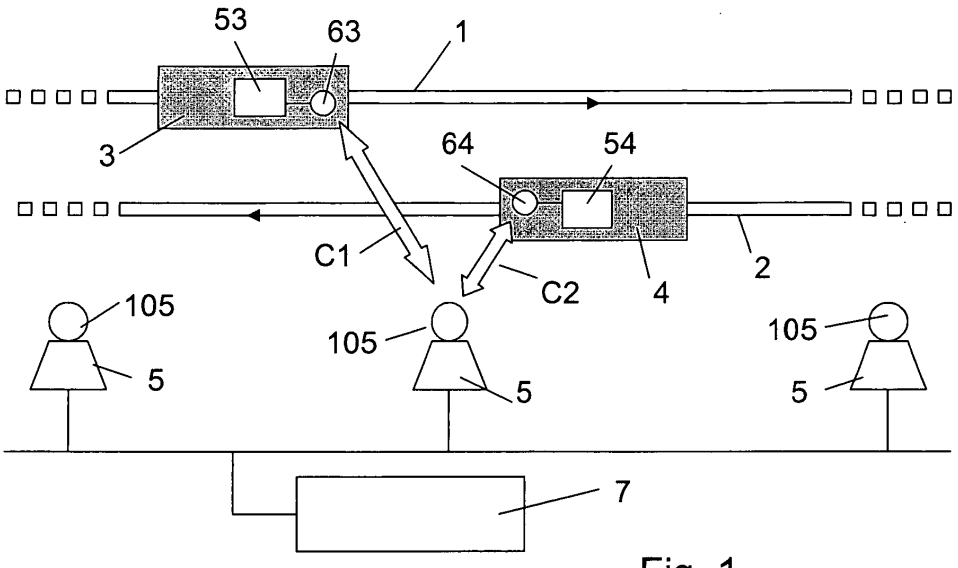

Fig. 1

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Description

[0001] Communication system for vehicles particularly railway vehicles or the like and stationary units and communication antenna for said system.

[0002] Communication system for vehicles, particularly railway vehicles or the like and stationary units, which system provides:

> equipment on each railway vehicle which so called on-board equipment is associated to a section transmitting signals interrogating at least one or more operating stationary units each one provided at one of various predetermined locations of the vehicle route and particularly of the railway line and which equipment is associated to a section receiving reply signals of at least one or more operating stationary units that have been interrogated, while operating stationary units are provided with receiving/transmitting means for receiving interrogation signals and for transmitting reply signals.

[0003] Communications between operating stationary units particularly so called balises of railway networks and vehicles, particularly trains, or the like are known.

[0004] Communications occur between said operating stationary units and on-board equipment or systems placed on vehicles and intended for controlling travel conditions of the vehicle.

[0005] When two vehicles, such as two trains moving along adjacent tracks, pass at a balise, so called cross talk communication can occur (cross talk).

[0006] The present invention is based on the problem of overcoming the above mentioned drawback allowing a communication signal to be univocally correlated to one of the two or more vehicles and thus avoiding the cross-talk phenomenon or the like.

[0007] A further problem in the railway field is to monitor the system or a device in such a way to provide high safety level and to allow vital block actions to be performed guaranteeing the safety condition and management of the traffic.

[0008] The invention solves the above drawbacks by providing a system of the type described hereinbefore, wherein the transmission section of the equipment on a vehicle generates an interrogation signal composed of a carrier wave that is frequency-modulated according to a modulation key corresponding to a univocal identification code of the railway vehicle or the like that is different and unique for each vehicle,
while receiving/transmitting means of operating stationary units receive said interrogation signal and re-transmit it to the receiving section associated to the on-board equipment adding the signal contribution containing the reply information of the corresponding operating stationary unit as a carrier modulation with said reply information according to a modulation protocol of the DPSK type to the signal received and frequency-modulated by the vehicle identification code.

[0009] By means of above characteristics, the on-board equipment is able to check if reply signals received from one or more operating stationary units are the one intended for the vehicle upon which said equipment is provided. Therefore in the case of two trains travelling for example on two adjacent tracks, the communication between a train and a stationary unit is not took for or it does not interfere with the communication between the other train and said operating unit. The fact of frequency encoding by means of a key composed of an identification code univocally associated to a vehicle and the fact of transmitting back the not modified interrogation signal from the operating stationary unit to the vehicle allows the consistency of the train identification code to be checked upon reception by the receiving section associated to the equipment.

[0010] According to an improvement such check is carried out automatically and according to safety criteria of the two on two type (2oo2). In this case the system according to the present invention provides, in addition to said first section receiving the reply signal transmitted by the operating stationary unit or units, even a second receiving section associated to the equipment which is separated and independent from said first section receiving the reply signal from the operating stationary unit or units and which second receiving section is intended for capturing in the air, directly the interrogation signal transmitted from the transmission section associated to the equipment and which said second receiving section has means for extracting the modulation key and that is the univocal identification code of the vehicle upon which the equipment is placed from the received interrogation signal.

[0011] The fact of extracting the modulation key and that is the univocal identification code of the vehicle upon which the equipment is placed can occur for example by providing the unmodulated carrier coming from means generating it to said second receiving section and basing on such carrier the interrogation signal can be processed for extracting the modulation key and that is the univocal identification code of the vehicle.

[0012] The vehicle identification code obtained by extracting the modulation key of the interrogation signal is transmitted to a comparison unit that can be combined or being part of the equipment.

[0013] The first section receiving the reply signal from on-board stationary unit or units has means independent from the ones of the second receiving section intended for receiving and extracting from the reply signal the component of said reply signal corresponding to the carrier modulated by the DPSK protocol with information to be transmitted to the vehicle and for extracting said information, while the signal corresponding to the carrier modulated by the key corresponding to the univocal identification code of the vehicle and coming from the modulator is provided also to said first receiving section and it is used for separating the retransmitted component of the

interrogation signal from the reply signal and so for separating said signal component corresponding to or carrying the information provided by the operating stationary unit.

[0014] Therefore in this case, the consistency of the identification code of the vehicle and particularly of the train occurs twice and independently. The first check is performed by capturing the interrogation signal transmitted from the transmission section and extracting from said signal the code by a specific dedicated receiving section, while the second check is carried out by using the interrogation signal, that is the carrier frequency-modulated by the modulation key corresponding to the univocal identification code of the vehicle from the modulator, that is to say said signal is provided to the receiving section for separating the component corresponding to the interrogation signal and the component relevant to information transmitted and modulated by DPSK protocol on the carrier from the reply signal of operating stationary unit or units and so for extracting said information.

[0015] According to a specific embodiment, the system according to the invention comprises a first transmission chain, a first receiving chain and a second receiving chain.

[0016] Such principle can be carried out in different ways.

[0017] Furher improvements of the system mentioned above are included in the independent claims.

[0018] A particular and advantageous characteristic provides the interrogation signal to be composed of the carrier encoded by FSK modulation (Frequency Shift Keying) using the univocal identification code of the vehicle and particularly of the railway vehicle as the encoding key and so as the modulation key.

[0019] Such code for example comprises information about the type of vehicle and the registration number of such vehicle.

[0020] The invention relates also to a method for the communication between vehicles and particularly railway vehicles or the like and stationary units, wherein each vehicle has an equipment provided with means for communicating with one or more operating stationary units provided with communication means.

[0021] In order to univocally identify that information received from an operating stationary unit are relevant to the vehicle, if two or more vehicles are contemporaneously travelling, the present invention provides the following steps:

a) upon transmission, by equipment mounted on said vehicle, generating a signal interrogating one or more operating stationary units consisting in encoding a carrier by a frequency modulation using a encoding or modulation key corresponding to a univocal identification code of the vehicle;

b) upon reception by said equipment, receving a reply signal of operating stationary unit or units and receiving the interrogation signal and separately demodulating the reply signal for extracting useful information and demodulating the received interrogation signal for extracting the modulation key and so the univocal identification code of the vehicle;

c) checking the consistency between the identification code identified at step b) and the identification code of the vehicle used for modulating the interrogation signal.

[0022] With reference to said method subclaims relate to further improvements that will be clear also from the shown embodiment.

[0023] Moreover the invention relates to a terminal for the communication between equipment mounted on a vehicle particularly a railway vehicle and at least an operating stationary unit provided with a communication unit;

which communication unit of equipment mounted on the vehicle comprises

a section for generating and transmitting a signal interrogating operating stationary unit or units from equipment, that is from the vehicle to said operating stationary unit, which interrogation signal is obtained by means of modulation using a univocal identification code of the vehicle as the modulation key;

a first unit receiving a reply signal from the operating stationary unit or units provided with means for extracting/demodulating information required by equipment to operating stationary unit or units and transmitted to equipment therefrom;

a second receiving section separated from the first one and provided with its own means for extracting/demodulating the univocal identification code of the vehicle from the interrogation signal transmitted from the generation and transmission section;

means for checking the consistency between the vehicle identification code obtained by the second receiving section and the vehicle identification code used for generating the interrogation signal.

[0024] Particularly the communication terminal is composed of a receiving antenna and a transmitting antenna to which there are associated circuits forming the first transmission section, the first and the second receiving section and possibly but not necessarily means for checking the consistency between the vehicle identification code extracted from communication and compared with the identification code used for generating the interrogation signal.

[0025] Said means can be manufactured in different ways. Subclaims relate to further improvements of said communication terminal relevant to a preferred and advantageous embodiment.

[0026] As it will be more clear in the following, advantages of the present invention are that cross talk conditions between two travelling trains interrogating a balise are avoided. Thus data provided by the balise for one of the two vehicles are not sent to the other vehicle not expecting said data generating potential dangerous or

malfunction situations. Moreover the system allows a communication free from cross talk to be obtained providing a step univocally identifying the receiver of information that is carried out according to high safety criteria (level SIL4) the consistency of the identity of the vehicle to which the communication is addressed, that is the reply from operating stationary unit. Particularly the consistency of the vehicle identity to which reply from operating unit or units is addressed is verified basing on the consistency between the identification code transmitted with the interrogation signal by the fact of using it as the modulation key, and the identification code received and detected by a specific and independent section receiving and extracting said code.

[0027] Considering the manufacturing point of view, the communication device comprises a simple circuit providing the section generating and transmitting the signal interrogating operating stationary units, the first and the second receiving sections. Such circuit can be made on a common terminal board that can be integrated in a transmitting and receiving antenna device having said electronic circuit in combination near the real antenna. As regards equipment to which information are addressed some slight additions are required such as a central processing unit for executing a software able to compare identification code and able to perform diagnostic actions and having memories required for storing the identification code and the software.

[0028] Further improvements are object of subclaims.

[0029] Characteristics of the invention and advantages deriving therefrom will be more clear from the following description of a non limitative embodiment shown in annexed drawings wherein:

Fig.1 schematically is a system according to the present invention working in a railway traffic control system.

Fig.2 is a block diagram of the on-board unit together with the communication device according to the present invention.

Fig.3 is a block diagram of the communication device according to the present invention and of the arrangement of the three communication sections as well as the diagnostic unit that are integrated on a common board or a common printed circuit.

Figures 4 to 6 separately are the enlarged transmission section, the second receiving section and the first receiving section respectively.

Figure 7 is diagnostic sections.

[0030] With reference to figure 1 it shows a railway traffic control system wherein a communication system according to the present invention is provided. The fact of using it for the communication between trains and operating stationary units is not a limitation, but it is a preferred example for using the system according to the present invention.

[0031] This figure shows two tracks 1, 2 with two trains 3, 4 travelling thereon. Along the railway line, that is along the two parallel tracks, there are provided at least one or more operating stationary units denoted by 5 which are intended for communicating by radio with on-board equipment 53, 54 placed on both vehicles, particularly trains 3 and 4. Each equipment 53 and 54 has a communication section 63 and 64 for transmitting and receiving signals from one or more of said operating stationary units 5 provided with communication units 105 for transmittng and receiving signals. In the railway field operating units are called balises.

[0032] In a particular embodiment such as the one used for railway traffic, communication units of operating stationary units 5 are of the type known as repeater or transponder and reflect the modulated carrier transmitted from communication sections 63, 64 thereto adding information on the reflected signal by a predetermined modulation of said reflected signal.

[0033] Information transmitted from operating units are managed by control means of the railway plant generally denoted by the box 7.

[0034] In order to avoid communication between the two trains and the operating unit denoted by arrows C1 and C2 to interfere one with the other, thus generating error conditions, the invention provides to univocally encode the communication using a frequency modulation called Frequency Shift Keying FSK and using a univocal identification code of the vehicle upon which the communication section and equipment is mounted as the modulation key.

[0035] In this case, the communication unit of each vehicle comprises a transmission section generating a signal interrogating operating stationary units which signal is a carrier modulation by frequency modulation and particularly under FSK mode by using the univocal identification code of the vehicle as the encoding key of the modulation.

[0036] The interrogation signal modulated in this way carries information univocally identifying the vehicle transmitting said signal. The interrogation signal is received by the communication unit of operating stationary units, which communication unit is advantageously composed of a transponder generating a reply signal composed of two components one being the interrogation signal that is simply reflected and the other component being the information modulated on the carrier according to a predetermined protocol and particularly a DPSK protocol.

[0037] In figure 2 the equipment 53, 54 and the communication section 63, 64 as well as the transmitting dipole 73, 74 and the receiving dipole 83, 84 are shown.

[0038] The communication section has the transmission section 10 connected to the transmitting dipole 73, 74 and receiving the identification code for the vehicle from a memory 11 provided inside the equipment 53, 54. The receiving dipole 83, 84 is connected to the input of the double receiving section. Particularly said receiving dipole is connected to a section receiving the reply signal

of the operating stationary unit denoted by 12 and to a section receiving the interrogation signal directly received by the transmitting dipole, which second receiving section is denoted by 13.

[0039] The output from the first receiving section 12 provides information that is transmitted to operating units of the equipment 53, 54 generally denoted by 14. The output from the second receiving section 13 provides the identification code for the vehicle that is transmitted to a consistency comparing and checking unit 15 which compares the code detected by the receiving section 13 with the one stored inside the memory 11.

[0040] If there is no consistency between the identification code of the vechicle stored inside the equiment 53, 54 and the one detected upon reception by the second receiving section 13, that is between the transmitted code and the received one the equipment or a dedicated section rejects received information and so the fact that information transmitted with a reply signal of an operating stationary unit is just the one for the receiving vehicle is guaranteed.

[0041] According to a further advantageous characteristic, the first receiving section 12 intended to extract the signal component relevant to information and so information from the reply signal separates the reply signal component composed of the interrogation signal reflected by the transponder of the operating stationary unit 5 by the fact that it receives (line 16) said component from the transmission section 10 the output from the modulated carrier generator being connected to the input of a mixer of the first receiving section 12, by means of which the reply signal component containing information provided from the operating stationary unit to the vehicle is separated, that is from the balise to the train.

[0042] By means of the above if the reply signal is the one intended for a different train with a different identification code, the first receiving unit 12 could not appropriately extract the reply signal component carrying information and so said information could not by extracted at least in the proper way.

[0043] Similarly the second receiving section 13 extracts the identification code of the train from the interrogation signal directly received from the transmission section 10 by air communication by means of dipoles of transmitting antenna 73, 74 and receiving antenna 83, 84 the output from the unmodulated carrier generator being provided to said section (line 17).

[0044] With reference to figures 3 to 7, there is shown in details an example of a communication device, that is an antenna or an antenna subsystem according to the present invention.

[0045] The antenna is one of the subsystems inside a train. It is composed of a mechanical housing, containing the defrosting device, inner electronics made of only one printed circuit, whose architecture is shown in figure 3. The inner board shown in figure 3 is composed of a microwave front-end generating a radiofrequency carrier at FM modulated-frequency of 5.810 GHz or 5.750 GHz, and it carries out a down conversion at frequency of 10,7 MHz (IF1) or 13 MHz (IF2).

[0046] In order to carry out such operation, the RF carrier is frequency-modulated by the antenna by a univocal code transmitted by the receiver, that is the equiment 53, 54; such carrier, that is FM modulated, is transmitted from the transmission section TX to the transponder of an operating stationary unit, so called balise, which replys by overlapping information of the balise to the received interrogation signal. Such reply signal, containing the interrogation signal as a FM modulation code and information of the balise under DPSK modulation, reaches the first receiving section Rx, and on the base of the code received from the equipment 53, 54 that is from the memory 11 thereof, the demodulation section demodulates the received signal obtaining information of the balise 5 and the identification code.

[0047] From the general flow diagram it is possible to note the following signal paths:

- CODE - ANTENNA TX chain corresponding to transmission section 10
- ANTENNA RX - DETECTED SIGNAL chain corresponding to the second receiving section 13
- ANTENNA RX - IF OUT chain corresponding to the first receiving section 12
- Diagnostic and control

[0048] In figure 3 boxes show transmission and receiving sections 10, 12, 13 of figure 2. As regards the two receiving sections a branch in common to the two sections or chains is denoted by 18. While diagnostic section is denoted by box 21.

[0049] Figure 4 shows the transmission section 10 and so the signal path defined as CODE-ANTENNA TX chain.

[0050] The code transmitted to the antenna from memory 11 of equipment 53, 54 (Receiver) is converted into a sinusoidal oscillation by VCO 110, particularly: a generated frequency of 350 KHZ corresponds to the low logic level and 500 KHz correspond to the high logic level.

[0051] Signal from VCO 110 is transmitted to a IQ vectorial modulator 210 together with the carrier frequency obtained by the dielectric resonator oscillator (DRO) 310. Therefore the output from the modulator 210 is a frequency-modulated oscillation at 5.810 GHz or 5.750 GHz and, being appropriately amplified by an amplifier 410 and filtered of spurious components by a band-pass filter 510, is transmitted to the antenna dipole TX 73, 74 and to mixer 2 210 of the first receiving section 12 (figure 6).

[0052] The coupler RF 610 allows power spread out from antenna dipole TX 73, 74 to be detected and a POWER OUT signal to be generated and allows also a signal relevant to the possible power reflected back because of damages to the antenna or because of obstacles placed near it to be generated wich signal is denoted by AN-

TENNA ROS in figure 4.

[0053] Appropriately processed ANTENNA ROS and POWER OUT signals at outputs 710, 810 are transmitted to the microcontroller 20 of the diagnostic section as in figure 7.

[0054] Moreover the transmission section 10 has an output 910 where the carrier frequency signal is present provided by the dielectric resonator oscillator (DRO) 310 and an output 1010 of the modulator 210 at which output 1010 a frequency modulated oscillation at 5.810 GHz or 5.750 GHz is present, that is the frequency-modulated carrier transmitted from the transmitting antenna dipole 73, 74.

[0055] Figure 5 shows a constructive example of the chain: ANTENNA RX - DETECTED CODE , that is the second receiving section.

[0056] This section of the antenna subsystem functions for "extracting" the identification code from the signal received from the antenna dipole RX 83, 84 and for transmitting it to the checking section 15 of equipment 53, 54 (receiver) which transmits it to CPU board after having bit re-synchronized it.

[0057] The signal received by the antenna dipole RX 83, 84 is made of:

a) a FM modulated carrier that is the signal transmitted in air by the transmitting antenna dipole 73, 74
b) a FM modulated carrier + DPSK composed of reply signal of operating stationary unit 5.

the "a" contribution is the signal transmitted from the transmission section (CODE - ANTENNA DIPOLE RX chain) and directly captured by the antenna dipole RX (83, 84), while "b" contribution is the reply signal received by a transponder of an operating stationary unit that has been interrogated by equipment (RECEIVER) by transmitting an interrogation signal generated and transmitted from the transmission section 10.

[0058] The ANTENNA RX - DETECTED CODE chain, that is the second receiving section 13, has to detect the code transmitted "in the air" by the antenna dipole TX 73, 74. The captured signal is transmitted to the mixer 1 130 together with the unmodulated oscillation generated by DRO taken from the output 910 of the transmission section 10.

[0059] The output from mixer 1 130 passes through a lowpass filter 230 attenuating all signals having a frequency higher than 500 KHz. Therefore only two tones at 500 and 350 KHz still remain, that, once converted into voltage by the converter 330 are sent to a threshold comparator 430 providing a signal having low or high logic state depending on the fact if its input is higher or lower than the set threshold respectively. Thus it is possible to "associate" the high logic state to the 500 KHz signal and the low logic state to the 350 KHz signal. The detected code is transmitted to equipment 53, 54 that is to the consistency checking section 15.

[0060] Figure 6 shows in details an example for making the first receiving section aiming at extracting information.

[0061] As already described above, 2 contributions arrive to antenna dipole RX 83, 84:

a) FM modulated carrier
b) FM modulated carrier + DPSK modulated information

the "b" contribution is the reply signal of operating stationary units and generated by transponder when it is interrogated upon transmission of the interrogation signal.

[0062] ANTENNA DIPOLE RX - IF OUT chain converts the received signal at IF OUT frequency making possible the access to information in the following way: the signal received by the transponder of operating stationary unit reaches mixer 2 120 toghether with oscillation RF FM modulated by the code and provided by the output 1010 of the transmission section 10. The output from mixer 2 120, that is appropriately amplified by the amplifier 320 and filtered by filters 420 and 520, is composed only of a signal at a predetermined frequency that can be comprehended, interpreted and used by equipment for performing functions controlling the train travel or other functions such as merely displaying information.

[0063] With reference to figure 7, it shows schematically the diagnostic and control section.

[0064] Values of signals:

ANTENNA ROS
POWER OUT
SUPPLY DIAGNOSTIC
BOARD TEMPERATURE
HEATER TEMPERATURE

are sampled and stored in the microcontroller 20 which, once interrogated by equipment 53, 54 (Receiver) by a connection RS485, will reply transmitting values required for performing controls of functionalities and for generating warnings and/or for performing emergency actions.

Claims

1. Communication system for vehicles, particularly railway vehicles or the like and stationary units, which system provides:

equipment on each railway vehicle which so called on-board equipment is associated to a section transmitting signals interrogating at least one or more operating stationary units each one provided at one of various predetermined locations of the vehicle route and particularly of the railway line and which equipment is associated to a section receiving reply signals of at least one or more operating stationary units that have

been interrogated, while operating stationary units are provided with receiving/transmitting means for receiving interrogation signals and for transmitting reply signals,
characterized in that
the transmission section of the equipment on a vehicle produces an interrogation signal composed of a carrier wave that is frequency modulated according to a modulation key corresponding to a univocal identification code of the railway vehicle or the like that is different and unique for each vehicle,
while receiving/transmitting means of operating stationary units receive said interrogation signal and retransmit it to the receiving section associated to the on-board equipment adding the signal contribution containing the reply information of the corresponding operating stationary unit as a carrier modulation with said reply information to the signal received and frequency modulated with the vehicle identification code.

2. System according to claim 1, **characterized in that** the signal contribution containing reply information of the corresponding operating stationary unit is in the form of a carrier modulated with said reply information according to a modulation protocol of the DPSK type.

3. System according to claims 1 or 2, **characterized in that** it provides, in addition to said first section receiving the reply signal transmitted by the operating stationary unit or units, even a second receiving section associated to the equipment which is separated and independent from said first section receiving the reply signal from the operating stationary unit or units and which second receiving section is intended for capturing in the air, directly the interrogation signal transmitted from the transmission section associated to the equipment and which said second receiving section has means for extracting the modulation key and that is the univocal identification code of the vehicle upon which the equipment is placed from the received interrogation signal.

4. System according to claim 3, **characterized in that** said extraction of the modulation key and that is of the univocal identification code of the vehicle upon which the equipment is placed occurs by providing the unmodulated carrier from means generating it to said second receiving section and basing on such carrier the interrogation signal can be processed for extracting the modulation key and that is the univocal identification code of the vehicle.

5. System according to one or more of preceding claims, **characterized in that** the vehicle identification code obtained by extracting the modulation key of the interrogation signal is transmitted to a comparison unit that can be combined or being part of the equipment.

6. System according to one or more of the preceding claims 2 to 5, **characterized in that** the first section receiving the reply signal from on-board stationary unit or units has means independent from the ones of the second receiving section intended to receive and extract from the reply signal the component of said reply signal corresponding to the carrier modulated by the DPSK protocol with information to be transmitted to the vehicle and for extracting said information, while the signal corresponding to the carrier modulated with the key corresponding to the univocal identification code of the vehicle and coming from the modulator is provided also to said first receiving section and it is used for separating the component re-transmitted of the interrogation signal from the reply signal and so for separating said signal component corresponding or carrying information provided by the operating stationary unit, so the consistency between the transmitted vehicle identification code and the received one is checked twice and independently.

7. System according to one or more of the preceding claims, **characterized in that** it comprises a first transmission chain, a first receiving chain and a second receiving chain, the transmission chain being intended for generating a signal interrogating an operating stationary unit, which signal is composed of the carrier encoded by FSK modulation (Frequency Shift Keying) using the univocal identification code of the vehicle and particularly of the railway vehicle as the encoding key and so as the modulation key, while a chain receiving the interrogation signal transmitted in the air is provided for extracting the vehicle identification code by demodulating action the signal of the unmodulated carrier being directly provided to said chain from the output of a generator of said carrier and while a chain receiving and extracting information from a reply signal composed of a reflected component of the interrogation signal and a component of the signal modulated with the information is provided, which chain extracts information by using the interrogation signal, that is the modulated carrier from the modulator of the chain generating the interrogation signal.

8. System according to one or more of the preceding claims, **characterized in that** it comprises a section for checking the consistency of the vehicle identification code used as the modulation key of the interrogation signal between the transmitted code and the code received and extracted by the second receiving section.

9. Method for the communication between vehicles particularly railway vehicles or the like and stationary units, wherein each vehicle has equipment provided with means for communicating with one or more operating stationary units provided with communication means, which method, in order to univocally identify that information received from an operating stationary unit is relevant to the vehicle, if two or more vehicles are contemporaneously travelling, provides the following steps:

a) upon transmission, by equipment mounted on said vehicle, generating a signal interrogating one or more operating stationary units consisting in encoding a carrier by a frequency modulation using a encoding or modulation key corresponding to a univocal identification code of the vehicle;
b) upon reception by said equipment, receving a reply signal of operating stationary unit or units and receiving the interrogation signal and separately demodulating the reply signal for extracting useful information and demodulating the received interrogation signal for extracting the modulation key and so the univocal identification code of the vehicle;
c) checking the consistency between the identification code identified at step b) and the identification code of the vehicle used for modulating the interrogation signal.

10. Method according to claim 9, **characterized in that** it provides to directly receive the transmitted interrogation signal and to extract the univocal identification code of the vehicle by extracting the modulation key from the received interrogation signal.

11. Method according to claim 9 or 10, **characterized in that** it provides to check the consistency, that is the identity between the transmitted univocal identification code of the vehicle and the received one and/or the univocal identification code of the vehicle used as the modulation key and the one extracted from the transmission signal received or captured in the air.

12. Method according to one or more of the preceding claims, **characterized in that** operating stationary units generate a reply signal composed of a component corresponding to the interrogation signal reflected back and a component composed of a carrier modulated by information.

13. Method according to claim 12, **characterized in that** information is extracted from the reply signal using the interrogation signal, or the carrier frequency-modulated by the encoding key being the univocal identification code of the vehicle, which is mixed with the reply signal for extracting the reply signal component carrying information, information being extracted from said component.

14. Method according to claim 12 or 13, **characterized in that** the univocal identification code of the vehicle corresponding to the encoding key of the frequency-modulation of the carrier and being the interrogation signal is extracted by using a signal corresponding to said unmodulated carrier and mixing said signal with the received interrogation signal.

15. Terminal for the communication between equipment mounted on a vehicle particularly a railway vehicle and at least an operating stationary unit provided with a communication unit;
which communication unit of equipment mounted on the vehicle comprises
a section for generating and transmitting a signal interrogating operating stationary unit or units from equipment, that is from the vehicle to said operating stationary unit, which interrogation signal is obtained by means of modulation using a univocal identification code of the vehicle as the modulation key;
a first section receiving a reply signal from the operating stationary unit or units provided with means for extracting/demodulating information required by equipment to operating stationary unit or units and transmitted to equipment therefrom,
characterized in that it comprises
a second receiving section separated from the first one and provided with its own means for extracting/demodulating the univocal identification code of the vehicle from the interrogation signal transmitted from the generation and transmission section;
means for checking the consistency between the vehicle identification code obtained by the second receiving section and the vehicle identification code used for generating the interrogation signal.

16. Communication terminal according to claim 15, **characterized in that** it is provided in combination with at least an operating stationary unit to which the interrogation signal is transmitted and which operating stationary unit generates a reply signal composed of a component corresponding to the interrogation signal and a component corresponding to a signal modulated by information required by equipment.

17. Communication terminal according to claims 15 and 16, **characterized in that** it comprises at least a transmission antenna dipole and at least a receiving antenna dipole, the transmission antenna dipole being connected to the output of a transmission section comprising an input for a univocal identification code of the vehicle, means for converting said univocal identification code of the vehicle into a sinusoidal

oscillating signal and means for modulating a carrier wave with said oscillating, sinusoidal signal, the output of said modulation means provides the carrier frequency-modulated by a FSK modulation to the transmission antenna dipole and which encoding key is composed of the univocal identification code of the vehicle.

18. Communication terminal according to one or more of the preceding claims 15 to 17, **characterized in that** the receiving antenna dipole is connected to a first receiving section, which receiving section processes the reply signal of an operating stationary unit for extracting information transmitted from such unit to vehicle equipment whose interrogation signal has been transmitted to said operating stationary unit, and which first receiving section comprises a mixer to which the reply signal and the signal relevant to the frequency-modulated carrier coming from the modulator of the transmission section is provided, and the output of said mixer is filtered for extracting information from said reply signal, the reply signal received by said first receiving section and transmitted from the operating stationary unit being composed of a component corresponding to the interrogation signal transmitted to said operating stationary unit from the transmission section of the communication terminal and of a signal component to which information is associated by modulation.

19. Communication terminal according to one or more of preceding claims 15 to 18, **characterized in that** the receving antenna dipole is connected also to a second receving section, which receving section is intended for directly receving the interrogation signal transmitted from the antenna dipole of the transmission section and which interrogation signal is provided to a mixer together with the signal corresponding to the output of the carrier generator of the transmission section, while the mixer output is connected to a lowpass filter whose output is connected to a voltage converter, whose output supplies a threshold comparator for reconstructing the encoding key of the carrier modulation and so the univocal identification code of the vehicle.

20. Communication terminal according to one or more of the preceding claims 15 to 19 **characterized in that** the identification code of the vehicle is transmitted to a comparison section for checking the consistency between the code extracted from the interrogation signal by the second receving section and the univocal identification code used for modulating the carrier of the interrogation signal.

21. Communication terminal according to one or more of the preceding claims, **characterized in that** it constitutes an antenna subsystem comprising transmission and receiving antenna dipoles and circuits composing the transmission section, the first and second receving section and possibly means for checking the consistency between the identification code of the vehicle extracted from the communication and compared with the identification code used for generating the interrogation signal.

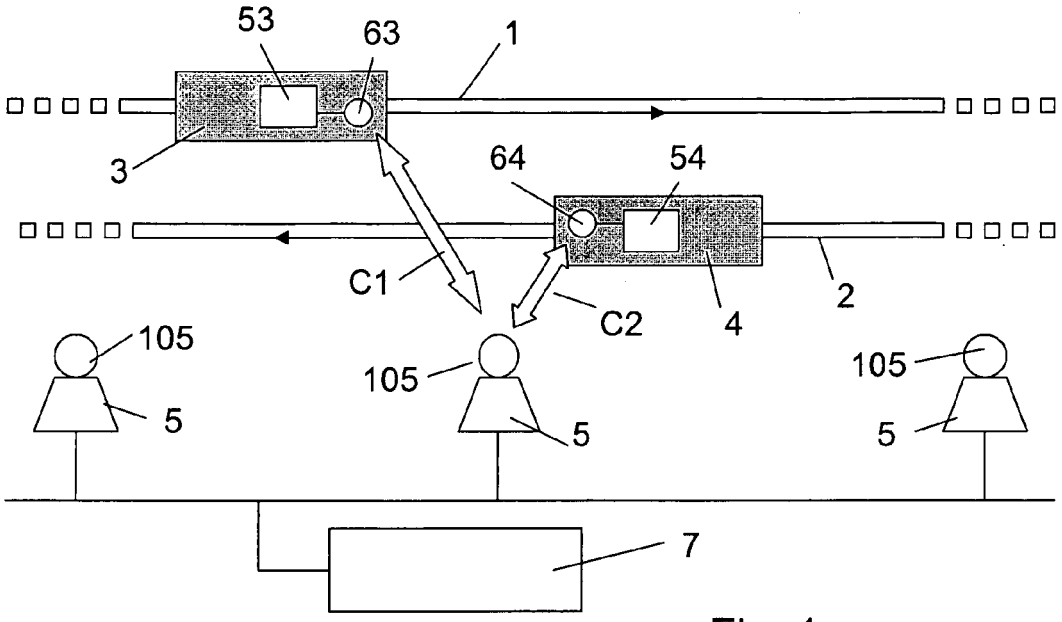
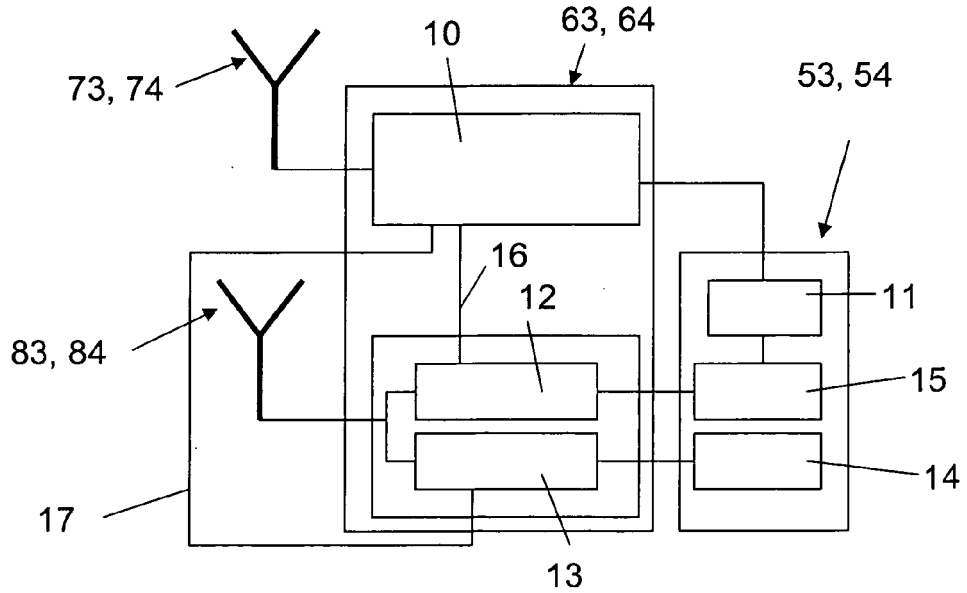

53
63
1
3
64
54
C1
C2
4
2
105
5
105
5
105
5
7

Fig. 1


73, 74
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63, 64
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16
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11
83, 84
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14
17
13

Fig. 2

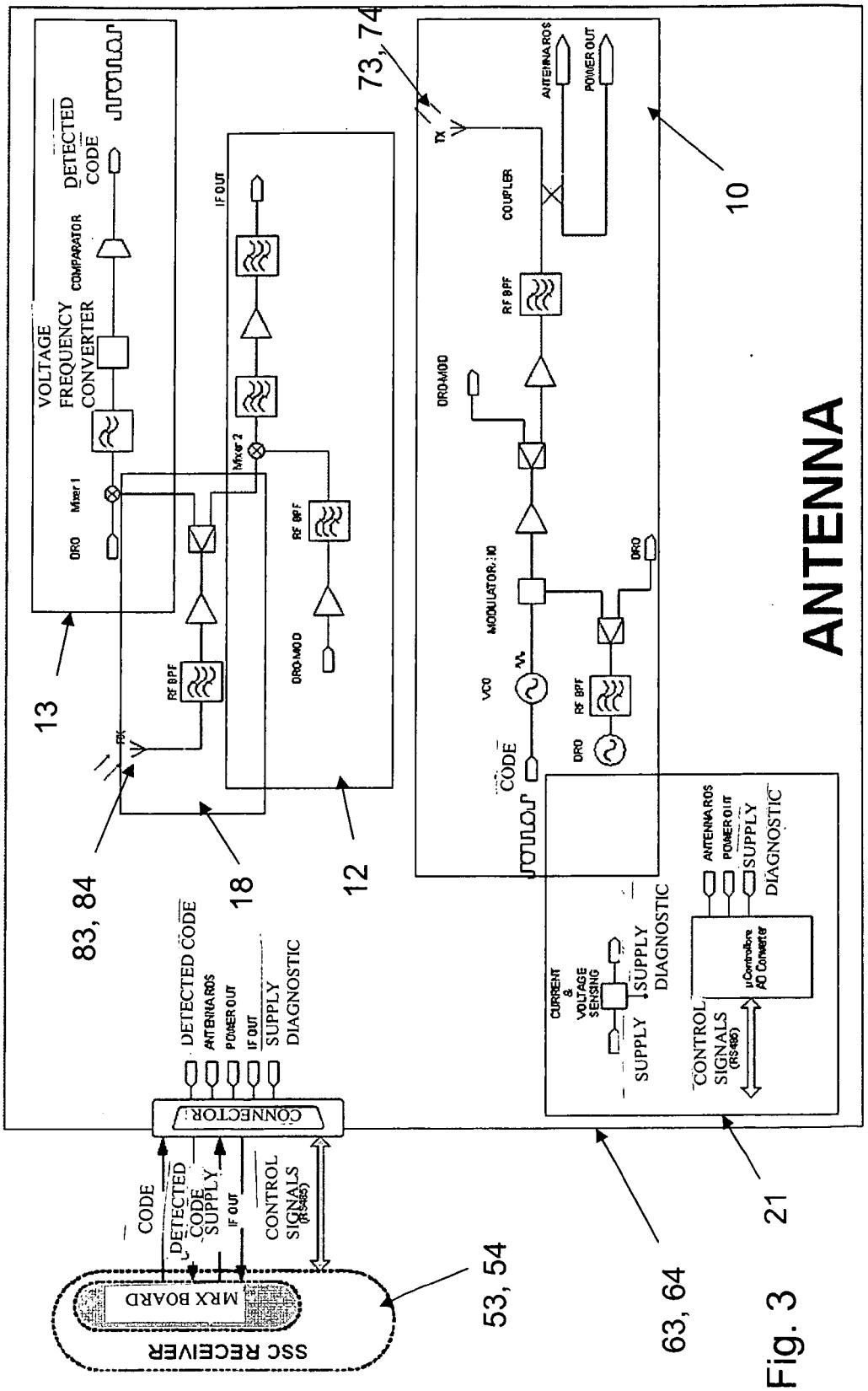
ANTENNA
SSC RECEIVER
MRX BOARD
CONNECTOR
CODE
DETECTED CODE
SUPPLY
IF OUT
CONTROL SIGNALS (RS485)
DETECTED CODE
ANTENNA ROS
POWER OUT
IF OUT
SUPPLY DIAGNOSTIC
VOLTAGE FREQUENCY CONVERTER
COMPARATOR
DRO
Mixer 1
Mixer 2
RF BPF
DRO-MOD
MODULATOR
VCO
COUPLER
TX
CURRENT & VOLTAGE SENSING
µController AD Converter
13
83, 84
18
12
73, 74
10
63, 64
53, 54
21

Fig. 3

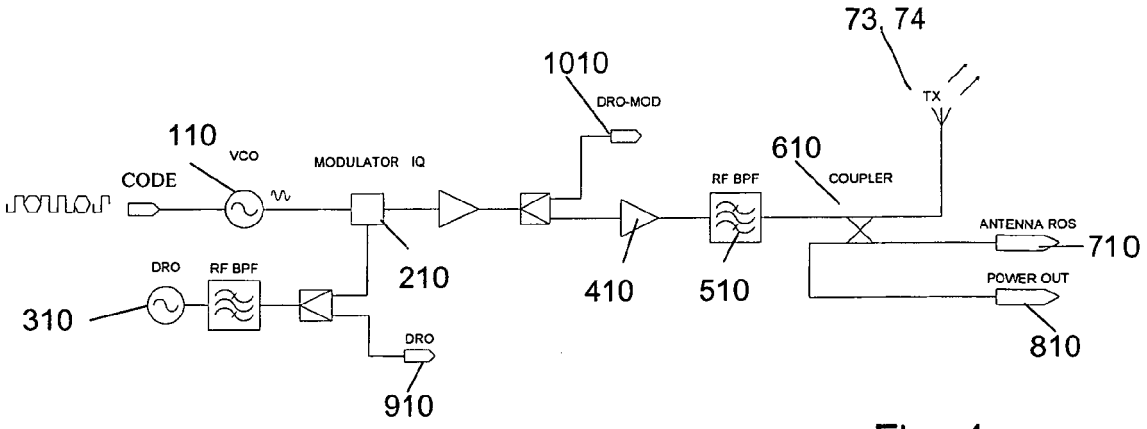

Fig. 4

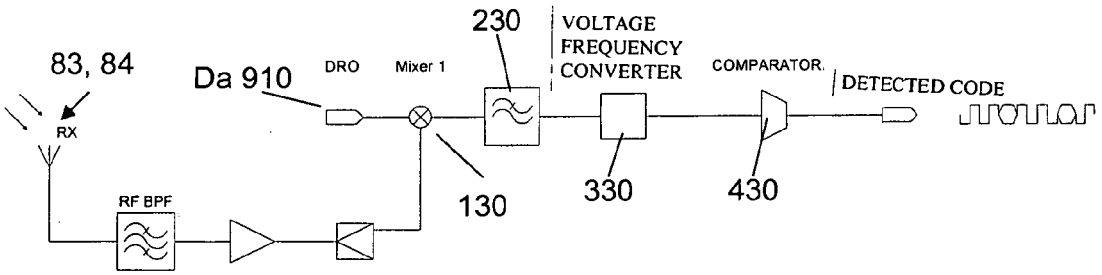

Fig. 5

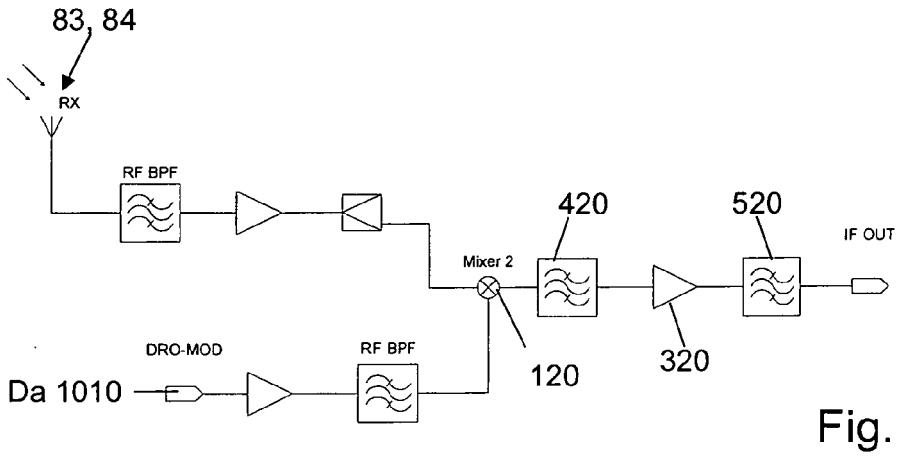

Fig. 6

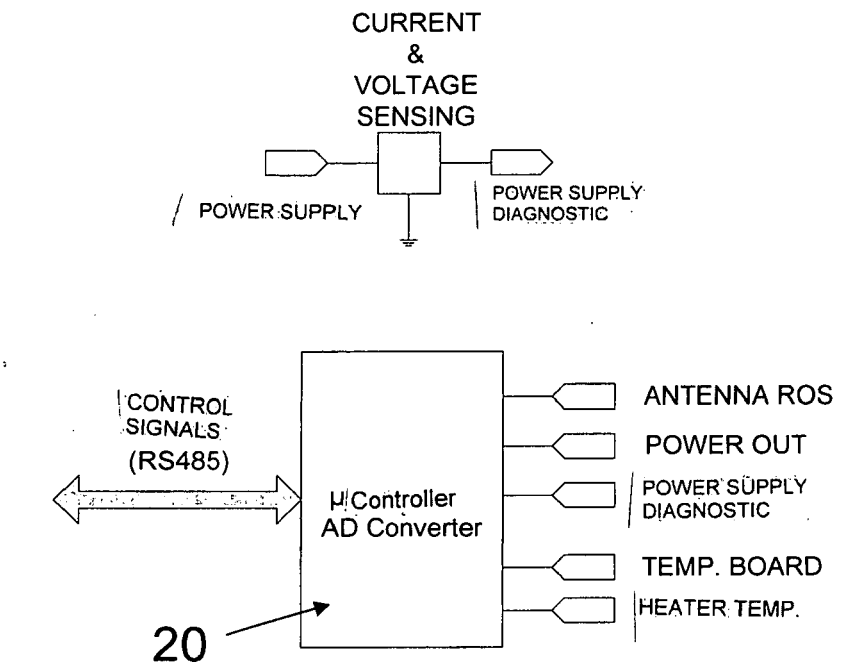
CURRENT
&
VOLTAGE
SENSING
POWER SUPPLY
POWER SUPPLY
DIAGNOSTIC
CONTROL
SIGNALS
(RS485)
µController
AD Converter
20
ANTENNA ROS
POWER OUT
POWER SUPPLY
DIAGNOSTIC
TEMP. BOARD
HEATER TEMP.

Fig. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 42 5516

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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